Modelling root system growth with ArchiSimple

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Christophe Lecarpentier
based on Loïc Pagès's courses

Plant Science Master

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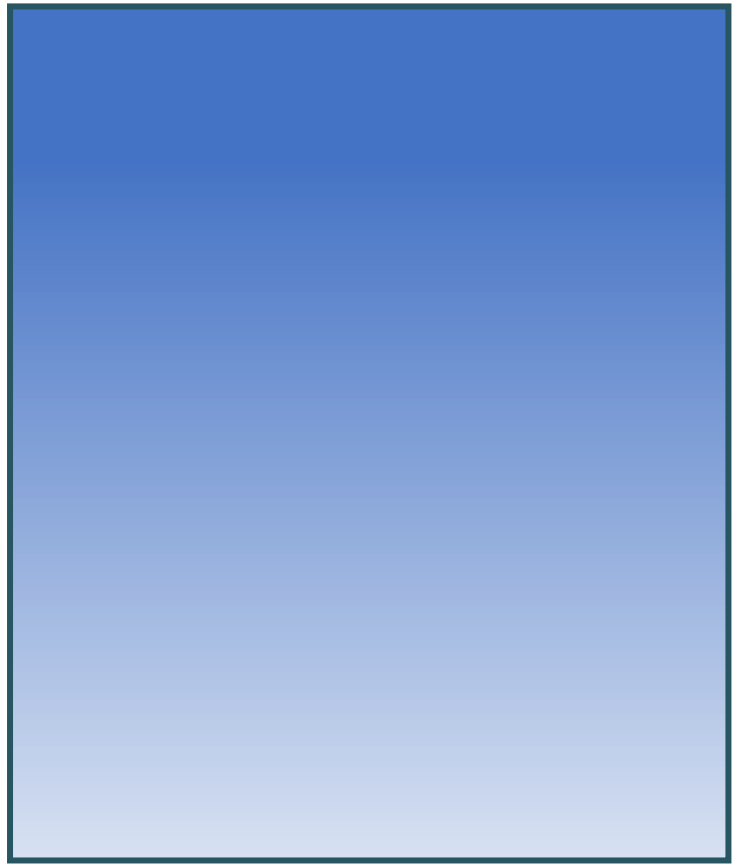
How root systems are represented and modelled ?

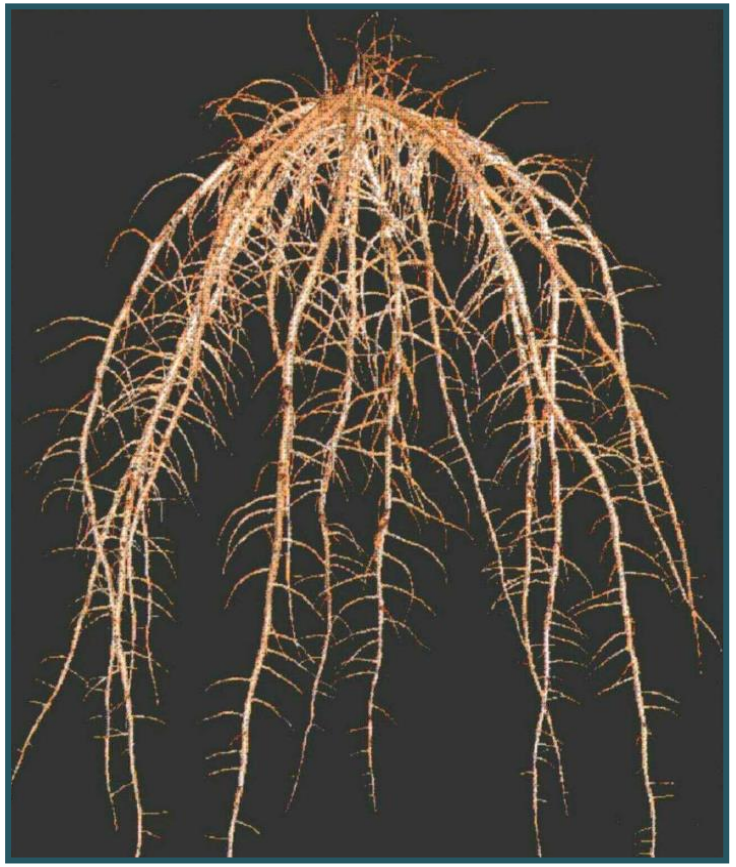
How root systems are represented ?

2 contrasting approaches

Map of root density

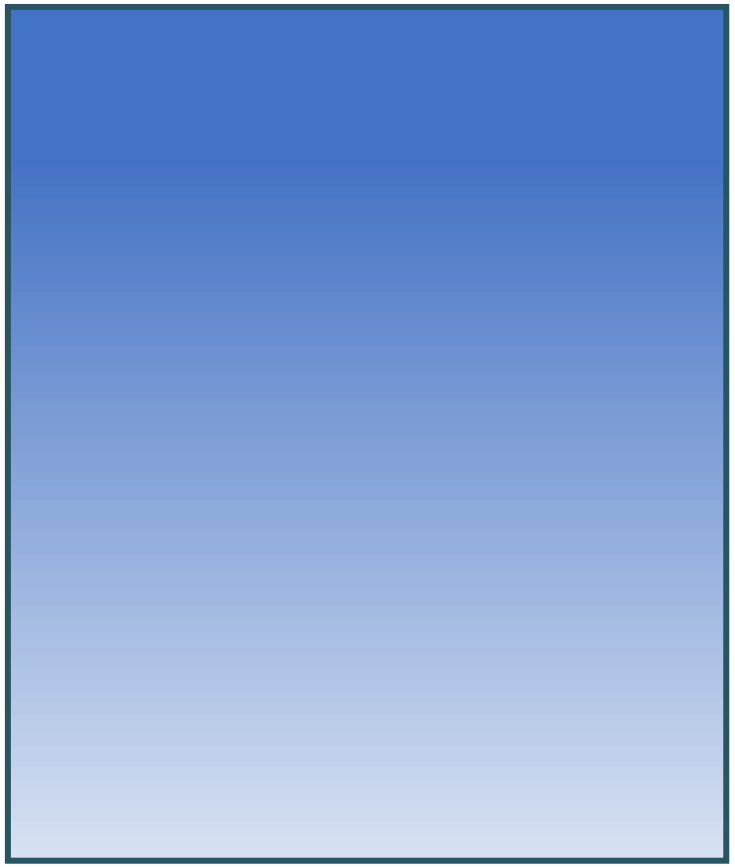


Root system architecture



Lynch, 1995, Plant Physiol

Map of root density



How root systems are represented ?

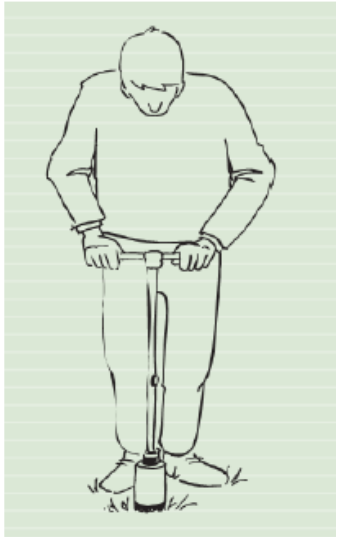
Map of root density : a classical approach

- Study of the soil by drill cores
  - Measuring root biomass at many points
  - At many heights
- Identifying zones with the presence of roots

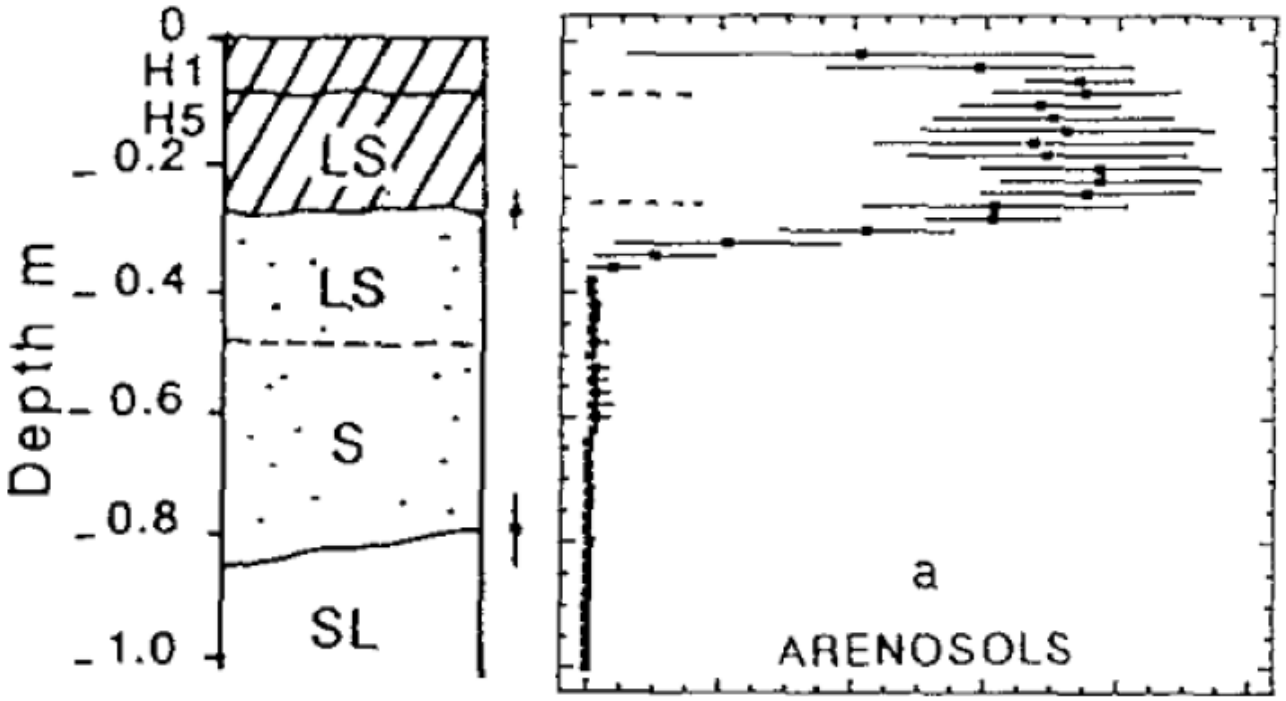
- Simple method
- Widely use
- Can be in 1D, 2D or 3D

How root systems are represented ?

Examples of 1D root map : monodimensionnal soil profiles

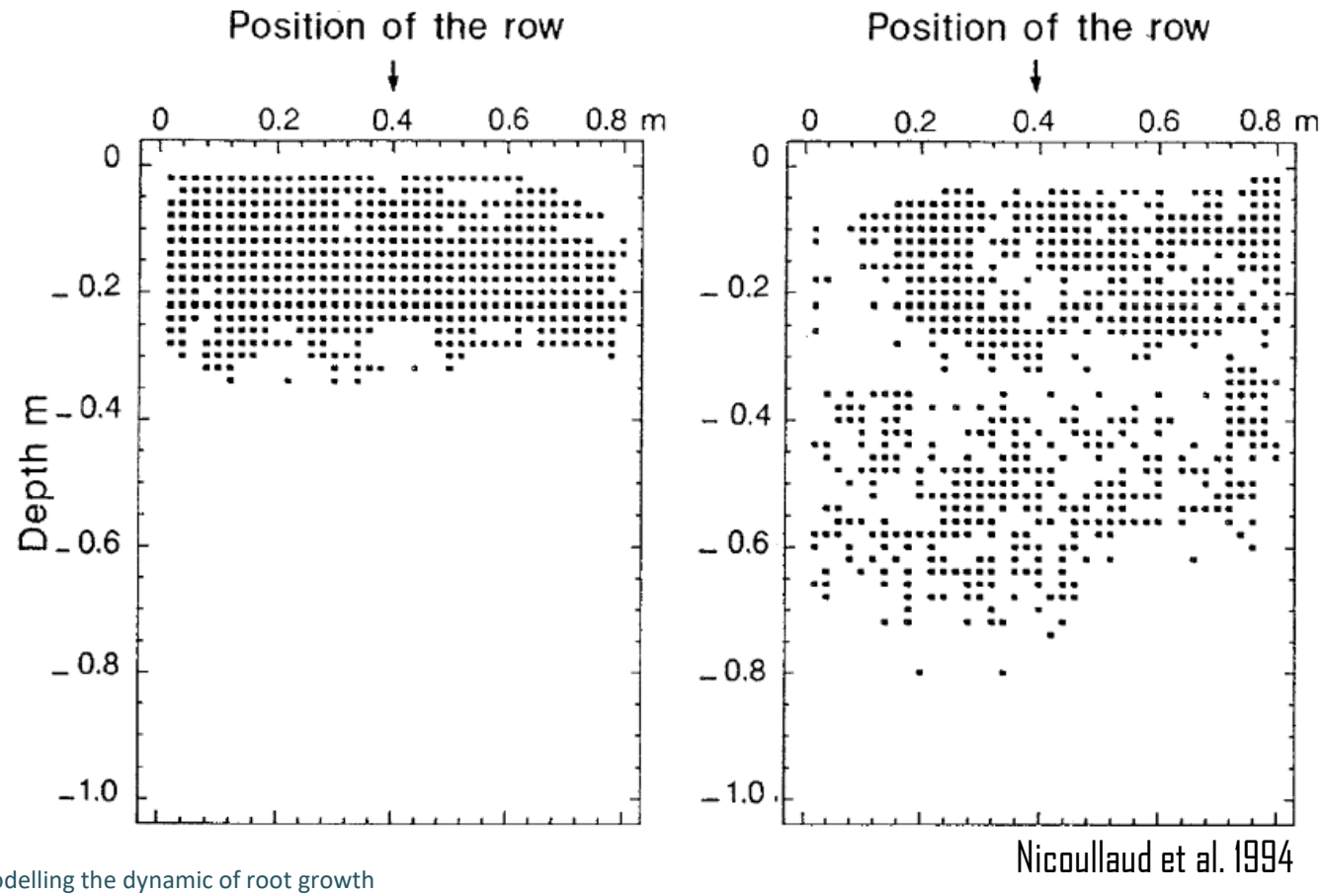


- Measuring root biomass at each height category (every 5 cm)

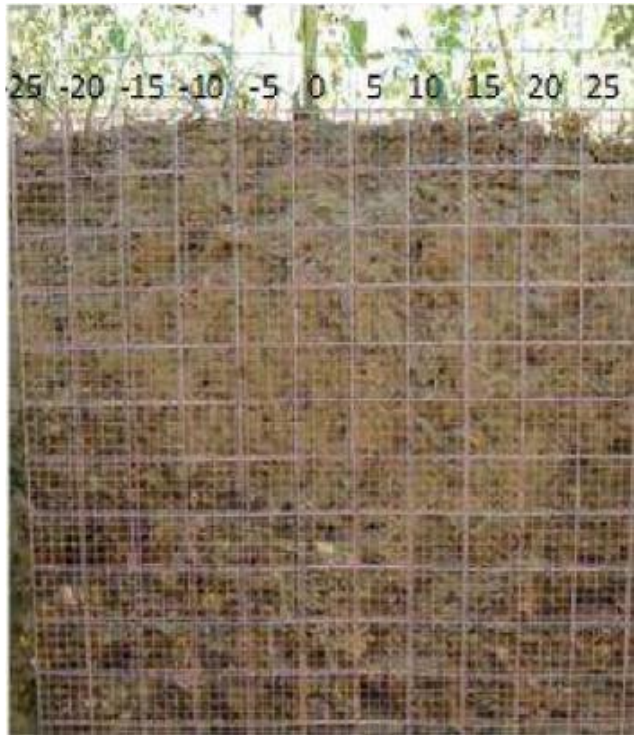


How root systems are represented ?

Examples of 2D root map : the case of maize

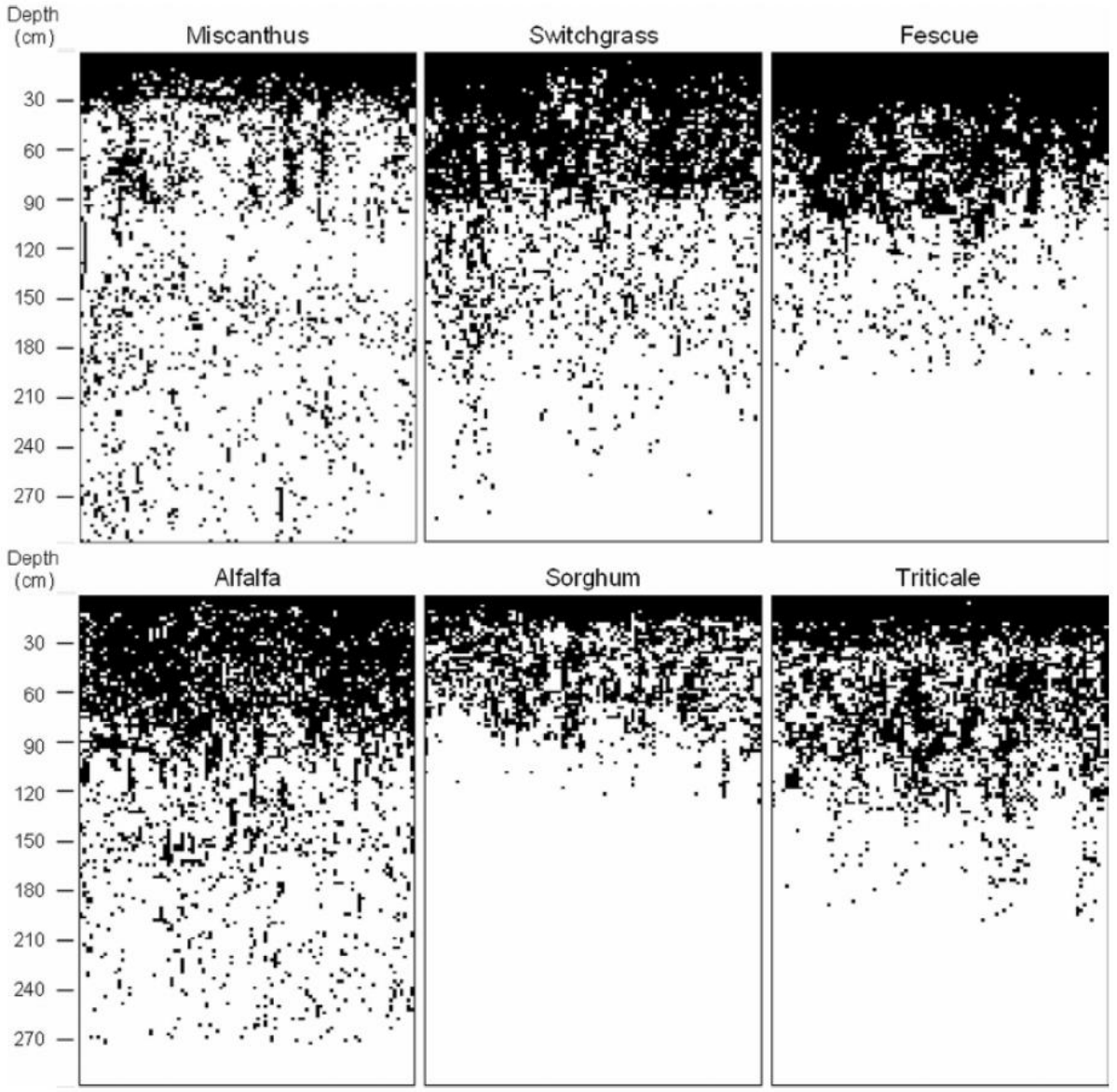


Nicoullaud et al. 1994

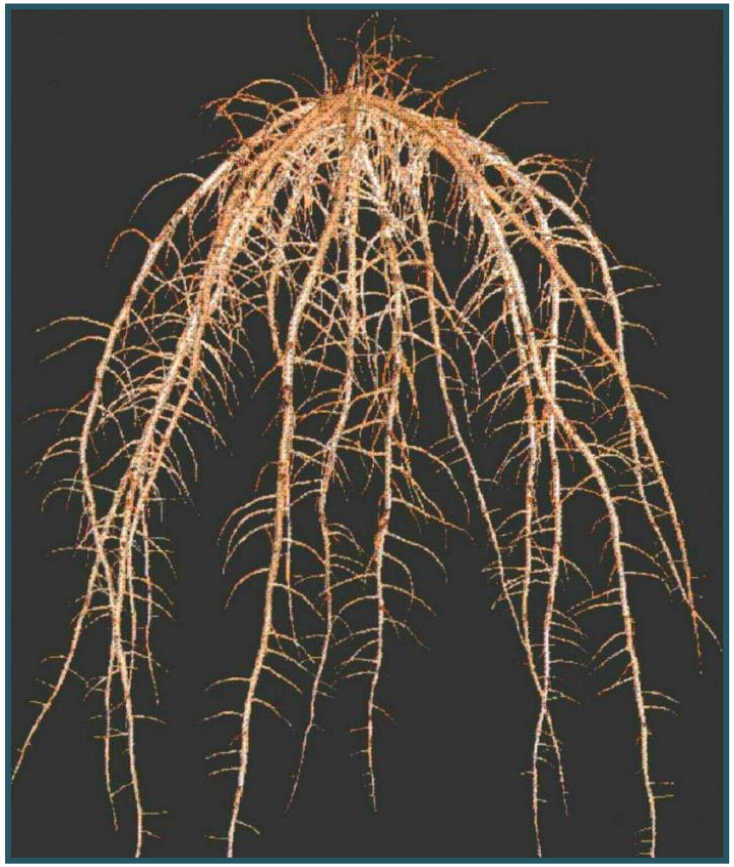


How root systems are represented ?

Examples of 2D root map : analysis of several species



Root system architecture



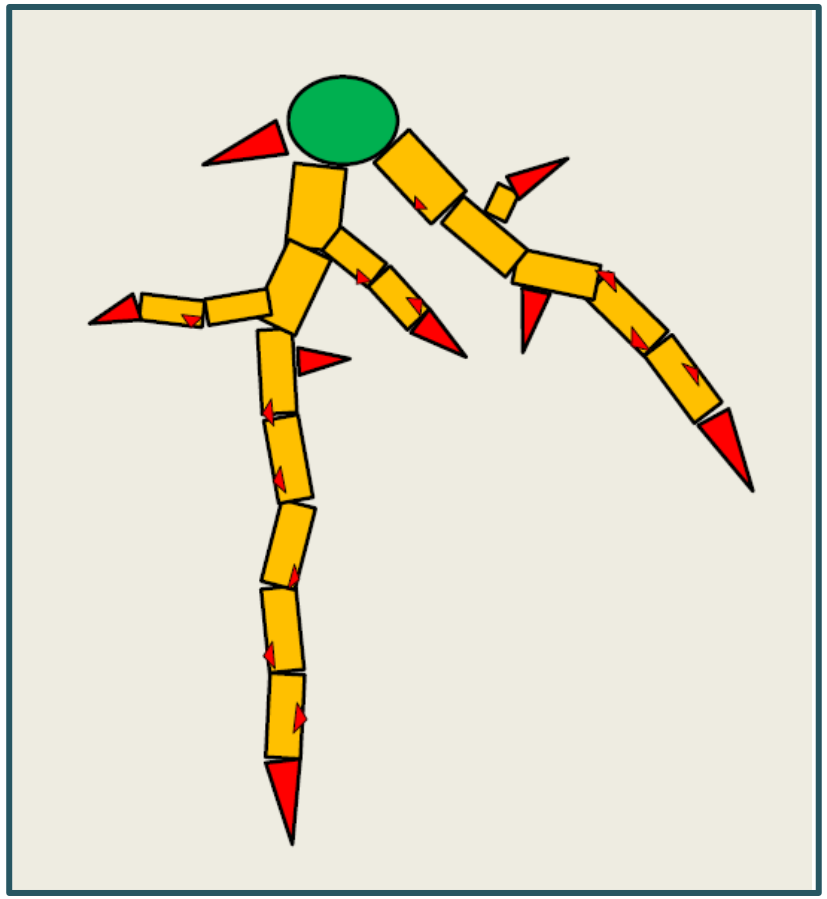
Lynch, 1995, Plant Physiol

How root systems are represented ?

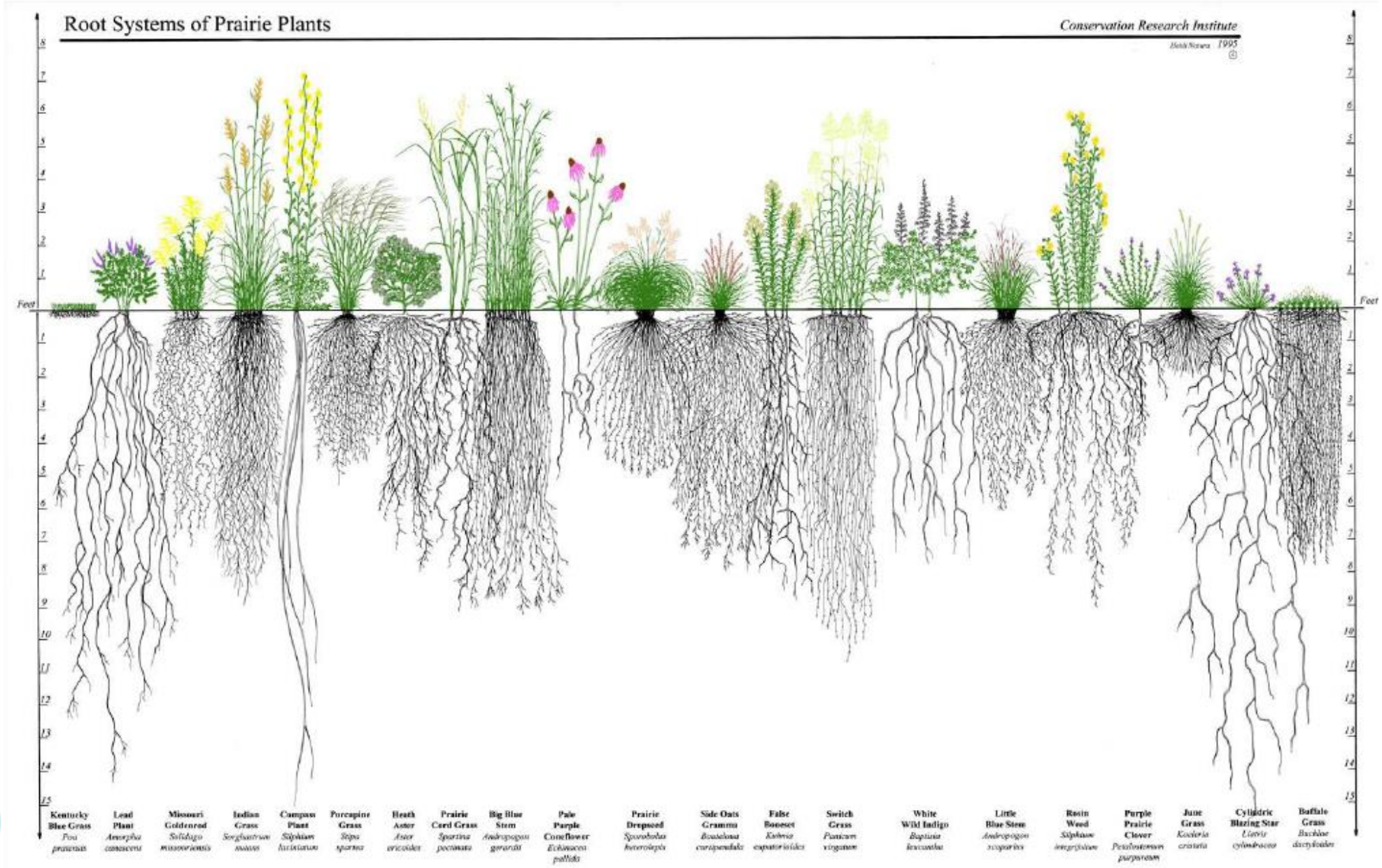
Root system architecture : a recent approach

- Botanic description of the plant
  - a plant is composed of many phytomers
  - phytomer : apex, internode, leaf, bud, root
- Ecophysiological description of plants
  - Considering the plant within its environment (biology, chemistry, physics)

- Recent
  - Aquisition of data thanks to many images (2D, 3D)
  - Computer progress



How root systems are represented ?



How root systems are represented ?

Root system architecture : different kinds of root systems (drawing)

Weaver, 1958, Ecology

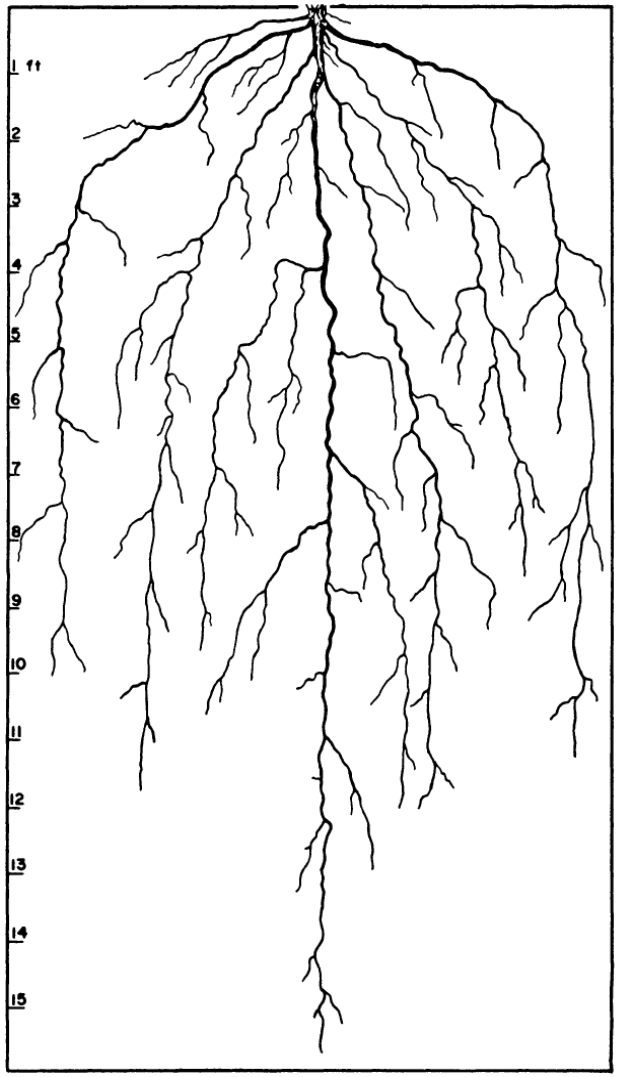


FIG. 1. Root system of blazing star (*Liatris punctata*).

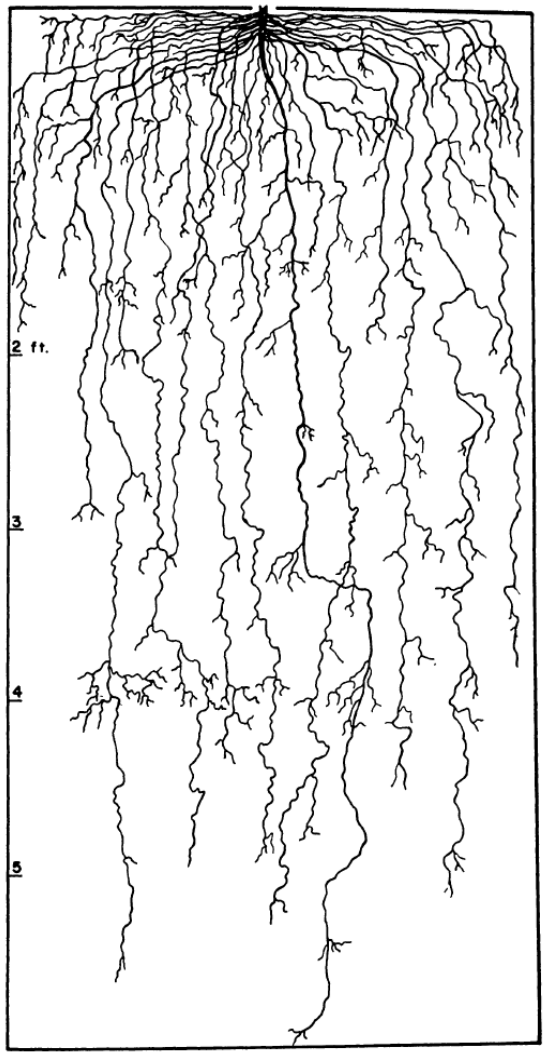


FIG. 2. Root system of broom snakeweed (*Gutierrezia sarothrae*). Redrawn from "The Ecological Relations of Roots."

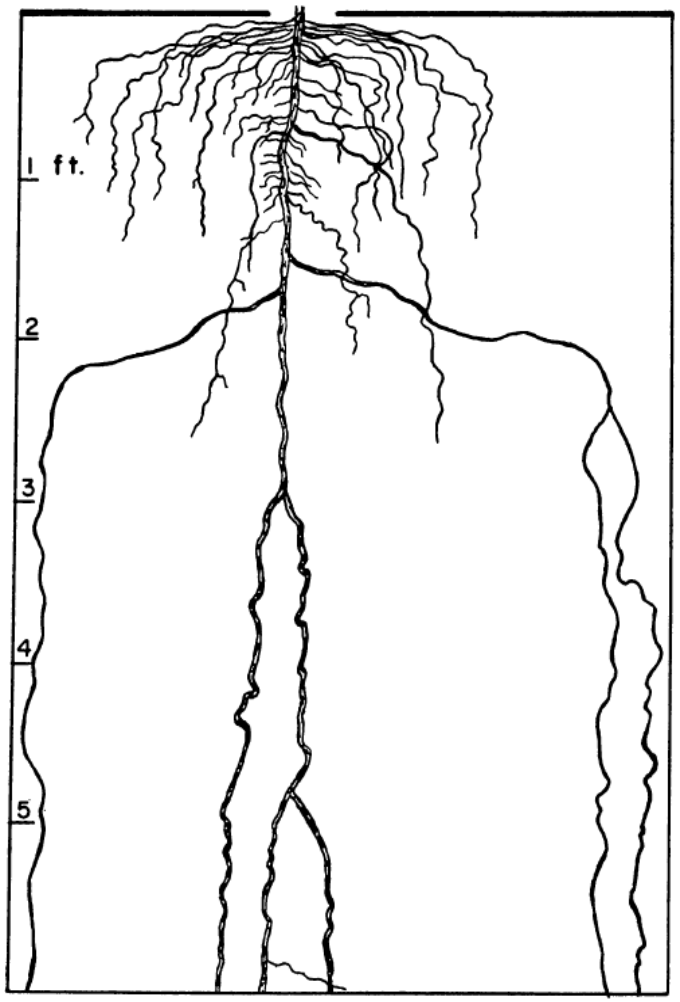
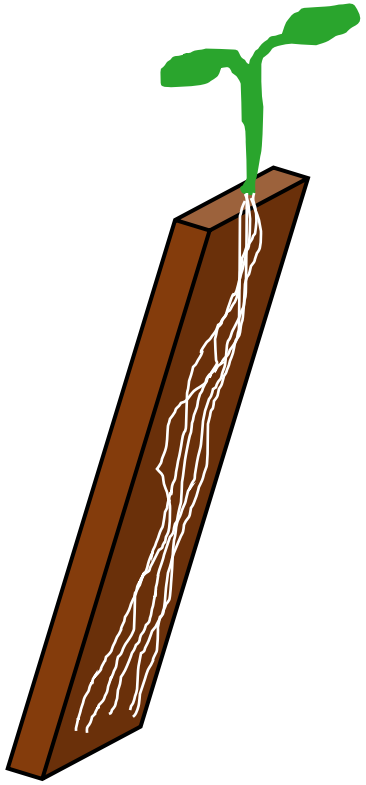


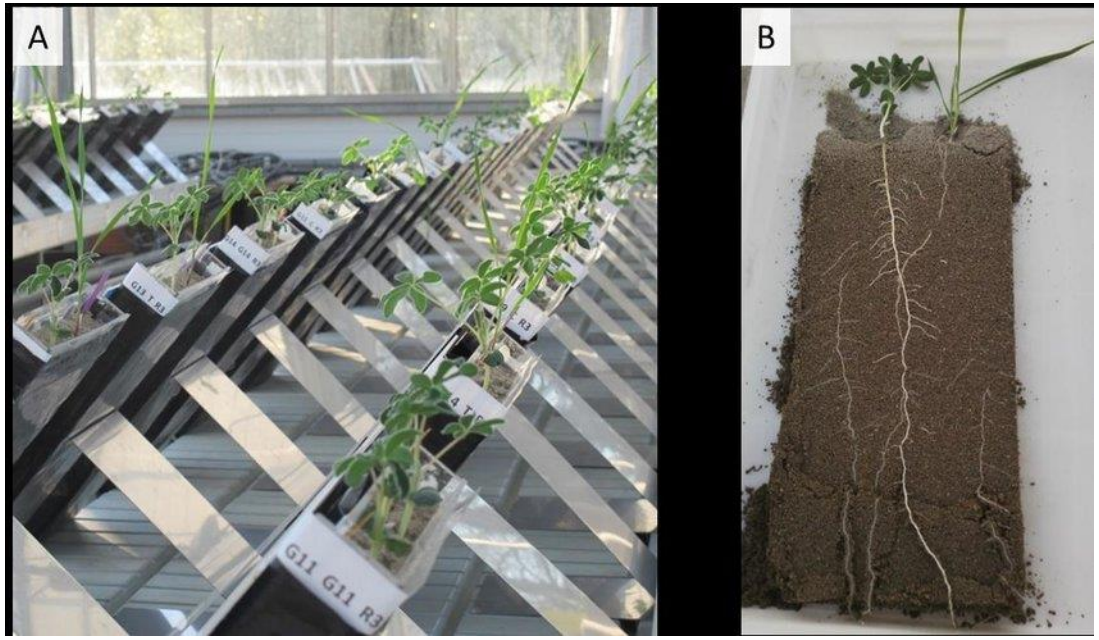
FIG. 3. Upper half of root system of hairy golden aster (*Chrysopsis villosa*). The lower half had only four fine branches. Redrawn from "Ecological Relations of Roots."

How root systems are represented ?

Root system architecture : experimental characterization using rhizotrons

Using rhizotron to characterize the dynamic of root system development



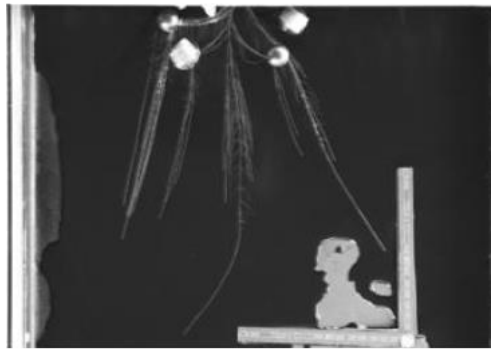


How root systems are represented ?

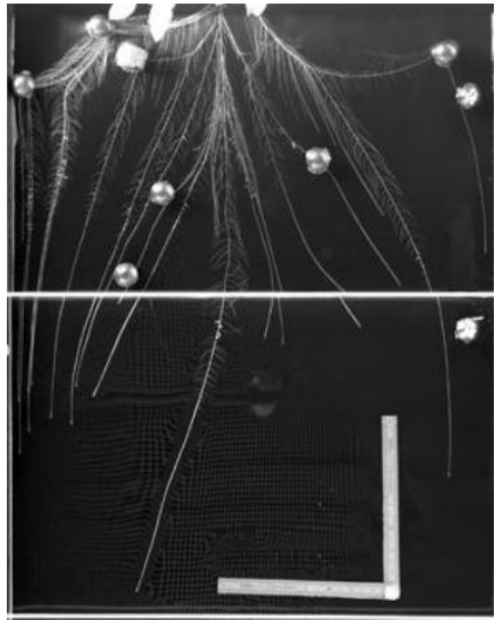
Root system architecture : experimental characterization using rhizotrons

Using rhizotron to characterize the dynamique of root system development

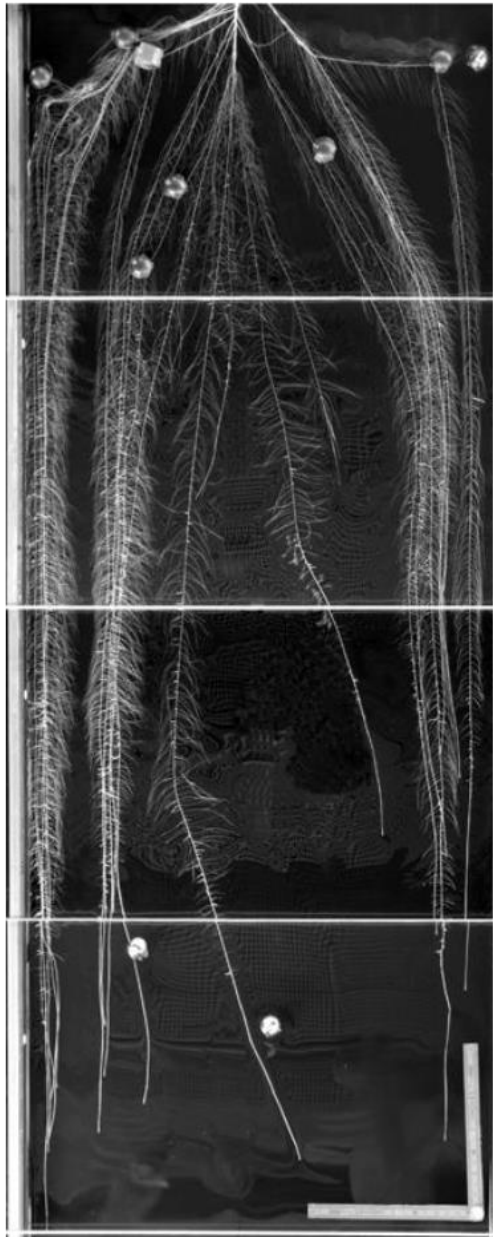
15 days after sowing



19 days after sowing



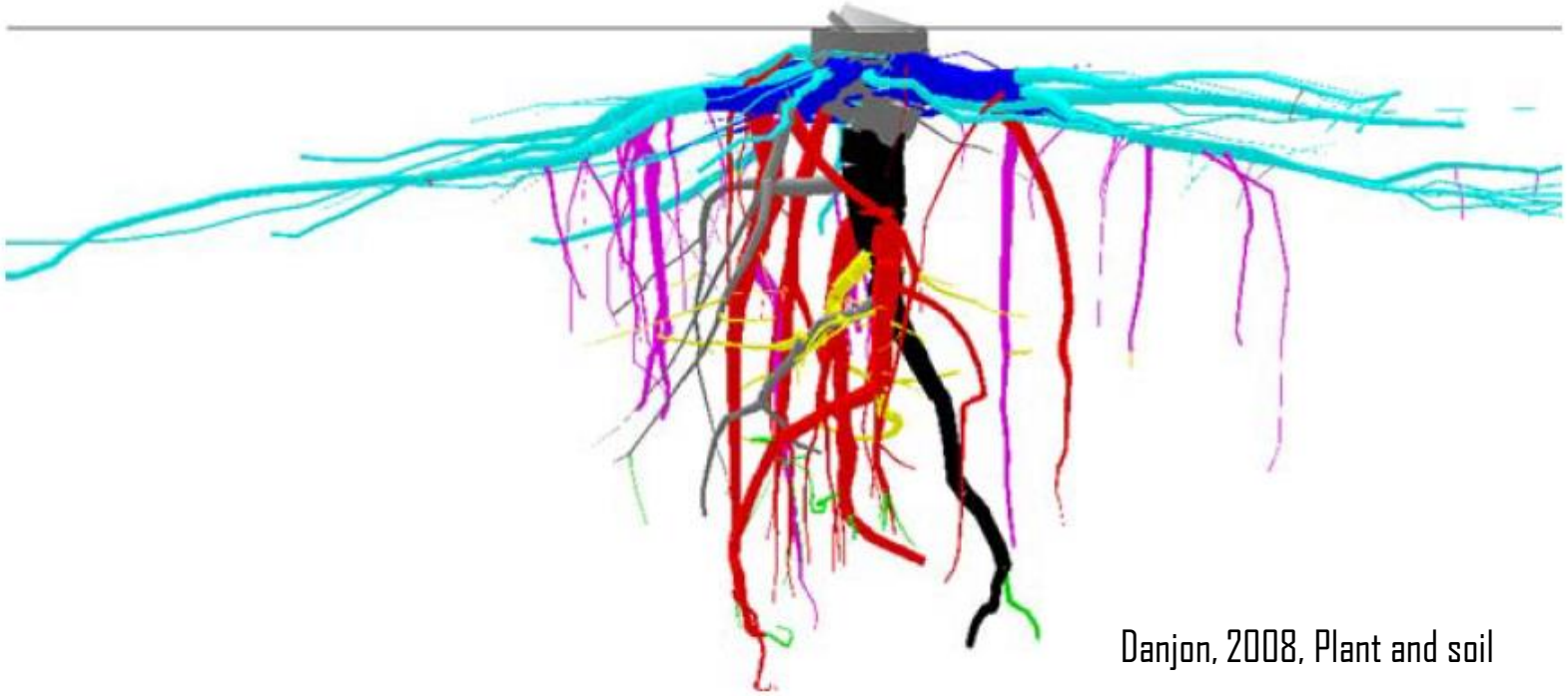
28 days after sowing



How root systems are represented ?

Root system architecture : 3D reconstruction of root systems

- Root system of a 27 years old tree in South West of France
- Measures done with Diplami software in 8 hours
- Color reprezent type of roots
  - **Grey** : oblique roots
  - **Black** : taproot
  - **Light blue** : horizontal surface
  - **Red and violet** : sinker



Danjon, 2008, Plant and soil

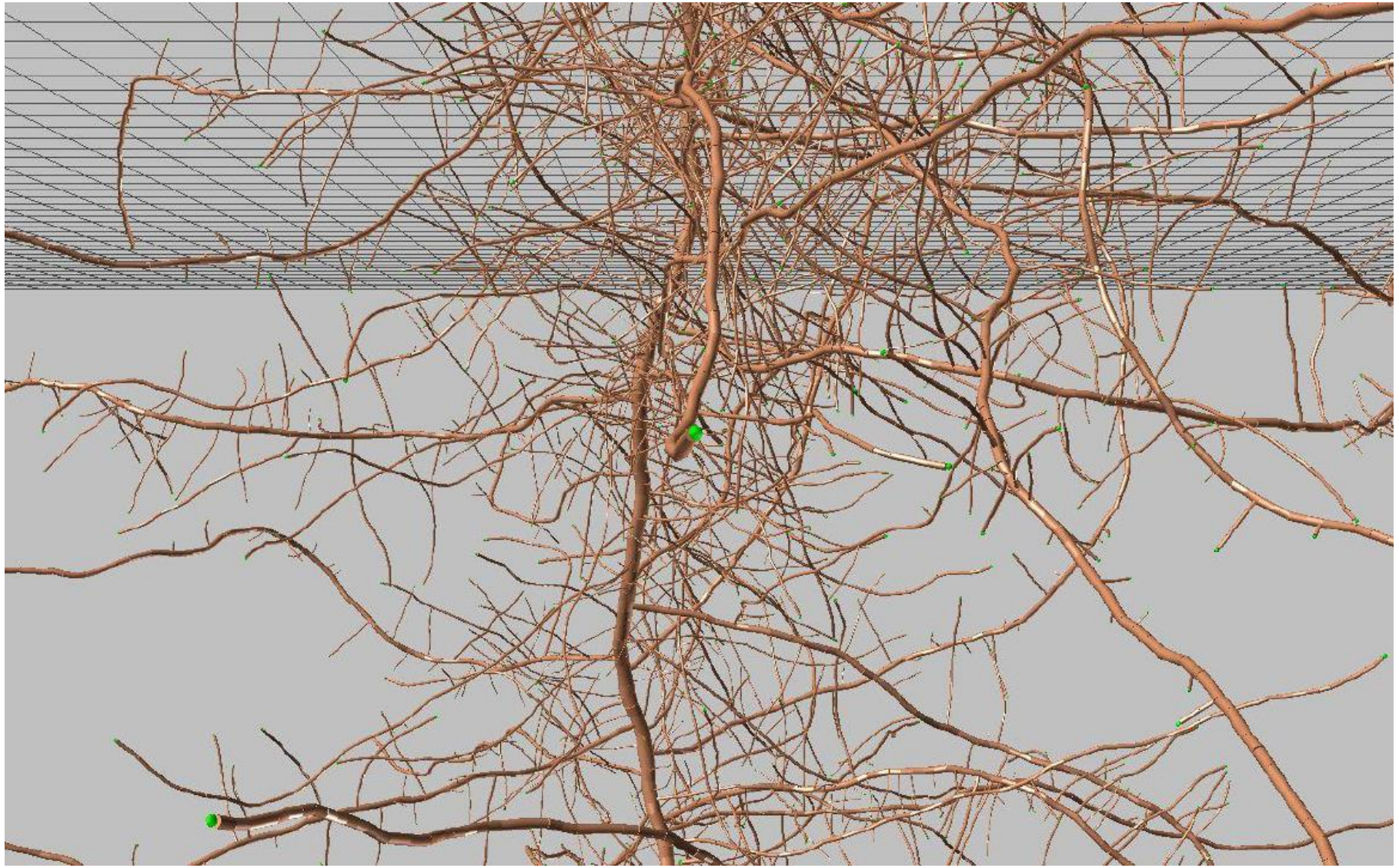
How root systems are represented ?

Root system architecture : the history

- Models that are used/developped since 80's
  - Integrating processes of root development
  - Mostly on cereals
  - Systems are not dynamics
- In the 90's:
  - Models focused on other species (maize, pea, palm tree, etc.)
- From 2000's:
  - Generic models : (RootTyp, SimRoot, Archisimple)

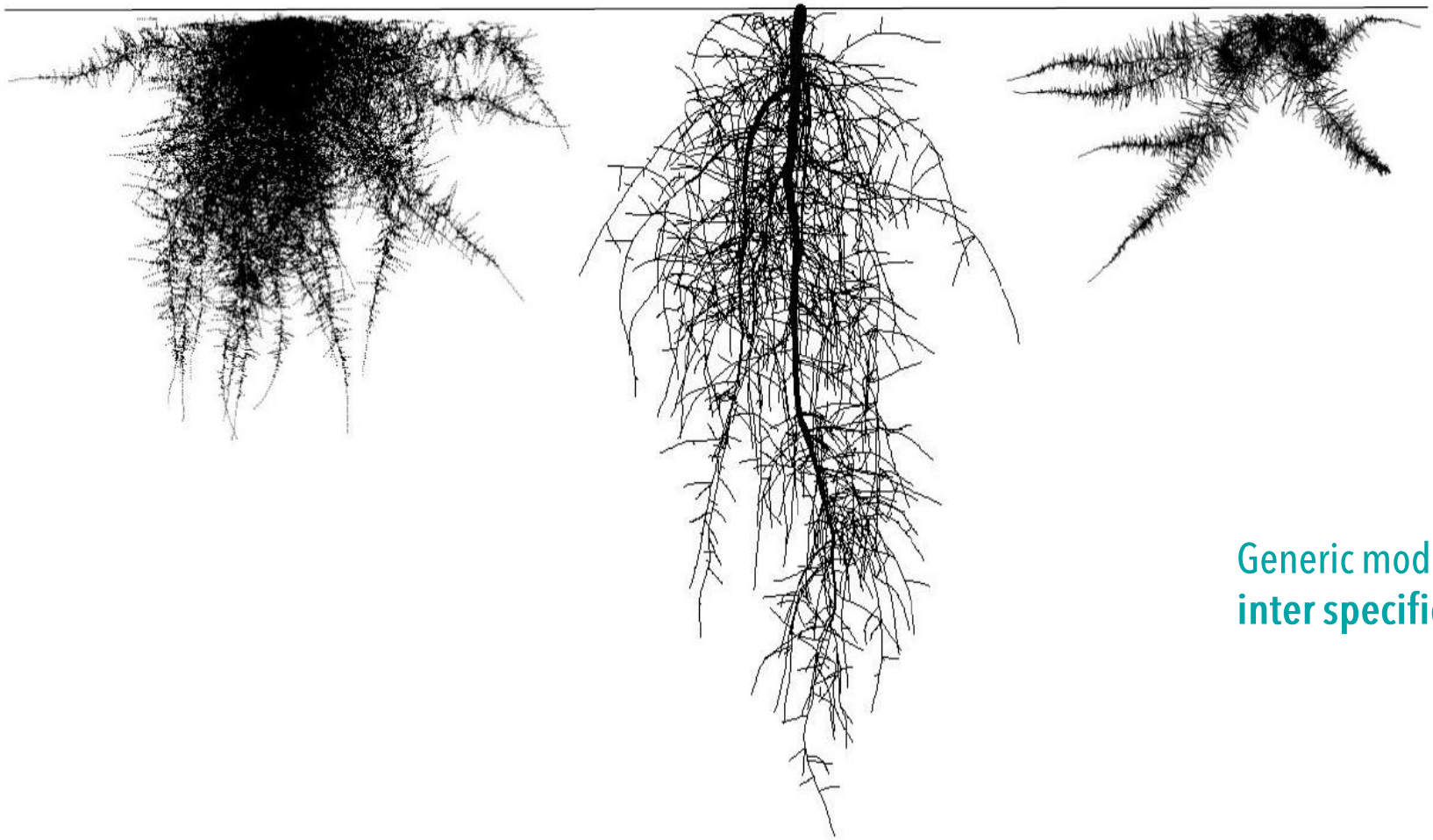
How root systems are represented ?

Root system architecture : examples of simulations of 3D root systems



How root systems are represented ?

Root system architecture : examples of simulations of 2D root systems



Generic models are useful to explore
inter specific diversity

How root systems are represented ?

Root system architecture : examples of simulations

- Limits :
  - Models with many parameters
  - 3D : require huge computationnal ressource
  - Huge experimental effort to estimate
    - Variables : root system biomass, root length
    - Parameters : specific traits
      - Root diameter, root length
      - Rootconductance
      - SRL, RTD

Only on young plants

Biology of root development

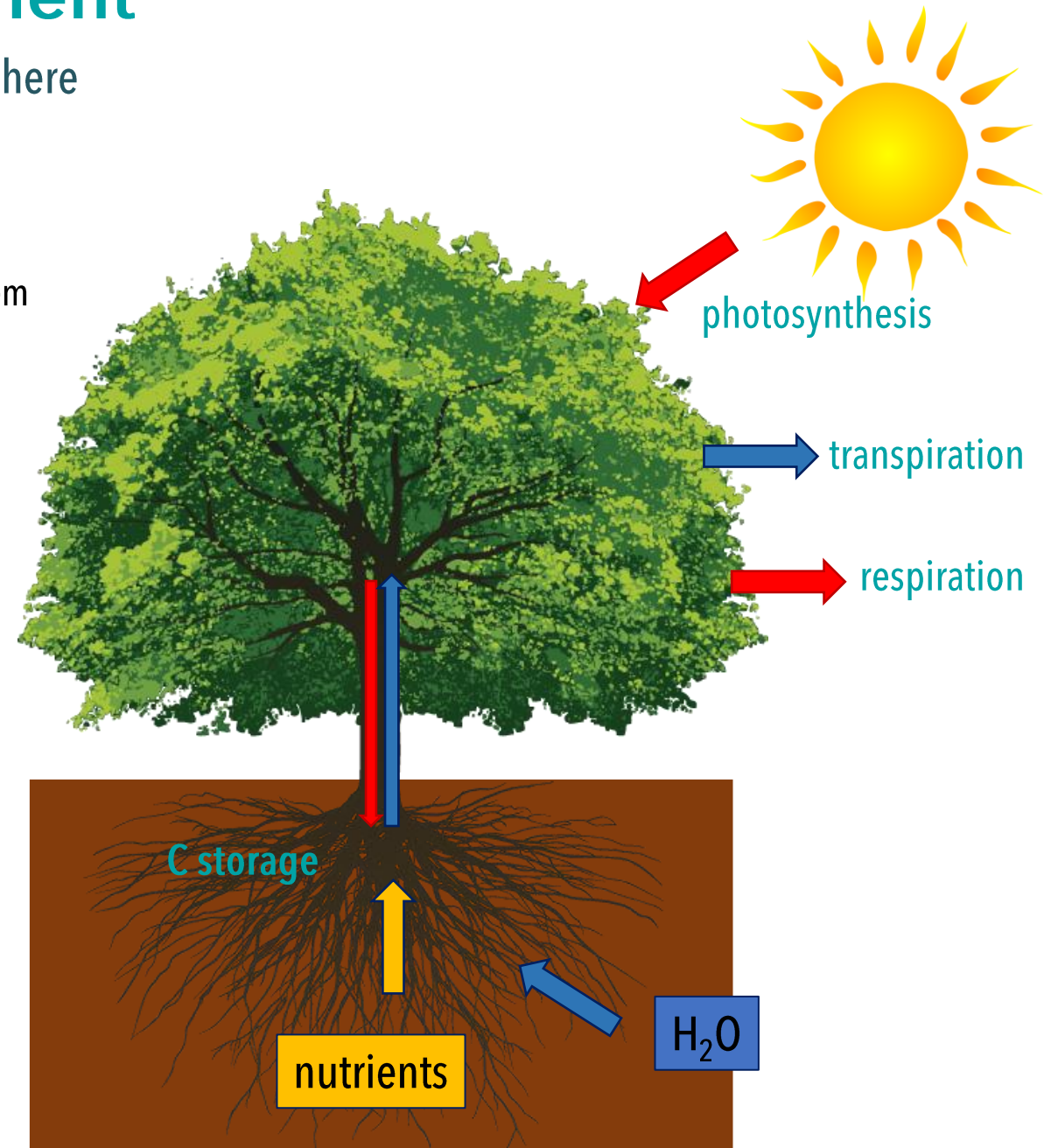
Biology of root development

Role of root in the whole system soil-plant-atmosphere

- Carbon is acquired by leaves thanks to photosynthesis and transported to sinks (fruits, roots, etc.) through the phloem
- Water and nutrients is absorbed by roots and transported to other organs through xylem

Belowground and above ground are interdependant

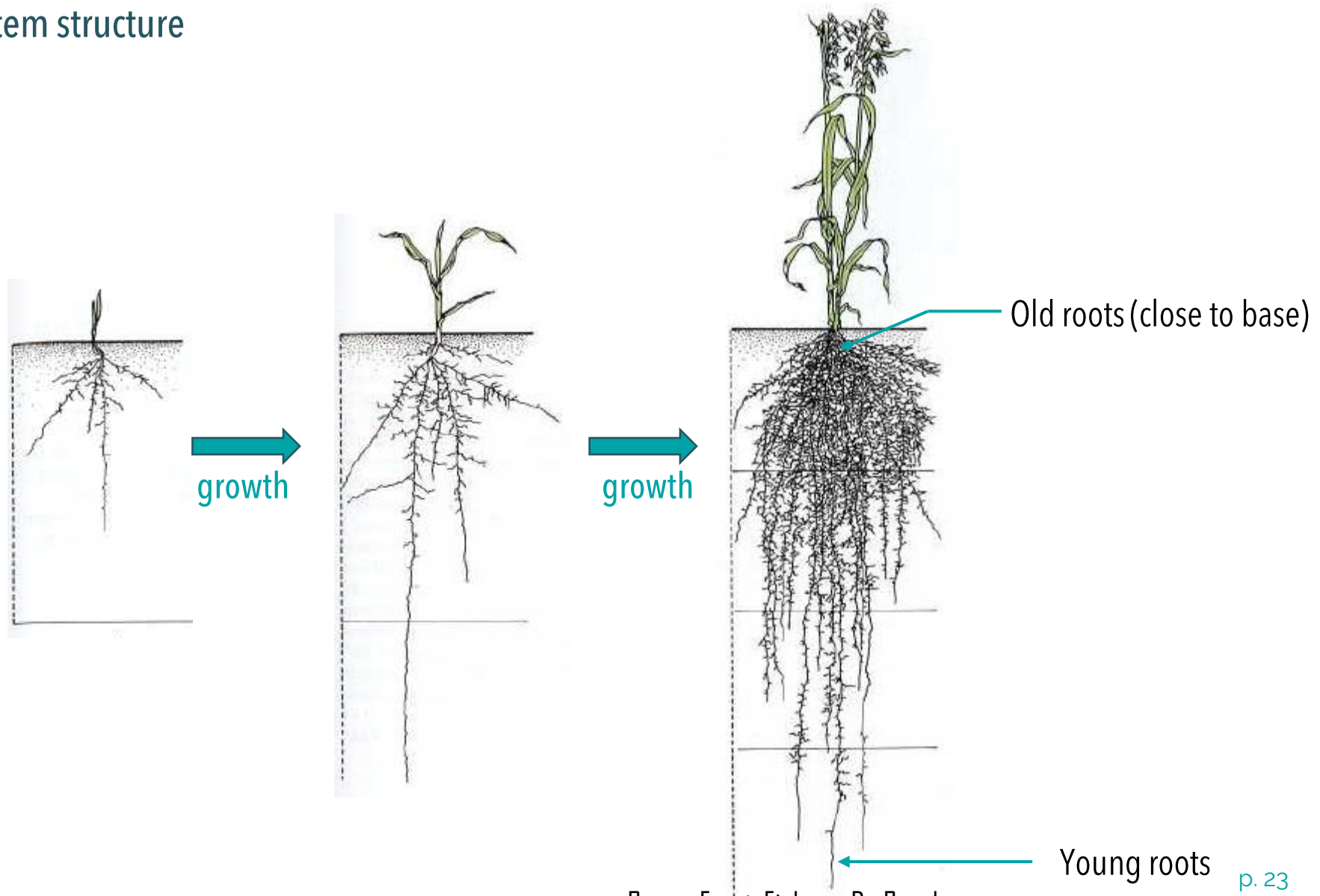
Root system defines a specific demand (amount of carbon)



Biology of root development

Global overview of root system structure

- Root and shoot developp synchronously
- Older roots are near the surface, close to the base of the stem
- Younger roots are at the bottom of root system (last meristem to elongates)

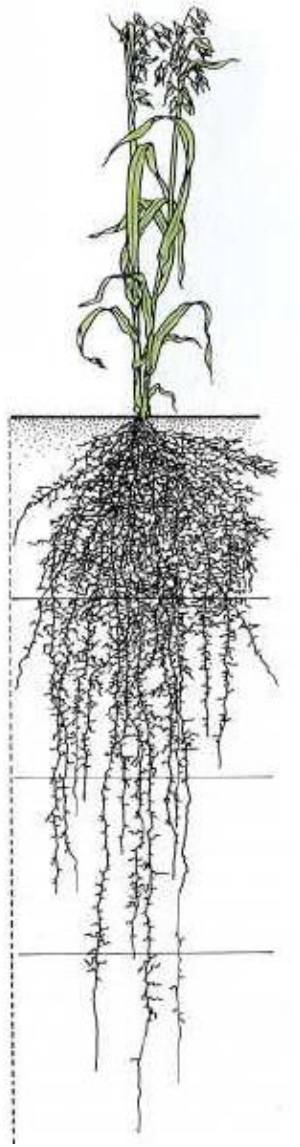


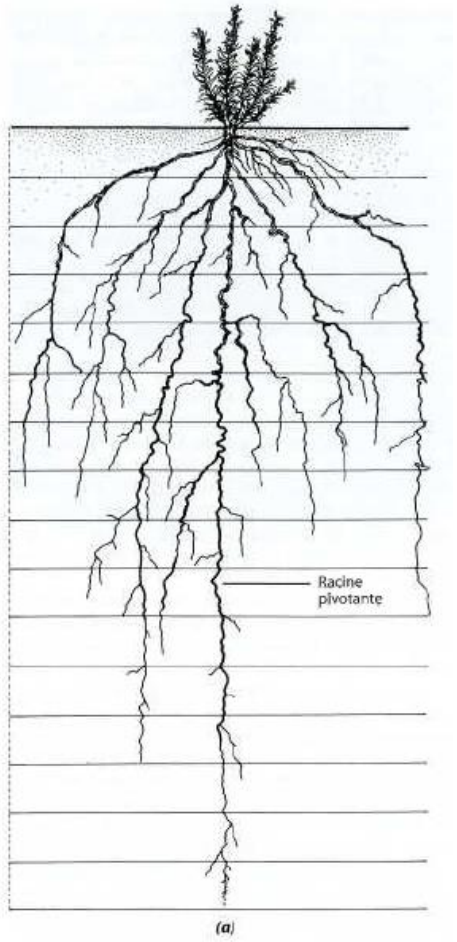
Biology of root development

Global overview of root system structure

Fasciculate root system

Triticum aestivum
(or Zea mays)





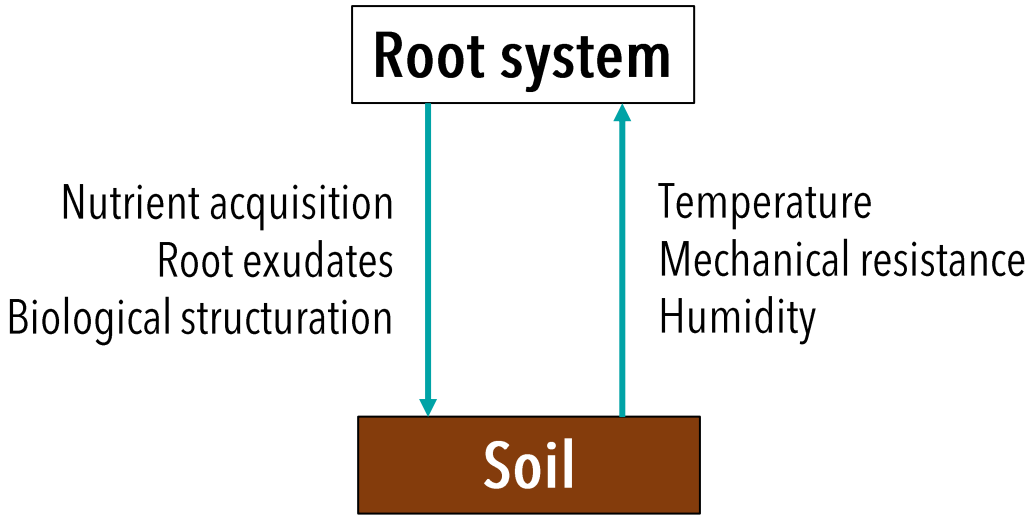
Pivoting root system

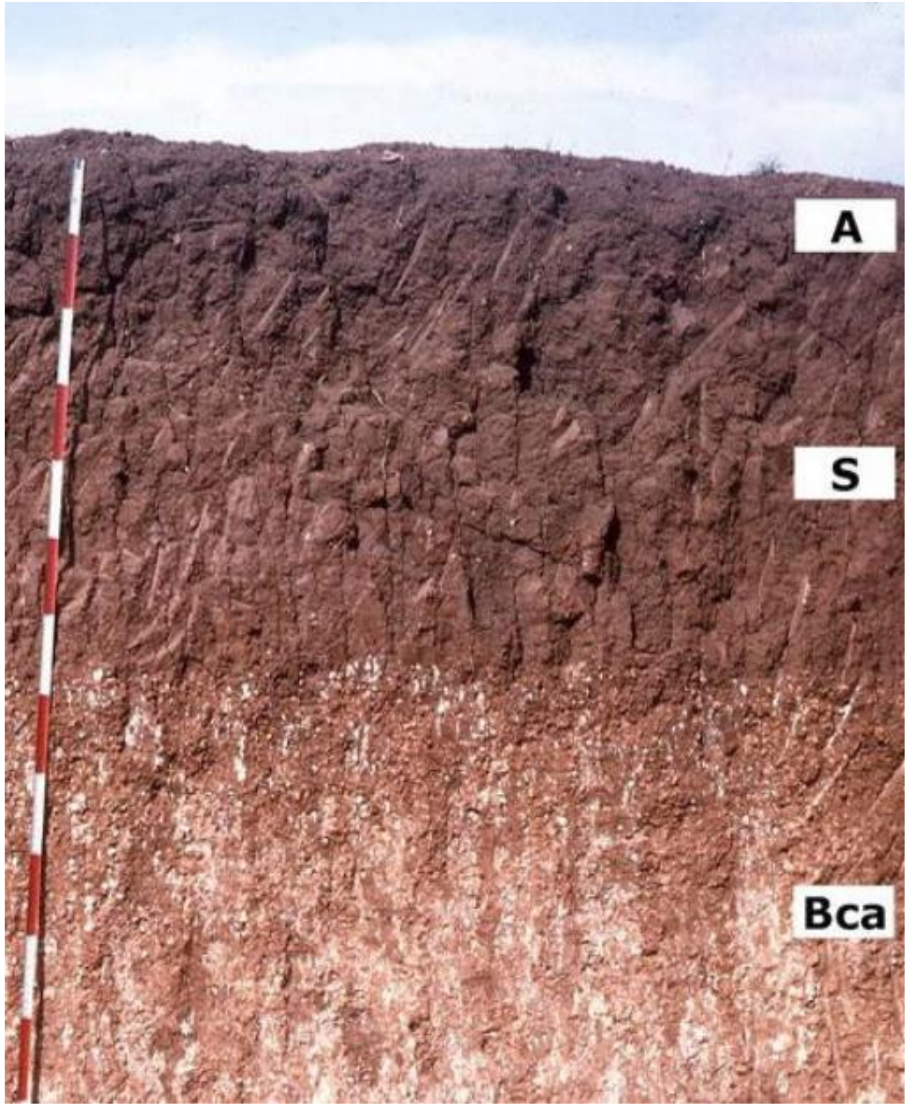
Liatris punctata
(or Brassica napus)

Biology of root development

Heterogeneous environment

- Soil is heterogeneous and classically charactirized in many horizons
- Soil and root systems have impact on each other





Biology of root development

Processes in root development

1. Elongation
2. Acropetal branching
3. Radial growth
4. Root emission
5. Root death

Biology of root development

Processes in root development

1. Elongation
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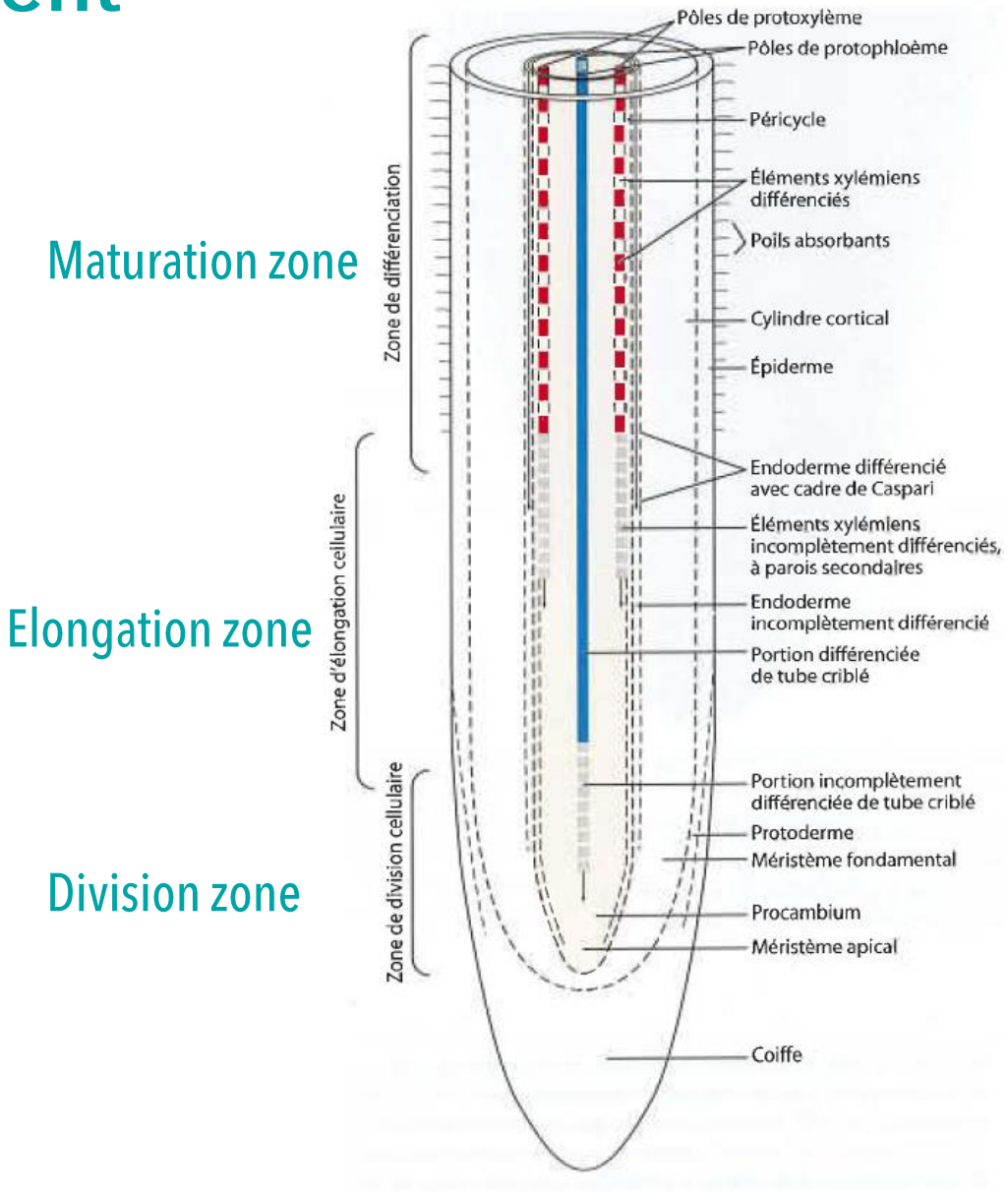
Biology of root development

Root elongation

- Division zone : at the extremity of the root
  - The apical meristem produces new cells
- Elongation zone : behind the division zone
  - Root elongates throught the elongation of each cells
  - cells elongates **only** in this zone
- Maturation zone : behind the elongation zone
  - Elements differentiates : (xylem, phloem)
  - Emergence of root hair

Elongation takes place only at the tip of the root



Biology of root development

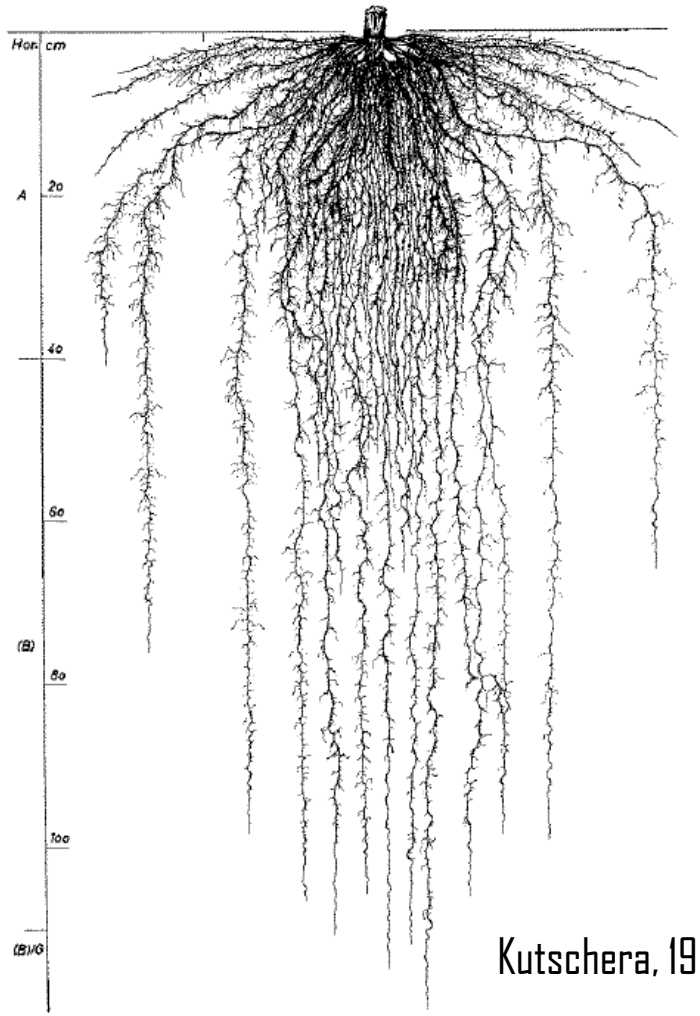
Root elongation

- Root elongation is defined by :
  - Speed
  - Duration
  - Direction

Depends on apical meristem size

Gravitropism ?

Maize root system



Kutschera, 1960

Biology of root development

Processes in root development

1. Elongation
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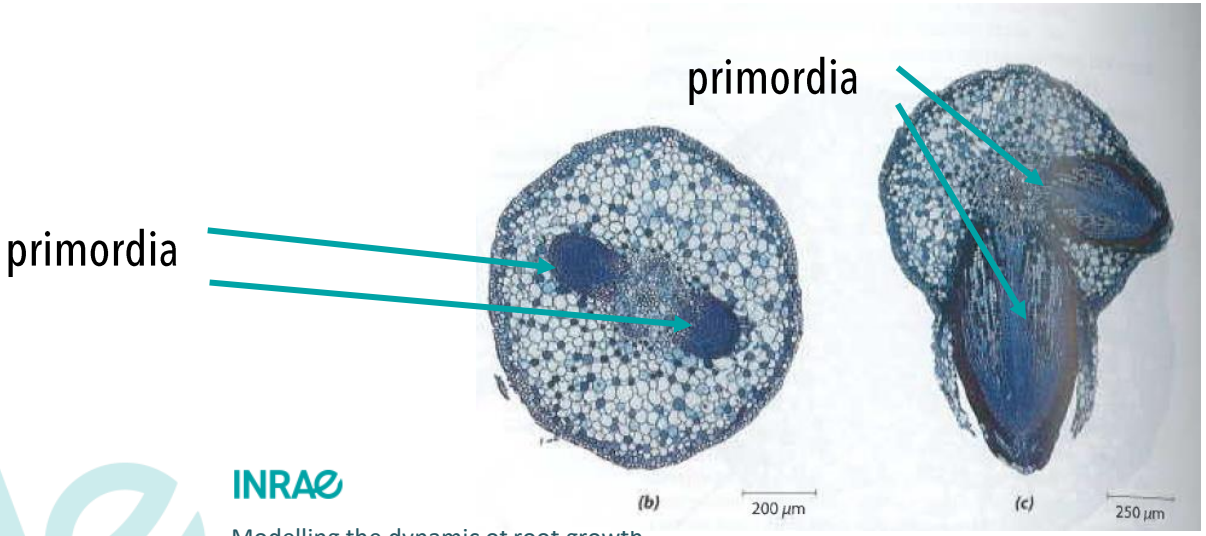
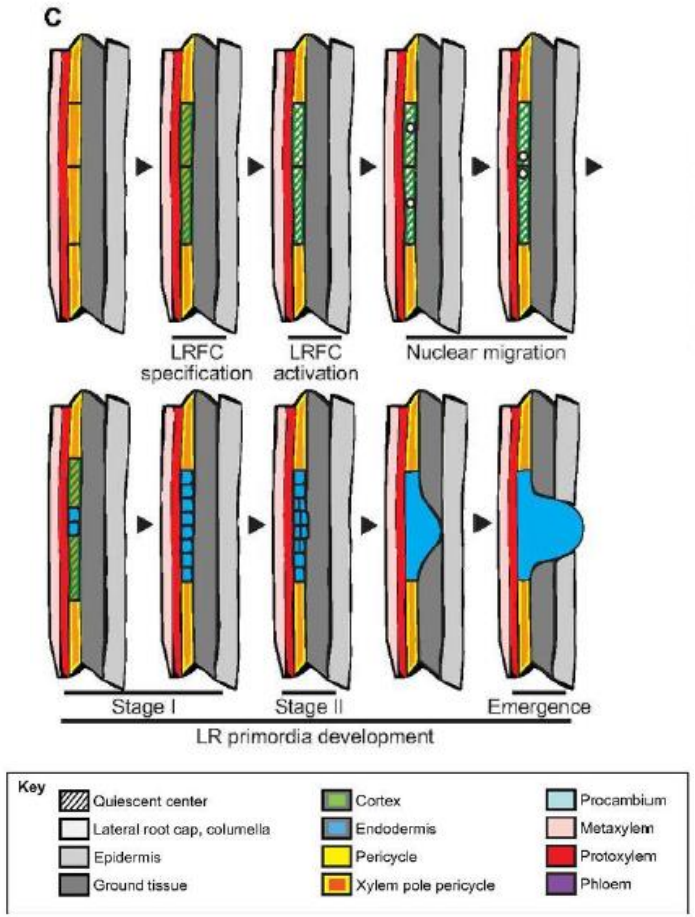
Biology of root development

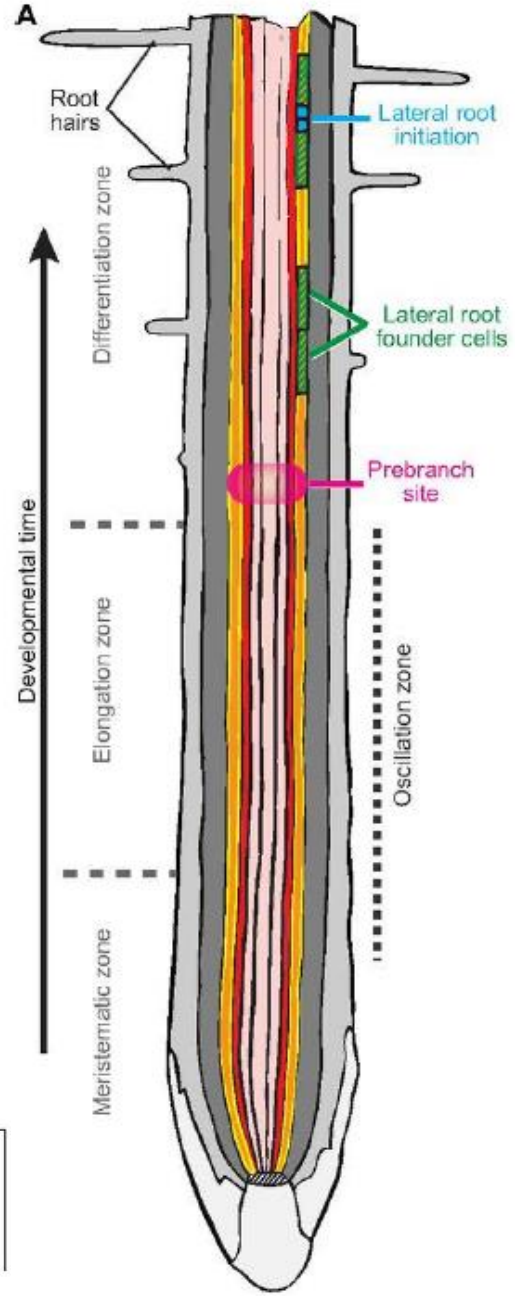
Root branching

- Root branching is acropetal (basis → root tip)
- Young zones are localized at the tip

- New primordia emerge from the endoderme and the pericycle
- Regular emergence

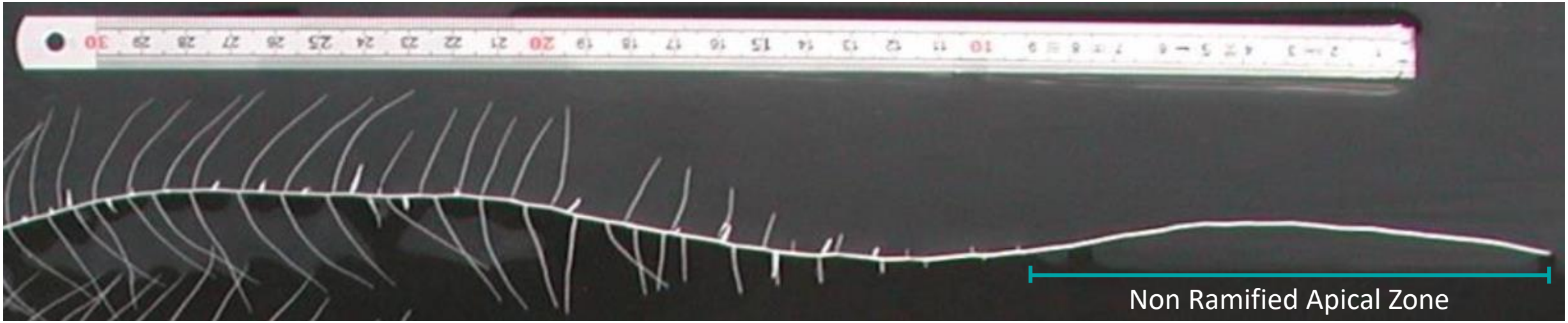






Biology of root development

Root branching



- Characterization of :
  - Root density → Distance between 2 consecutive ramifications
  - Dynamic of root emergence → Length of Non Ramified Apical Zone

Length of Non Ramified Apical Zone

Time between initiation of a bud and the emergence of a new lateral root

Biology of root development

Processes in root development

1. Elongation
2. Acropetal branching
3. Radial growth
4. Root emission
5. Root death

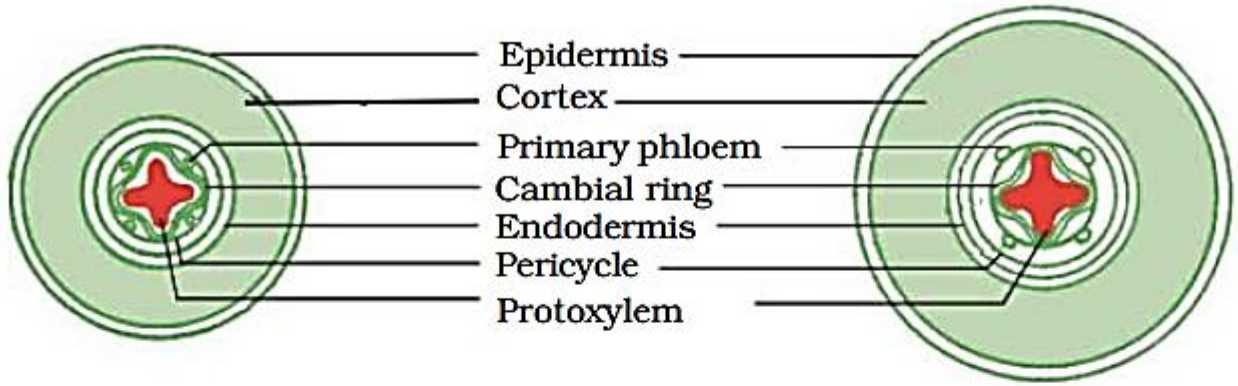
Biology of root development

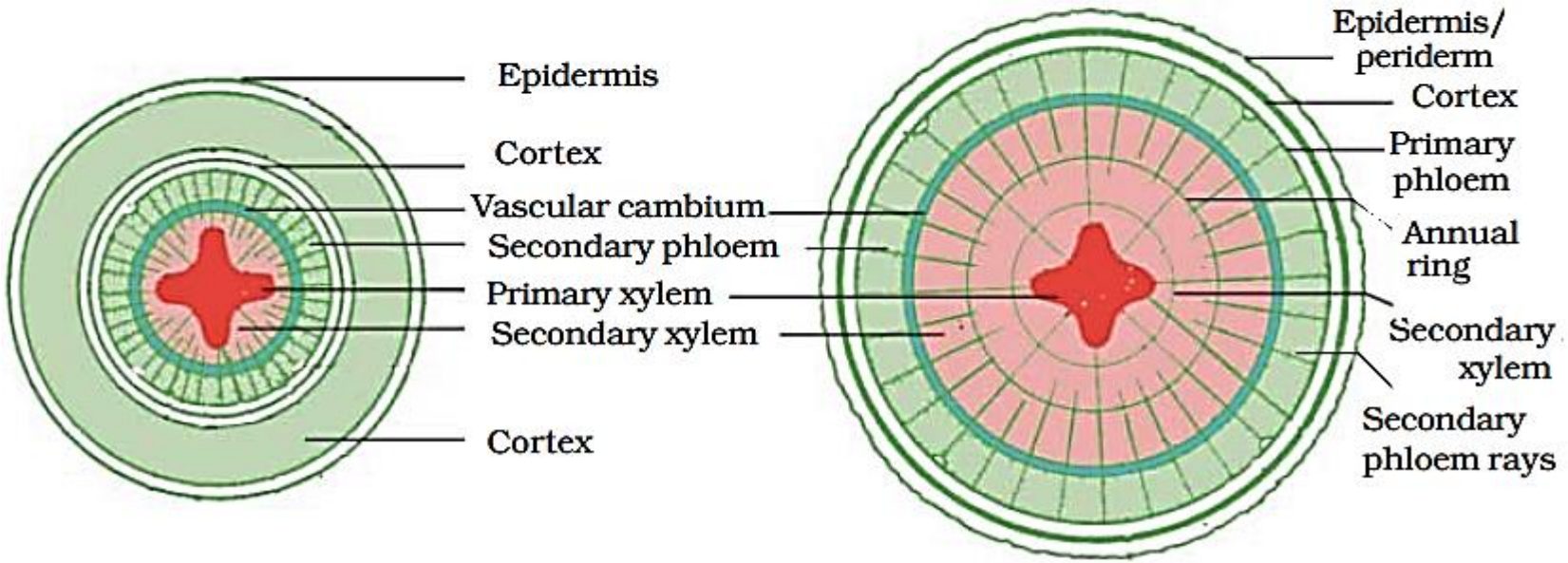
Radial growth

- Development of :
  - Cambium
  - Secondary phloem
  - Secondary xylem

Radial growth

- Reinforcement of roots:
  - Enhance conduction
  - Enhance anchoring
- Not all species
- Not all roots





Biology of root development

Processes in root development

1. Elongation
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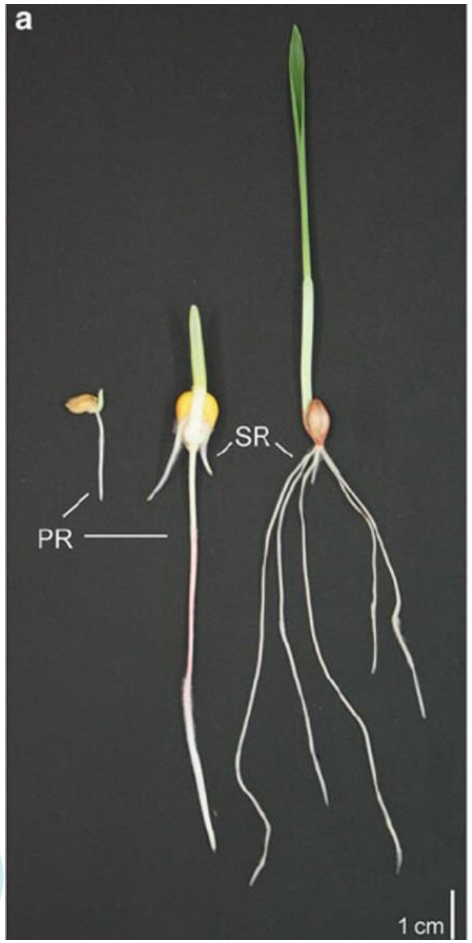
Biology of root development

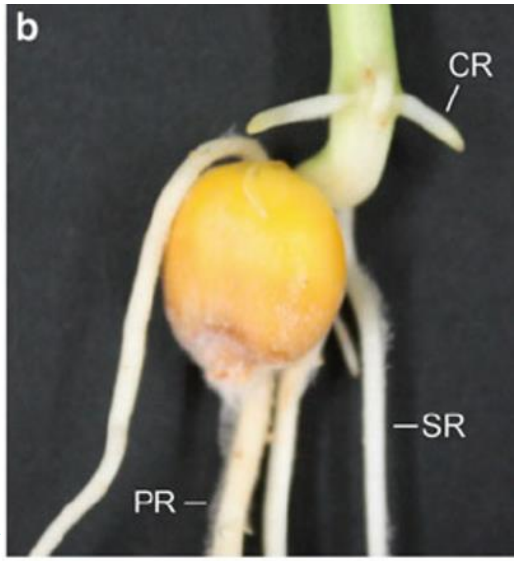
Root emission

- **Seminal roots**

Roots that emerge from the embryo



Different for each species



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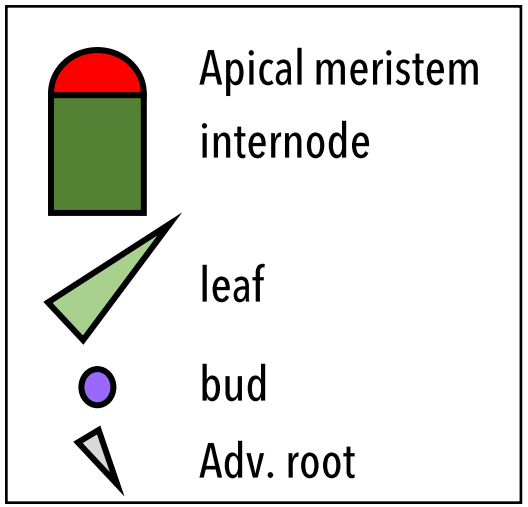
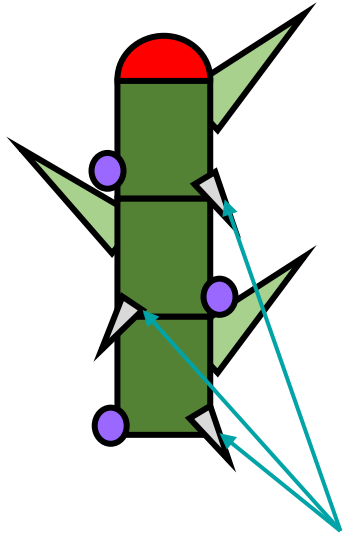
Biology of root development

Root emission

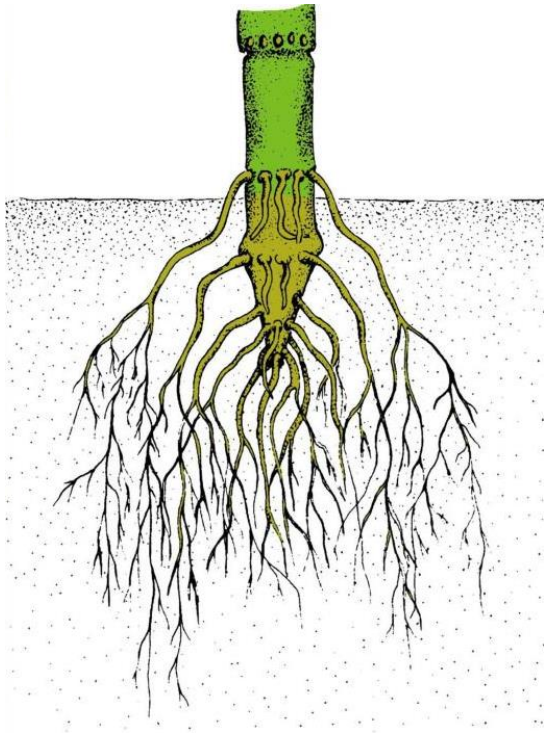
- **Adventitious roots**

Roots that emerge from phytomers (from the stem)
Common in cereals, where first internodes are shorts





Adventitious roots



Exemple of wheat

Exemple of maize

Biology of root development

Processes in root development

1. Elongation
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5. Root death

Biology of root development

Root death

- Almost all roots die during plant life

Root life time depends on the **volumic mass** and the **size of apical meristem**

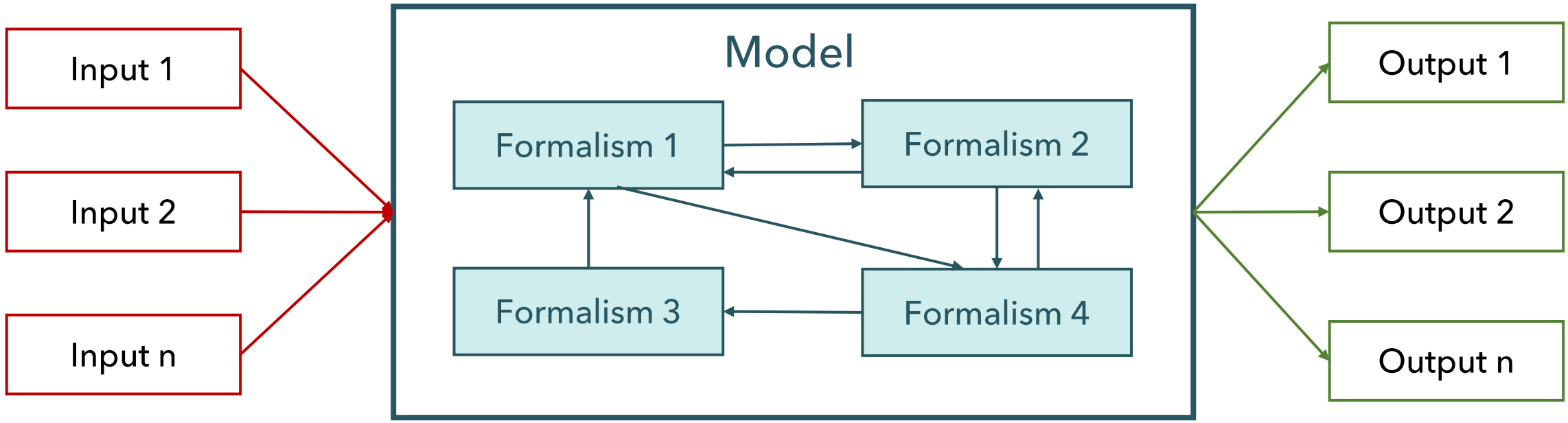
Formalisms of ArchiSimple

What is a model ?

Introduction

What is a model ?

Usually, models are more complex than just a simple equation and are composed of different equations that interact with each other



Introduction

What is a parameter ?

Variable

Mathematical term that is changing during the simulation.

State variables are variables that are calculated by the model (eg. Biomass, LAI)

Input variables are variable that are estimated experimentally

Parameter

Mathematical term that keeps its value during the whole simulation. However, its value can change between simulations (eg. phyllochron, RUE)

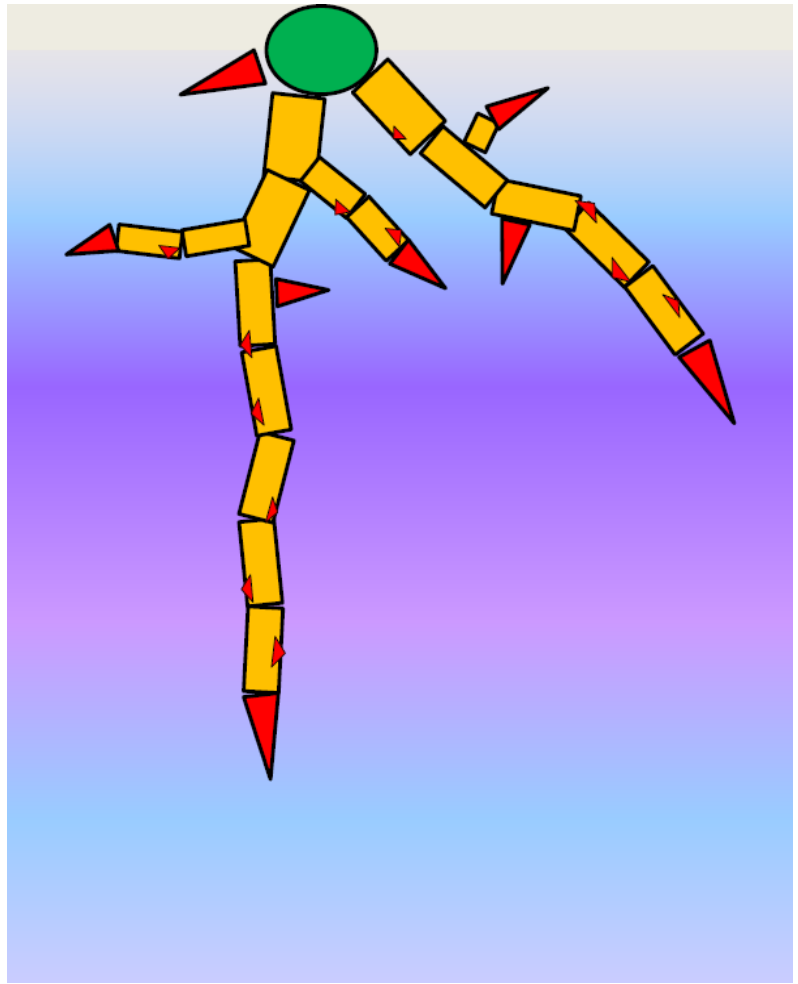
Constant

Mathematical term that will never change either during the simulation nor between simulations (eg. Physical constants such as constant gaz)

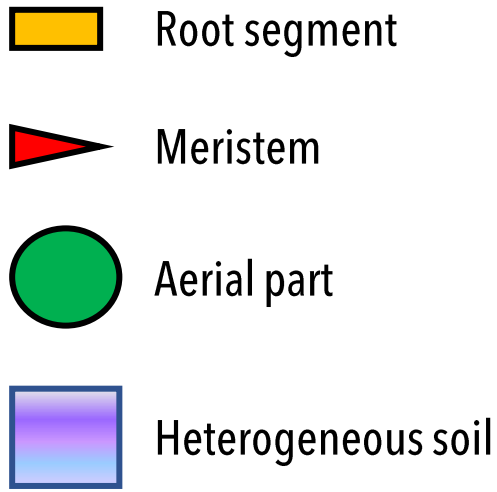
Biology of root development

Global overview of ArchiSimple

- Growth is driven by **meristem diameter**
- The **architecture** of roots is explicitly reprezented in 3D
- Parameters of the model are **ecophysiological traits** of root system architecture
  - Root diameter
  - Branching density
  - Root hierarchy
  - Elongation speed
- Root diameters are defined by
  - Maximal diameter
  - Minimal diameter



Several objects that are connected together



How does ArchiSimple simulates the growth of root system ?

Biology of root development

How ArchiSimple simulates root growth ?

1. Elongation
2. Acropetal branching
3. Radial growth
4. Root emission
5. Root death

Biology of root development

How ArchiSimple simulates root growth ?

1. Elongation
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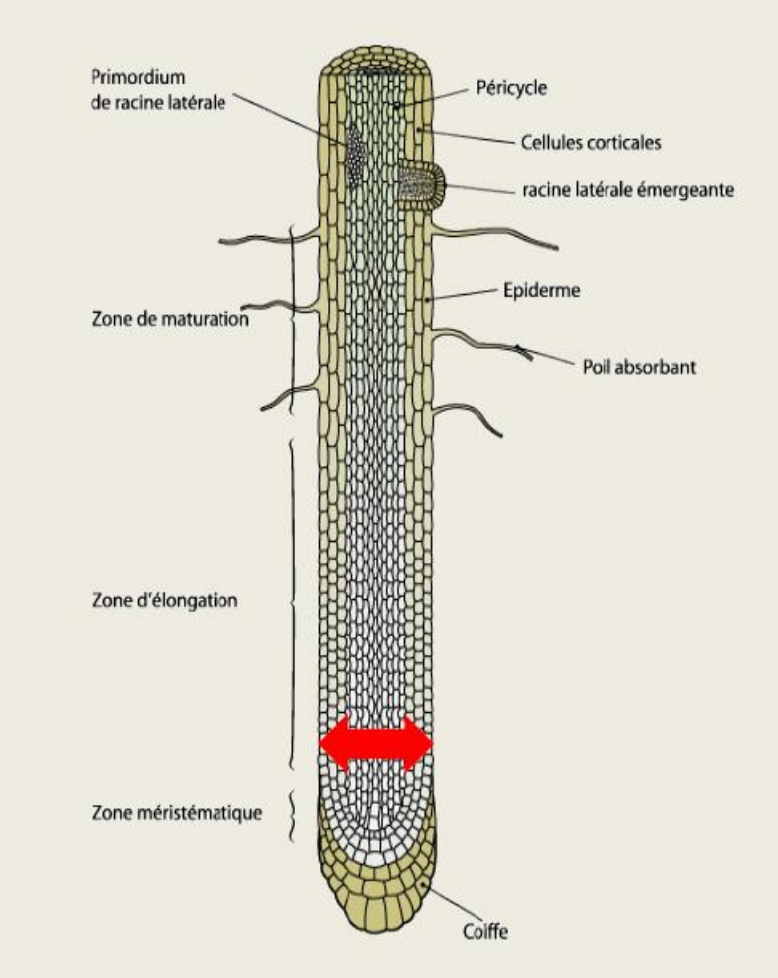
5. Root death

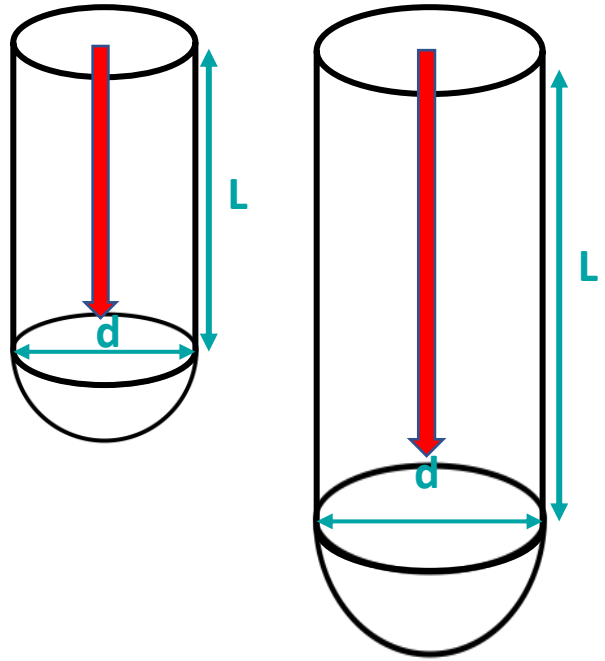
- Elongation speed
- Elongation duration
- Elongation direction

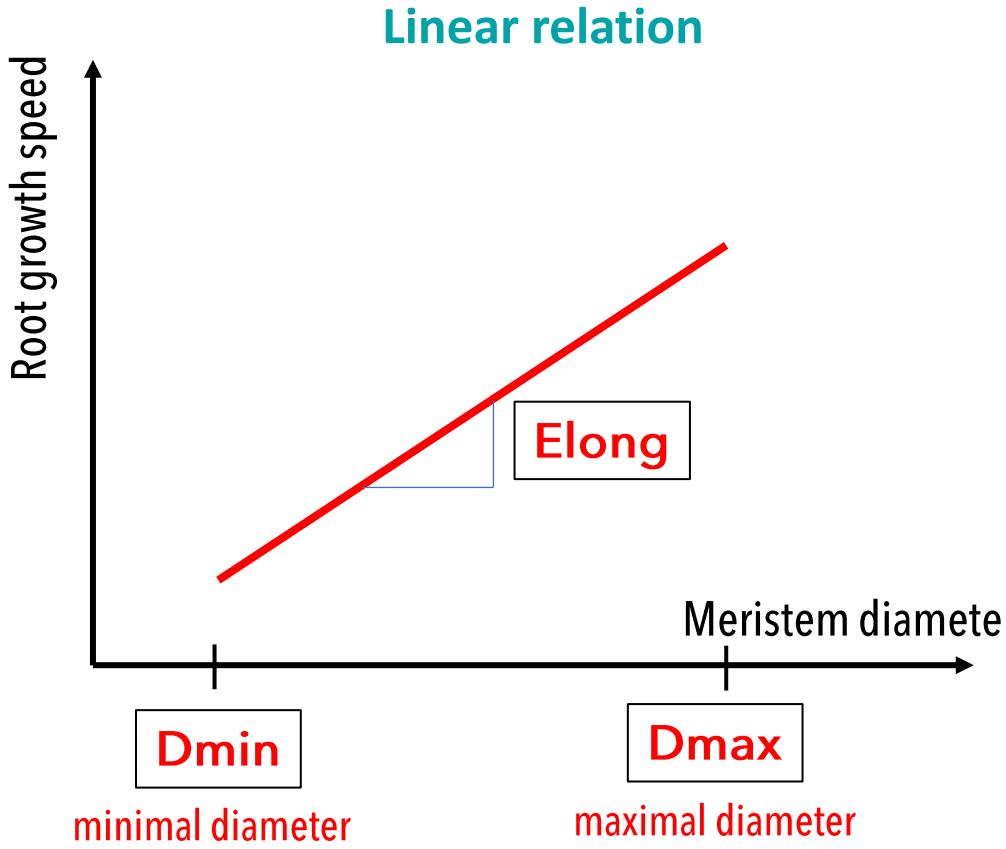
Formalisms of ArchiSimple

How ArchiSimple simulates root elongation ?

Growth speed of root depends on apical diameter



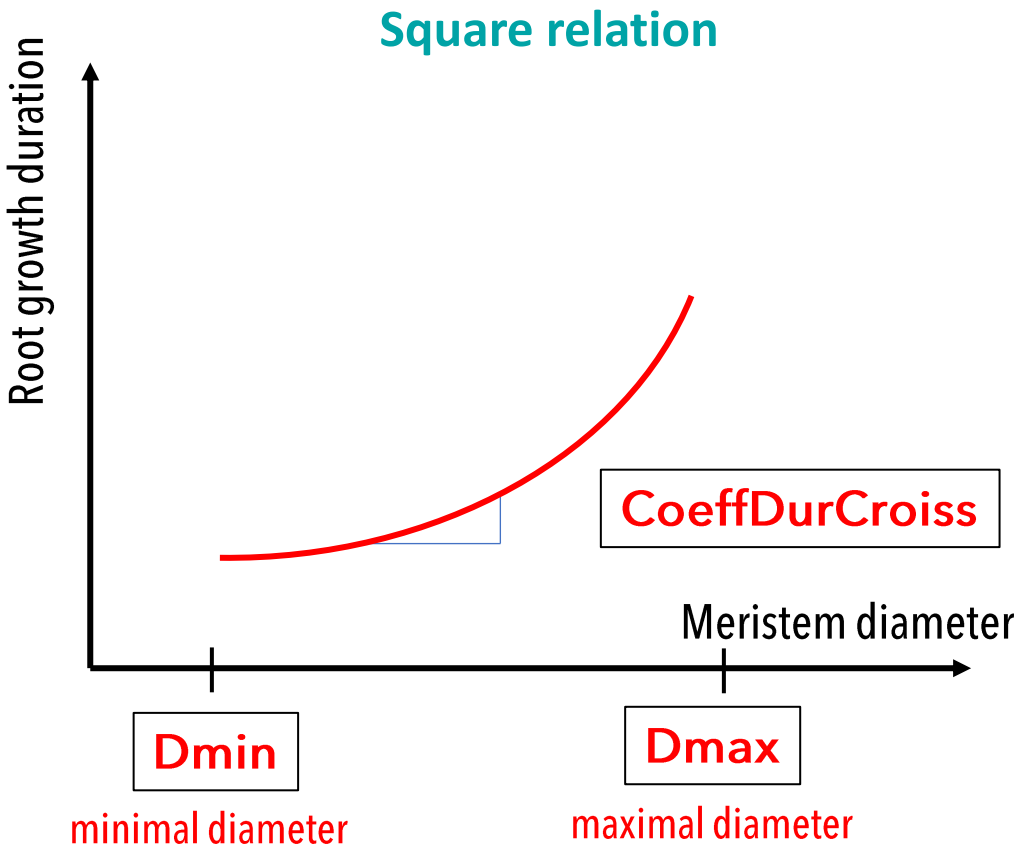




Formalisms of ArchiSimple

How ArchiSimple simulates root elongation ?

Growth duration of root depends on apical diameter



Formalisms of ArchiSimple

How ArchiSimple simulates root elongation ?

Growth direction is set by the user

- 2 parameters :

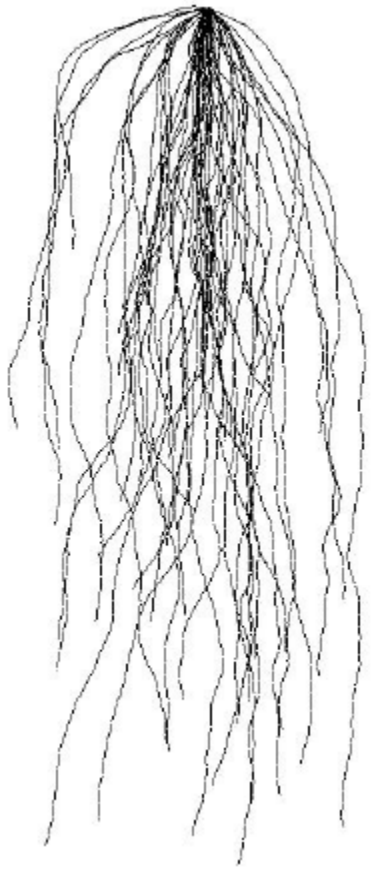
Tgravi

- Type of gravitropism
  - 0 : gravitropism
  - 1 : exotropism
  - 2 : plagiotropism

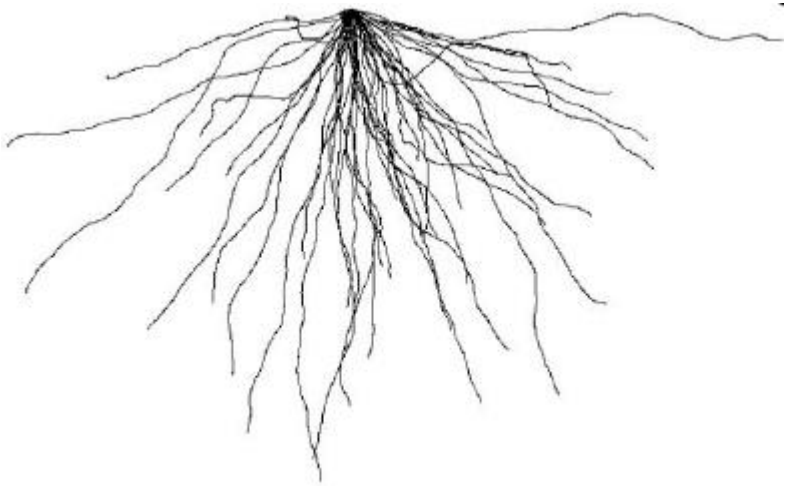
Igravi

- Intensity of gravotropism

Gravotropism



Exotropism



Plagiotropism

Biology of root development

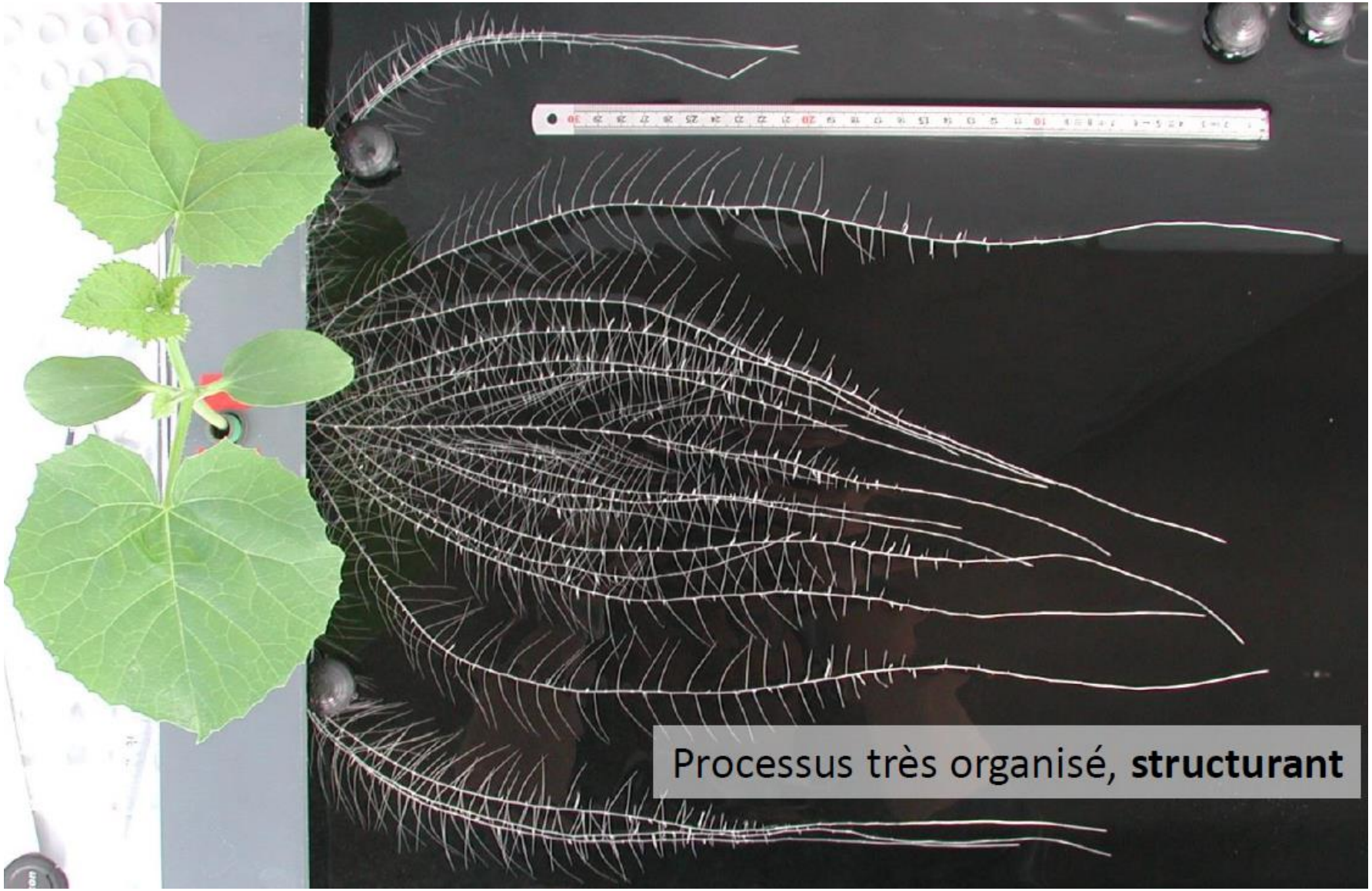
How ArchiSimple simulates root growth ?

1. Elongation
2. Acropetal branching
3. Radial growth
4. Root emission
5. Root death

- Root density
- Dynamic of root emergence
- Diameter of daughter roots

Formalisms of ArchiSimple

How ArchiSimple simulates root branching ?



Formalisms of ArchiSimple

How ArchiSimple simulates root branching ?

Timing of ramifications

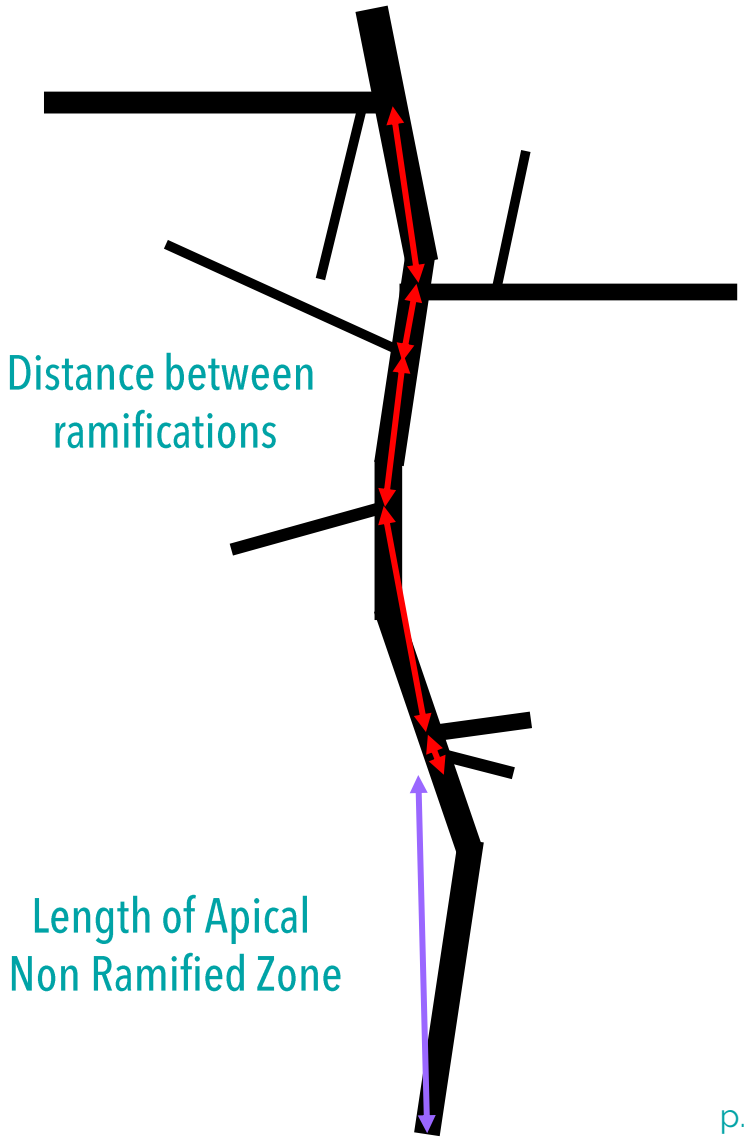
- Ramifications occur regularly (defined by the distance between two consecutive ramifications)
  - Probability to produce a lateral primordium

DIR

Around 1 when the distance between consecutive ramifications reaches **DIR**

- Dynamic of root emergence
  - Delay between the emergence of a meristem and its elongation

DurDevPrim



Formalisms of ArchiSimple

How ArchiSimple simulates root branching ?

Properties of new meristems

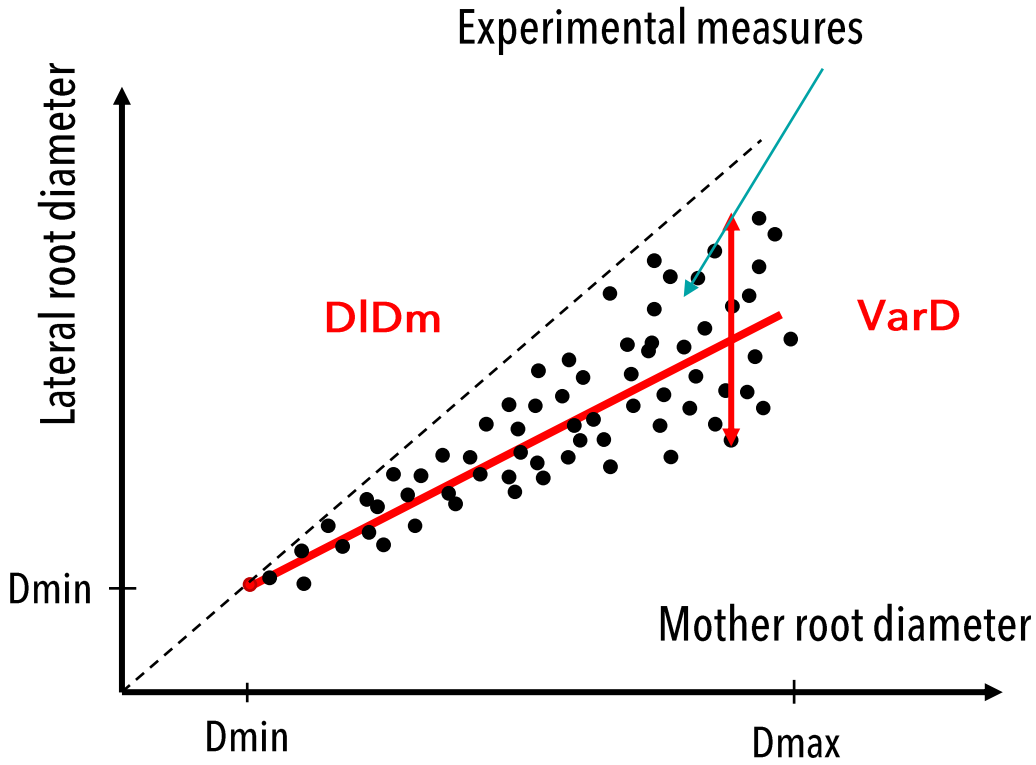
- Diameter of **lateral** roots depends on diameter of **mother** roots

- Diameter of **lateral** roots depends on the **variability** of diameter roots

DlDm

VarD

Estimation of the size of the apical meristem of lateral root



Biology of root development

How ArchiSimple simulates root growth ?

1. Elongation
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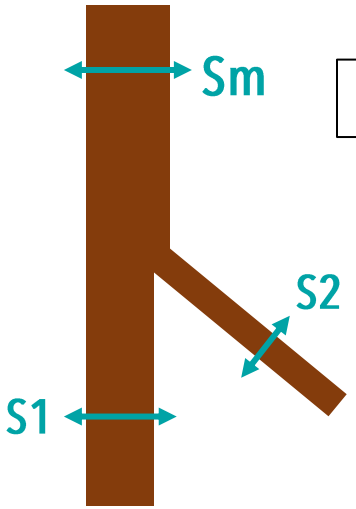
Formalisms of ArchiSimple

How ArchiSimple simulates root radial growth ?

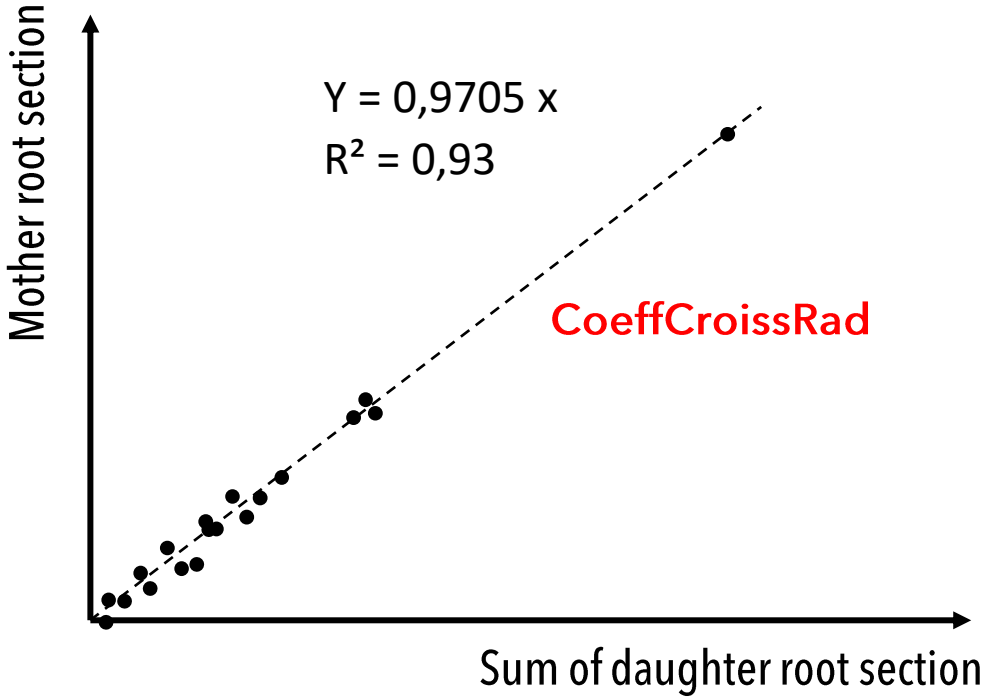
Radial growth

- Linear relation between section of mother root and the sum of the sections of all daughter roots



CoeffCroissRad

Sm = CoeffCroissRad x (S1 + S2)



Biology of root development

How ArchiSimple simulates root emission ?

1. Elongation
2. Acropetal branching
3. Radial growth
4. Root emission
5. Root death

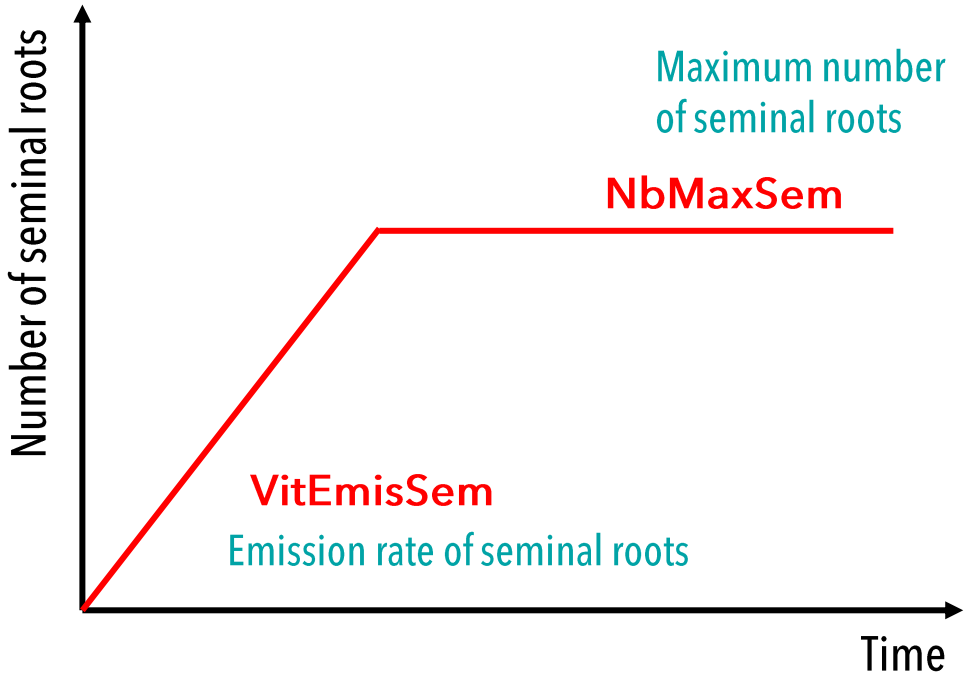
Formalisms of ArchiSimple

How ArchiSimple simulates root emission ?

Seminal roots

- Seminal roots are **linearly produced** until their number reach the **maximum number of seminal roots**

PropDmaxSem
Diameter of seminal roots
(proportion of Dmax)

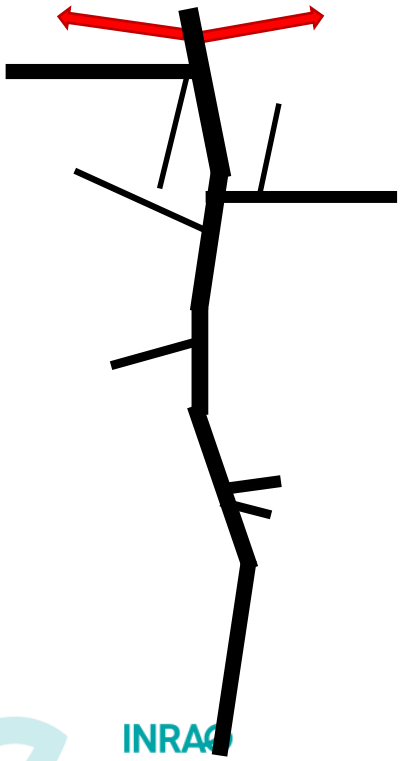


Formalisms of ArchiSimple

How ArchiSimple simulates root growth ?

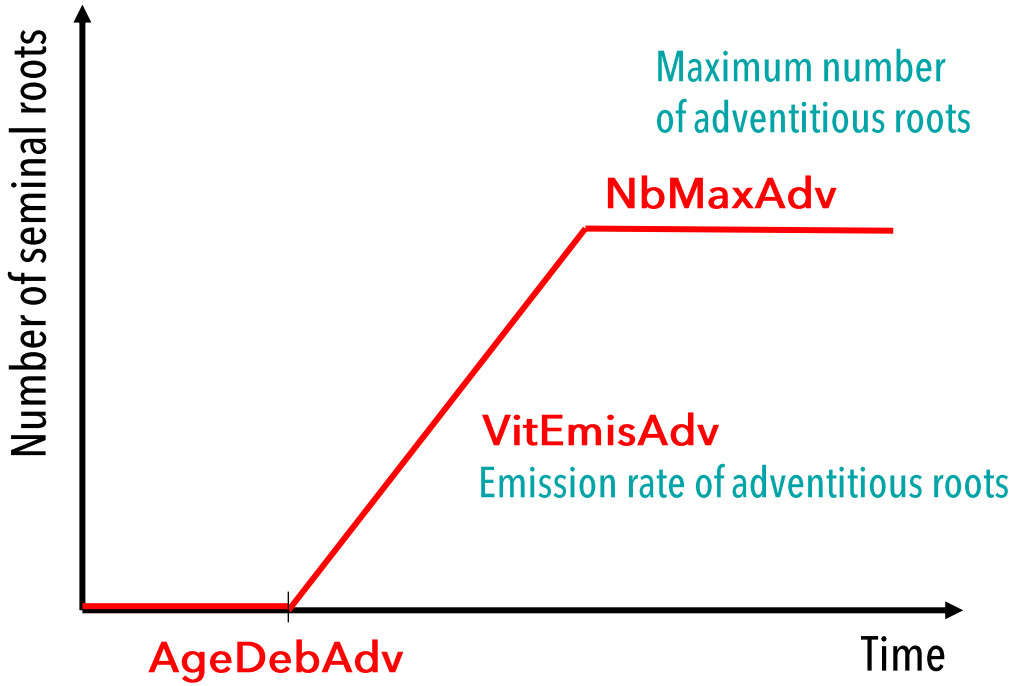
Adventitious roots

- Adventitious roots are **linearly produced** until their number reach the **maximum number of adventitious roots**



PropDmaxAdv

Diameter of adventitious roots (proportion of Dmax)



Biology of root development

How ArchiSimple simulates root death ?

1. Elongation
2. Acropetal branching
3. Radial growth
4. Root emission
5. Root death

Formalisms of ArchiSimple

How ArchiSimple simulates root death ?

Root life duration

- Coefficient of proportionnality

CoeffDurVie

Life duration of root depends on **root density** and **root diameter**

Formalisms of ArchiSimple

All parameters of ArchiSimple

Root emission

NbMaxSem

PropDmaxSem

VitEmisSem

NbMaxAdv

PropDmaxAdv

VitEmisAdv

AgeDebAdv

Root branching

DIR

DurDevPrim

DlDm

VarD

Root elongation

Tgravi

Igravi

CoeffDurCroiss

Elong

Root radial growth

CoeffCroissRad

Root death

CoeffDurVie

Root diameter

Dmin

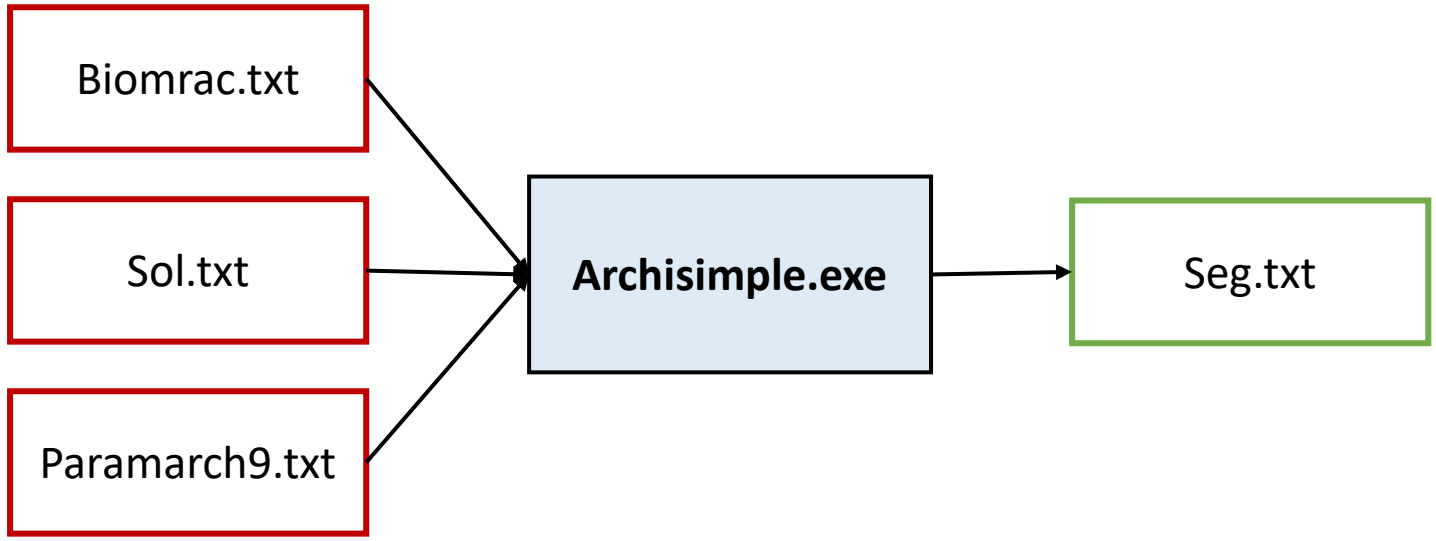
Dmax

How to use ArchiSimple

Informatic structure

Formalisms of ArchiSimple

How to use ArchiSimple?



3 fichiers d'entrées

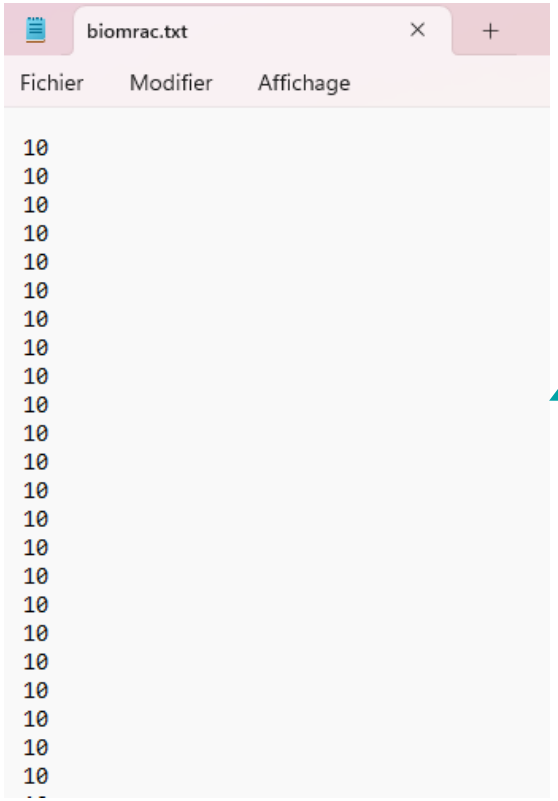
- **Biomrac.txt** :
  limitation journalière de croissance
  (carbone qui arrive par les partie aérienne)
- **Sol.txt** : structure du sol
- **Paramarch9.txt** : paramètres du modèle

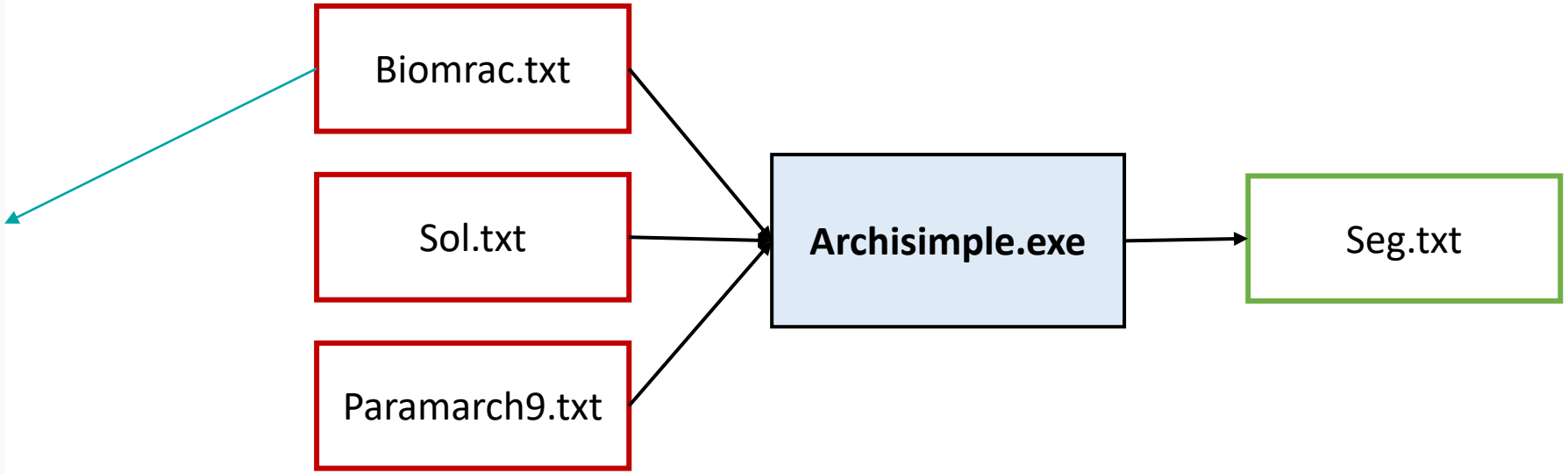
1 output

- **seg.txt** :
  the list of all root segments, their dimensions and their position in space

Formalisms of ArchiSimple

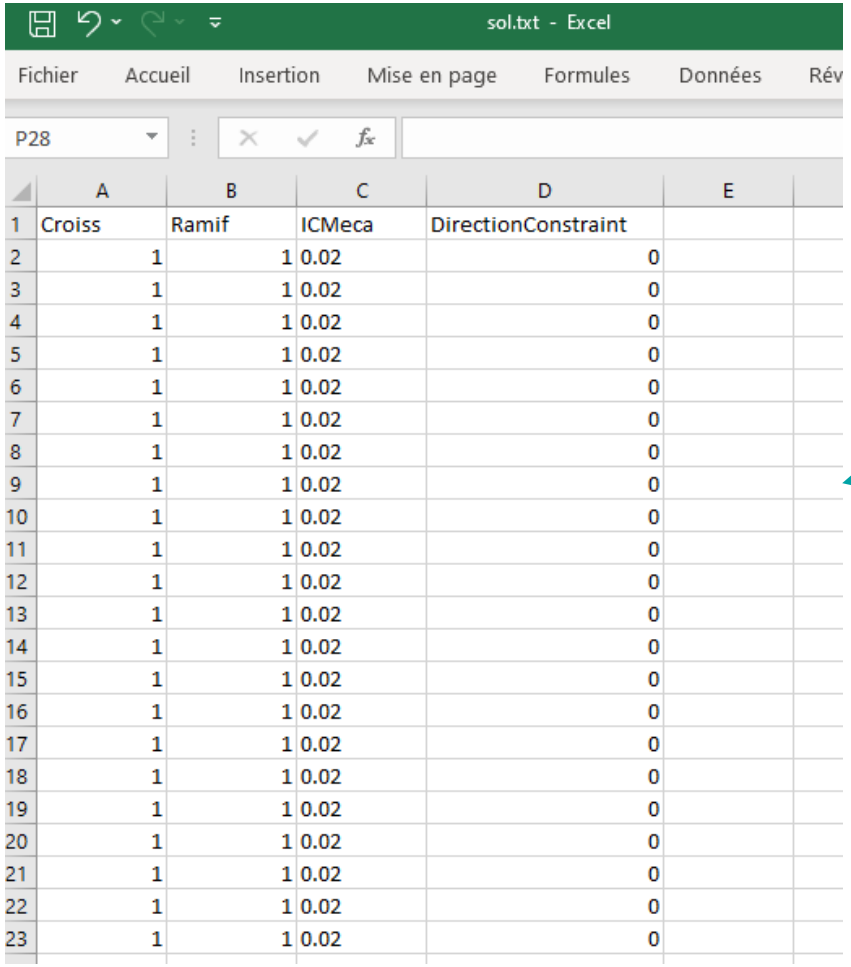
How to use ArchiSimple?



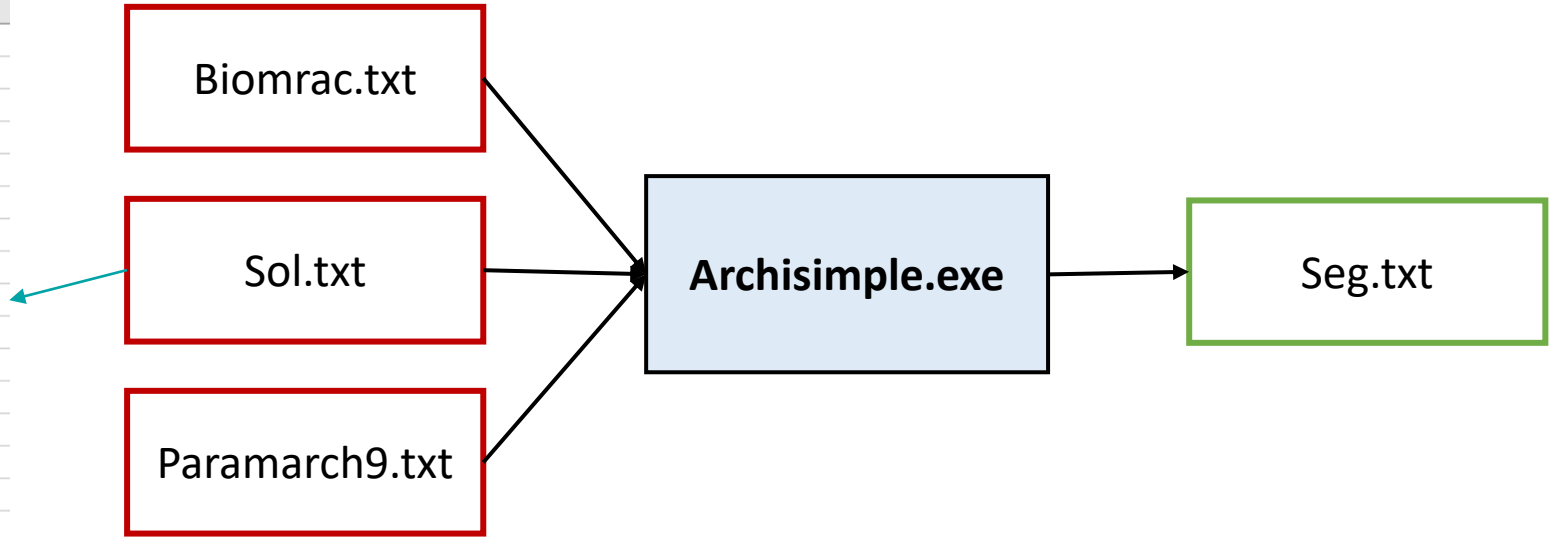


Formalisms of ArchiSimple

How to use ArchiSimple?



	A	B	C	D	E
1	Croiss	Ramif	ICMeca	DirectionConstraint	
2	1	1	0.02	0	
3	1	1	0.02	0	
4	1	1	0.02	0	
5	1	1	0.02	0	
6	1	1	0.02	0	
7	1	1	0.02	0	
8	1	1	0.02	0	
9	1	1	0.02	0	
10	1	1	0.02	0	
11	1	1	0.02	0	
12	1	1	0.02	0	
13	1	1	0.02	0	
14	1	1	0.02	0	
15	1	1	0.02	0	
16	1	1	0.02	0	
17	1	1	0.02	0	
18	1	1	0.02	0	
19	1	1	0.02	0	
20	1	1	0.02	0	
21	1	1	0.02	0	
22	1	1	0.02	0	
23	1	1	0.02	0	



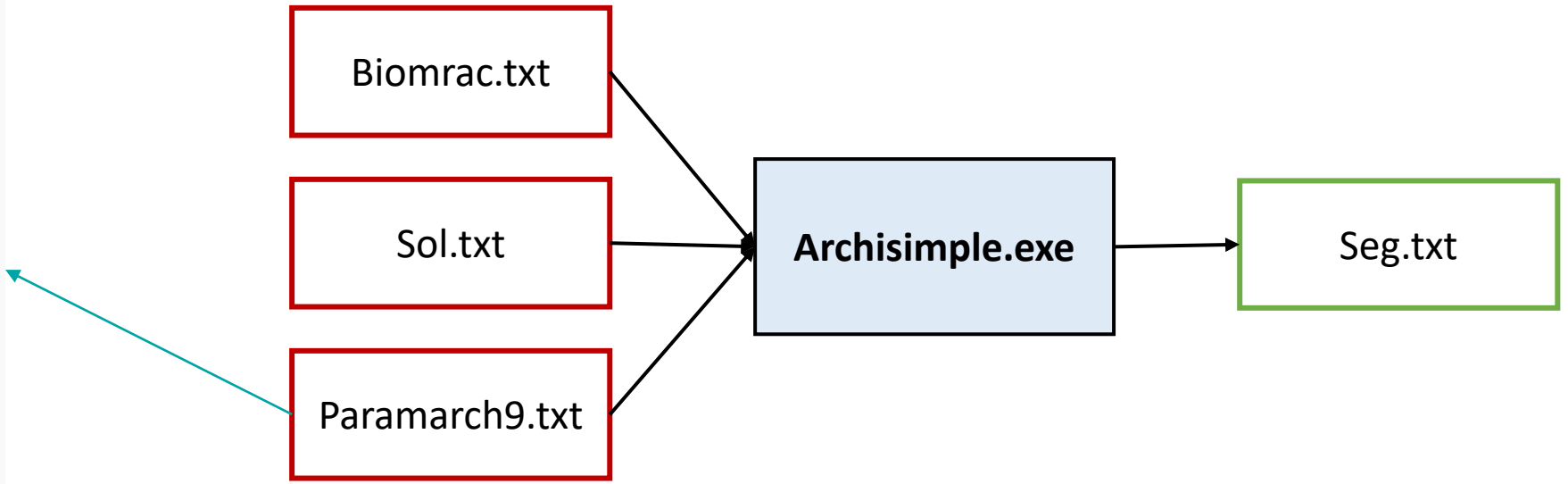
Formalisms of ArchiSimple

How to use ArchiSimple?

paramarch9.txt

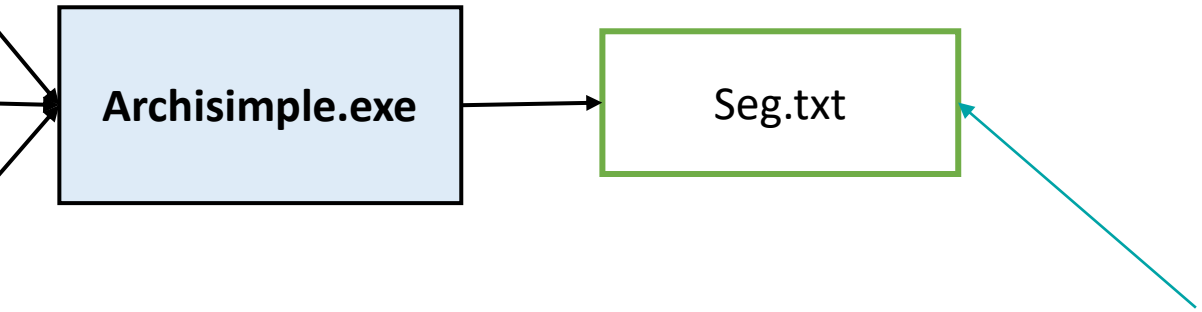
Fichier Modifier Affichage

```
30
1
1
1
0
0
0
0
0
0.1
0.95
50
1
0.05
5
2.5
0.35
0.15
0.13
600
10000
0.3
```



Formalisms of ArchiSimple

How to use ArchiSimple?



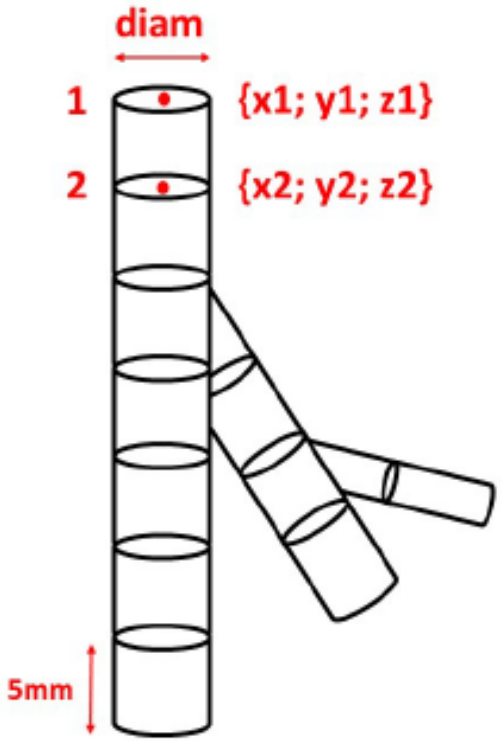
seg.txt - Bloc-notes

Fichier Edition Format Affichage ?

NumAxe	Jour	Diam	X1	Y1	Z1	X2	Y2	Z2
1	7	2.38	0.00	0.00	10.00	-0.21	0.09	14.99
1	7	2.35	-0.21	0.09	14.99	-0.14	0.26	19.99
1	8	2.34	-0.14	0.26	19.99	0.15	0.38	24.98
1	8	2.34	0.15	0.38	24.98	0.61	0.35	29.96
1	8	2.31	0.61	0.35	29.96	1.24	0.12	34.91
1	9	2.27	1.24	0.12	34.91	1.98	0.16	39.86
1	9	2.25	1.98	0.16	39.86	2.73	0.19	44.80
1	9	2.23	2.73	0.19	44.80	3.42	-0.04	49.75
1	10	2.23	3.42	-0.04	49.75	3.75	0.05	54.74
1	10	2.18	3.75	0.05	54.74	3.97	0.44	59.72
1	10	2.15	3.97	0.44	59.72	4.00	0.47	64.72
1	11	2.13	4.00	0.47	64.72	4.31	0.65	69.71
1	11	2.09	4.31	0.65	69.71	4.72	1.00	74.68
1	11	2.09	4.72	1.00	74.68	5.32	1.48	79.62
1	12	2.07	5.32	1.48	79.62	5.87	2.12	84.55
1	12	2.06	5.87	2.12	84.55	6.29	2.25	89.53
1	12	2.03	6.29	2.25	89.53	6.55	2.57	94.51
1	13	1.99	6.55	2.57	94.51	6.96	2.47	99.49
1	13	1.95	6.96	2.47	99.49	7.56	2.70	104.45
1	13	1.93	7.56	2.70	104.45	8.25	2.83	109.40
1	14	1.91	8.25	2.83	109.40	8.52	2.78	114.39
1	14	1.89	8.52	2.78	114.39	8.37	2.80	119.39
1	14	1.88	8.37	2.80	119.39	8.35	2.58	124.39
1	15	1.88	8.35	2.58	124.39	8.56	2.38	129.38
1	15	1.85	8.56	2.38	129.38	8.59	1.94	134.36
1	15	1.84	8.59	1.94	134.36	8.34	1.31	139.31
1	16	1.80	8.34	1.31	139.31	8.27	0.44	144.24
1	16	1.80	8.27	0.44	144.24	7.90	-0.24	149.18
1	16	1.77	7.90	-0.24	149.18	7.53	-0.40	154.16
1	17	1.74	7.53	-0.40	154.16	6.86	-0.38	159.12

Formalisms of ArchiSimple

How to use ArchiSimple?



seg.txt - Bloc-notes

Fichier Edition Format Affichage ?

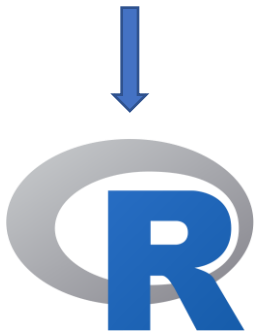
NumAxe	Jour	Diam	X1	Y1	Z1	X2	Y2	Z2
1	7	2.38	0.00	0.00	10.00	-0.21	0.09	14.99
1	7	2.35	-0.21	0.09	14.99	-0.14	0.26	19.99
1	8	2.34	-0.14	0.26	19.99	0.15	0.38	24.98
1	8	2.34	0.15	0.38	24.98	0.61	0.35	29.96
1	8	2.31	0.61	0.35	29.96	1.24	0.12	34.91
1	9	2.27	1.24	0.12	34.91	1.98	0.16	39.86
1	9	2.25	1.98	0.16	39.86	2.73	0.19	44.80
1	9	2.23	2.73	0.19	44.80	3.42	-0.04	49.75
1	10	2.23	3.42	-0.04	49.75	3.75	0.05	54.74
1	10	2.18	3.75	0.05	54.74	3.97	0.44	59.72
1	10	2.15	3.97	0.44	59.72	4.00	0.47	64.72
1	11	2.13	4.00	0.47	64.72	4.31	0.65	69.71
1	11	2.09	4.31	0.65	69.71	4.72	1.00	74.68
1	11	2.09	4.72	1.00	74.68	5.32	1.48	79.62
1	12	2.07	5.32	1.48	79.62	5.87	2.12	84.55
1	12	2.06	5.87	2.12	84.55	6.29	2.25	89.53
1	12	2.03	6.29	2.25	89.53	6.55	2.57	94.51
1	13	1.99	6.55	2.57	94.51	6.96	2.47	99.49
1	13	1.95	6.96	2.47	99.49	7.56	2.70	104.45
1	13	1.93	7.56	2.70	104.45	8.25	2.83	109.40
1	14	1.91	8.25	2.83	109.40	8.52	2.78	114.39
1	14	1.89	8.52	2.78	114.39	8.37	2.80	119.39
1	14	1.88	8.37	2.80	119.39	8.35	2.58	124.39
1	15	1.88	8.35	2.58	124.39	8.56	2.38	129.38
1	15	1.85	8.56	2.38	129.38	8.59	1.94	134.36
1	15	1.84	8.59	1.94	134.36	8.34	1.31	139.31
1	16	1.80	8.34	1.31	139.31	8.27	0.44	144.24
1	16	1.80	8.27	0.44	144.24	7.90	-0.24	149.18
1	16	1.77	7.90	-0.24	149.18	7.53	-0.40	154.16
1	17	1.74	7.53	-0.40	154.16	6.86	-0.38	159.12

Formalisms of ArchiSimple

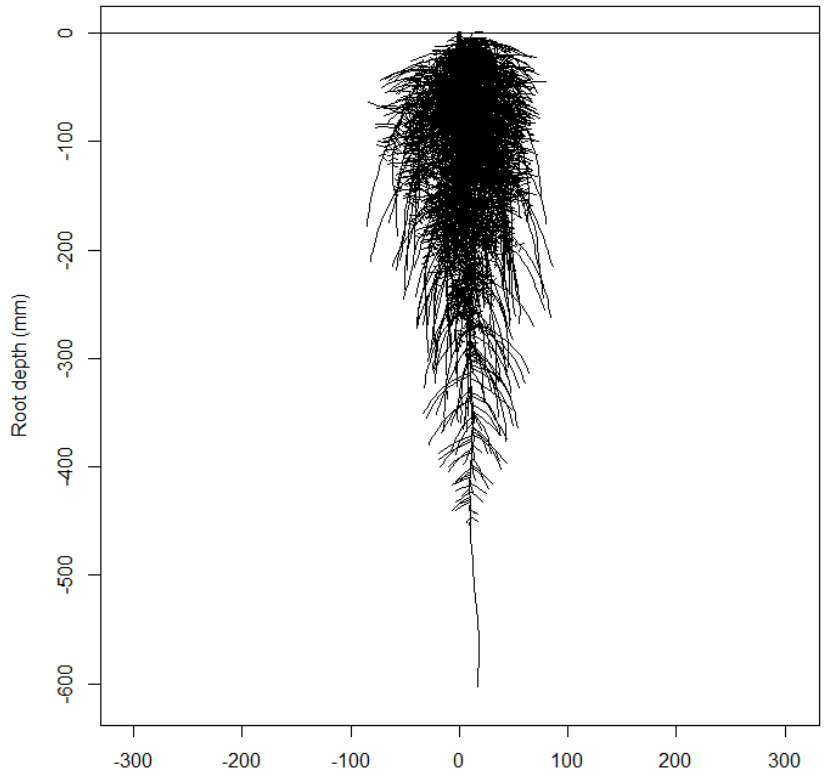
How to use ArchiSimple?

Representation of root system

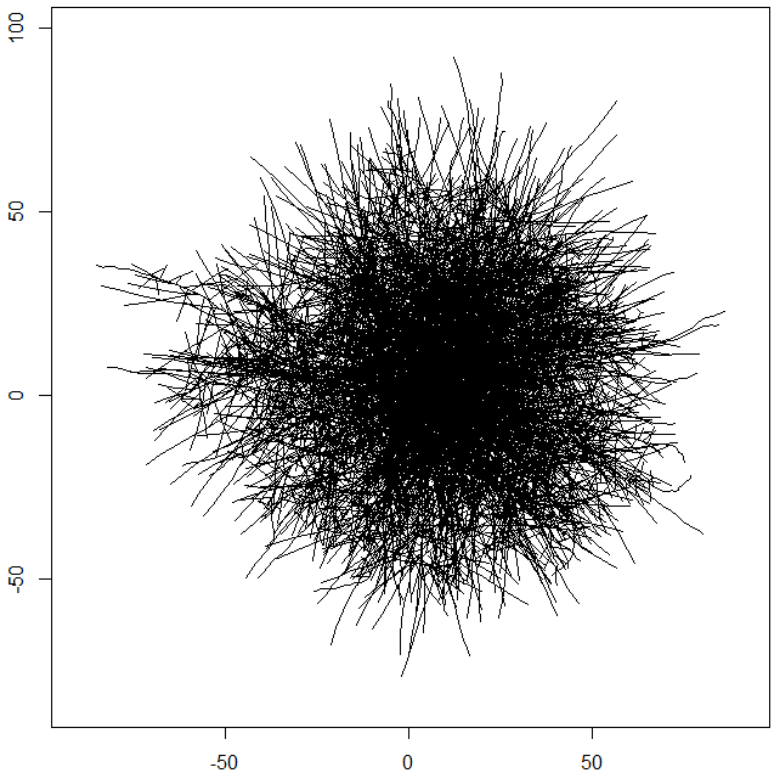
Seg.txt



DrawRootSystemXZ



DrawRootSystemXY



Formalisms of ArchiSimple

How to use ArchiSimple?

Development of root system according to time

Let’s practice !

Formalisms of ArchiSimple

All parameters of ArchiSimple

Root emission

- NbMaxSem
- PropDmaxSem
- VitEmisSem
- NbMaxAdv
- PropDmaxAdv
- VitEmisAdv
- AgeDebAdv

Root branching

- DIR
- DurDevPrim
- DlDm
- VarD

Root elongation

- Tgravi
- Igravi
- CoeffDurCroiss
- Elong

Root radial growth

- CoeffCroissRad

Root death

- CoeffDurVie

Root diameter

- Dmin
- Dmax

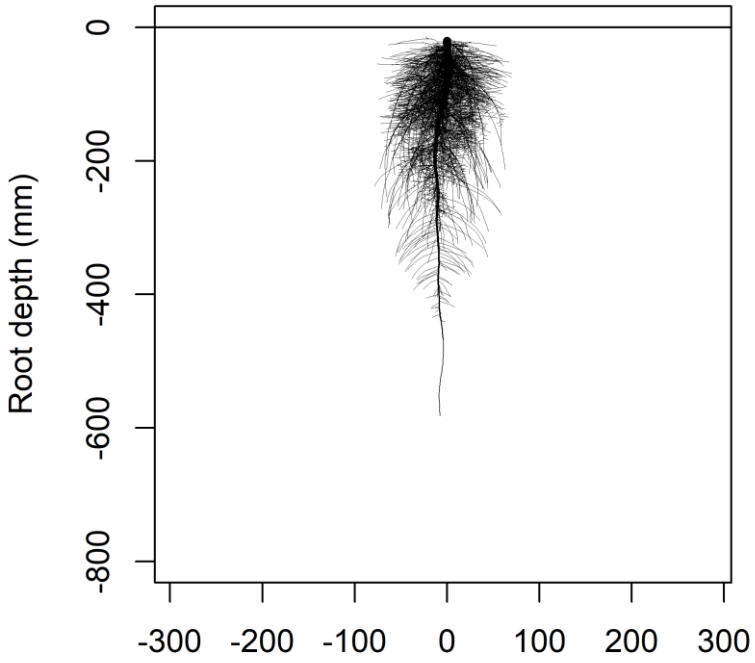
Playing with ArchiSimple

Focus on some parameters

Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	25
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	2,5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Playing with ArchiSimple

Focus on some parameters



Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	25
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	2,5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Depth	Biomass
581 cm	2,94 g

Playing with ArchiSimple

Focus on some parameters

http://e.pc.cd/HX0y6alK

→ TP

→ ./RootSystemSimulation.Rproj

→ ./rscript/TP_RunArchiSomple2023.R

N_simul	NbMaxSem	Tgravi	DIR	Elong	Depth	Biomass
0	1	1	2,5	25	582g	3,12 g
1	4	1	2,5	25		
2	1	0	2,5	25		
3	1	1	1,5	25		
4	1	1	5	25		
5	1	1	2,5	15		
6	1	1	2,5	50		

Au pire …

https://shorturl.at/oL137

Playing with ArchiSimple

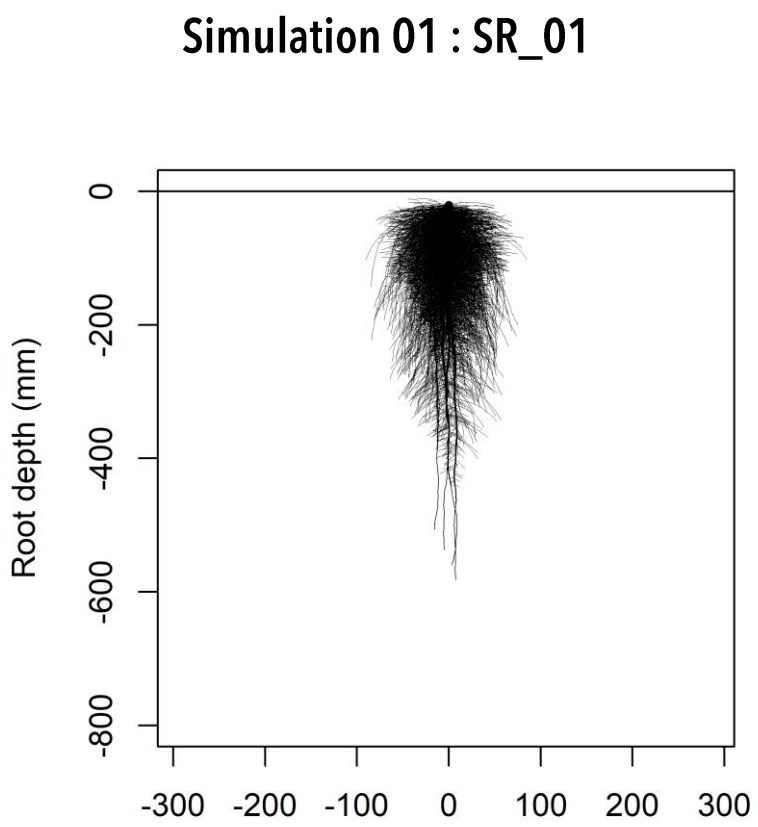
Focus on some parameters

Simulation 01 : SR_01

Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	4
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	25
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	2,5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Playing with ArchiSimple

Focus on some parameters



Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	4
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	25
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	2,5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Depth	Biomass
582 cm	8,34 g

Playing with ArchiSimple

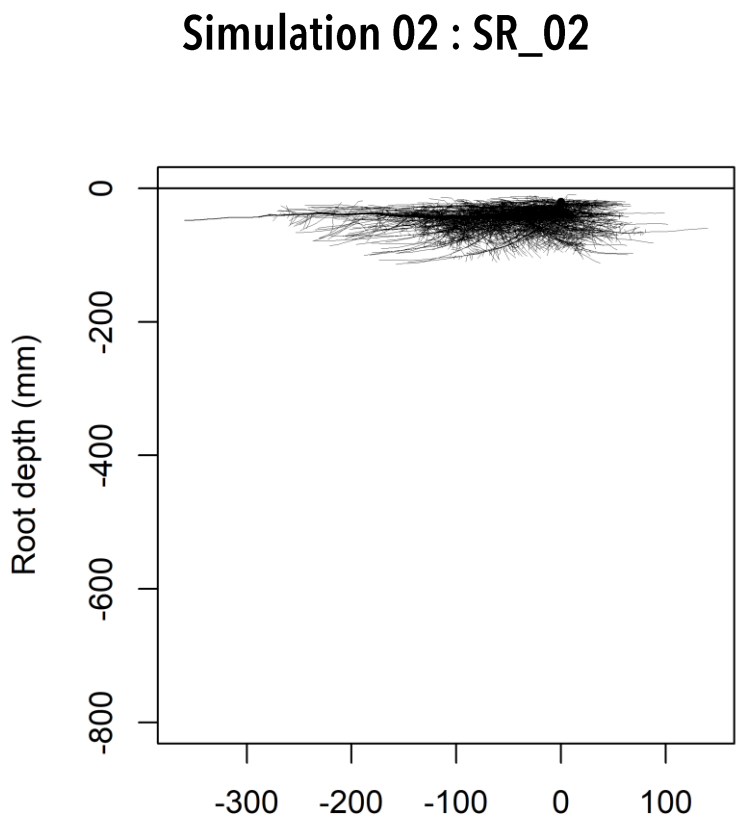
Focus on some parameters

Simulation 02 : SR_02

Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	25
Tgravi	**0**
Igravi	0,05
DurDevPrim	5
DIR	2,5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Playing with ArchiSimple

Focus on some parameters



Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	25
Tgravi	0
Igravi	0,05
DurDevPrim	5
DIR	2,5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Depth	Biomass
124 cm	3,02 g

Playing with ArchiSimple

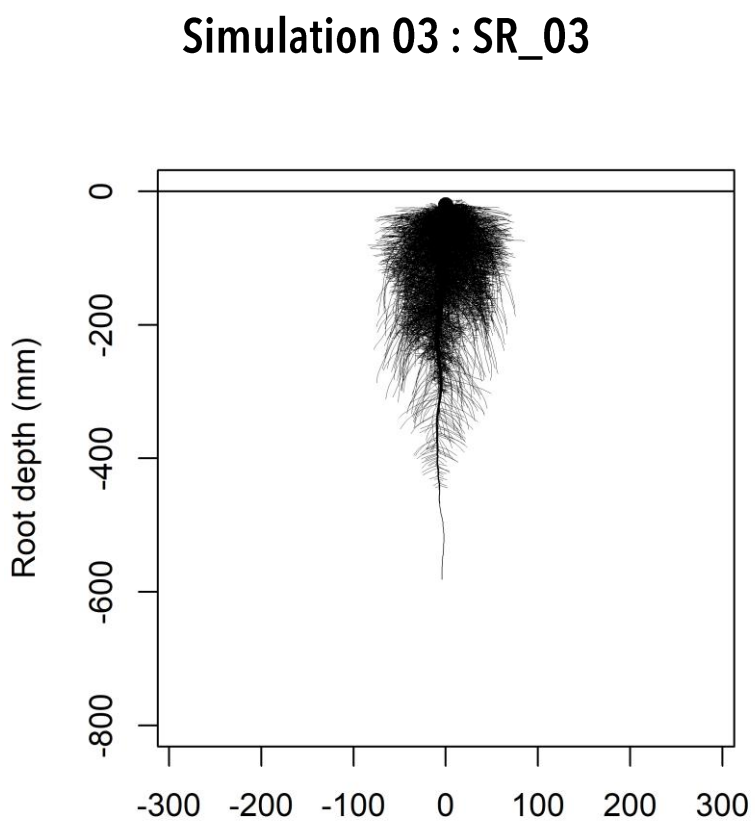
Focus on some parameters

Simulation 03 : SR_03

Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	25
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	**0,5**
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Playing with ArchiSimple

Focus on some parameters

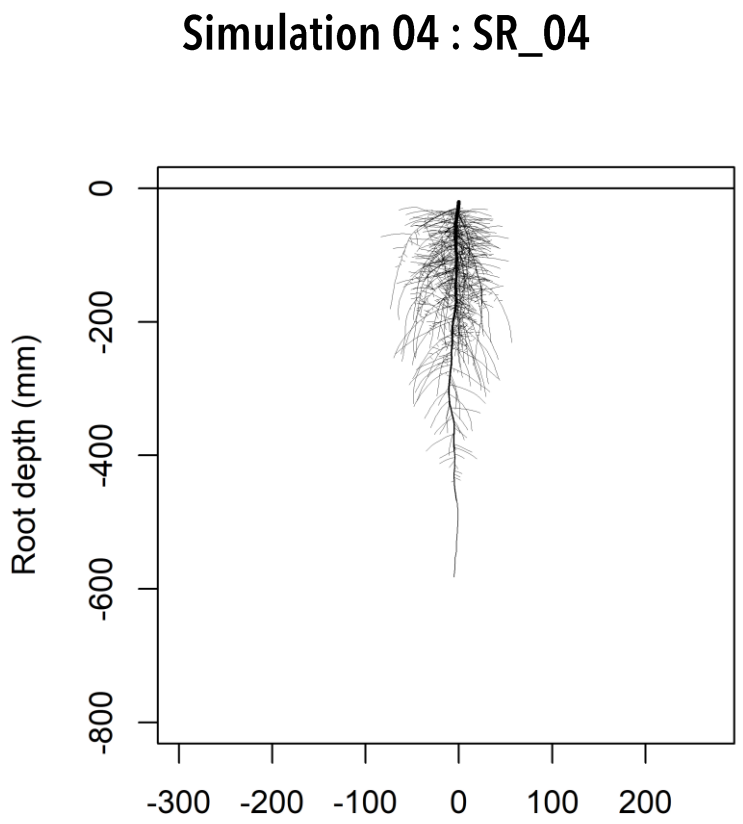


Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	25
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	**0,5**
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Depth	Biomass
582 cm	8,17 g

Playing with ArchiSimple

Focus on some parameters



Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	25
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Depth	Biomass
582 cm	0,95 g

Playing with ArchiSimple

Focus on some parameters

Simulation 04 : SR_04

Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	25
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Playing with ArchiSimple

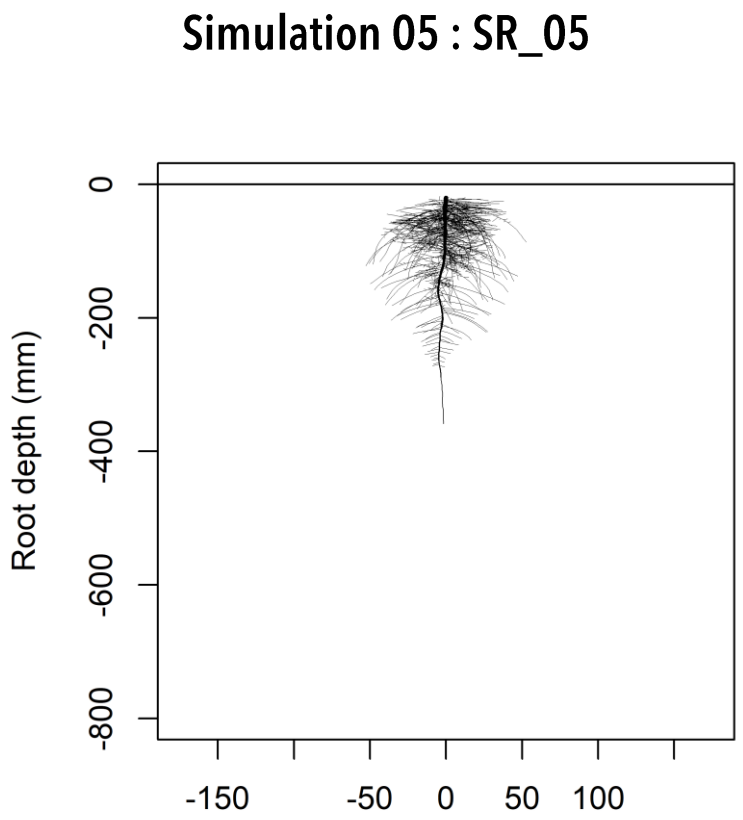
Focus on some parameters

Simulation 05 : SR_05

Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	15
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	2,5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Playing with ArchiSimple

Focus on some parameters



Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	15
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	2,5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Depth	Biomass
358 cm	0,82 g

Playing with ArchiSimple

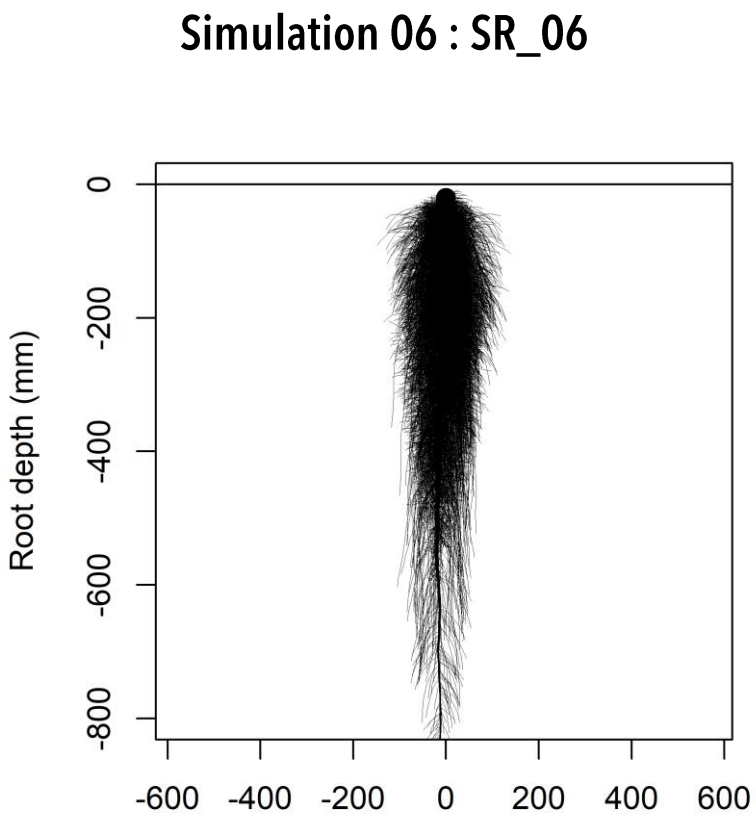
Focus on some parameters

Simulation 06 : SR_06

Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	50
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	2,5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Playing with ArchiSimple

Focus on some parameters



Parameter	Value
ageSimul	30
VitEmisSem	1
PropDmaxSem	1
NbMaxSem	1
AgeDebAdv	0
DistMaxAdv	0
ViteEmisAdv	0
PropDmaxAdv	0
NbMaxAdv	0
Dmin	0,1
Dmax	0,95
Elong	50
Tgravi	1
Igravi	0,05
DurDevPrim	5
DIR	2,5
DlDm	0,35
VarD	0,15
RTD	0,13
CoeffDurCroiss	600
CoeffDurVie	10000
CoeffCroissRad	0,3

Depth	Biomass
1149 cm	25,53 g

Playing with ArchiSimple

Focus on some parameters

N_simul	NbMaxSem	Tgravi	DIR	Elong	Depth (mm)	Biomass (g)
0	1	1	2,5	25	581 cm	2,94 g
1	4	1	2,5	25	582 cm	8,34 g
2	1	0	2,5	25	124 cm	3,02 g
3	1	1	1,5	25	582 cm	8,17 g
4	1	1	5	25	582 cm	0,95 g
5	1	1	2,5	15	358 cm	0,82 g
6	1	1	2,5	50	1149 cm	25,53 g