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Ecophysiological response of *Populus euphratica* to drought and recovery

Marie-Béatrice Bogeat-Triboulot, Didier Le Thiec, David Hukin, Hervé Cochard and Erwin Dreyer

*UMR UHP-INRA Forest Ecology and Ecophysiology
INRA Nancy - France*

P. euphratica : a drought resistant species within a drought sensitive genus?

Ein Avdat natural park, Israel



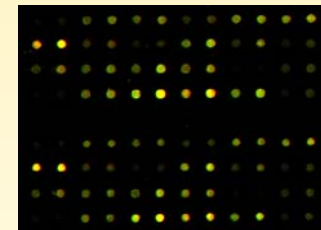
- ✓ section Turanga - central Asia, north Africa
- ✓ famous for its tolerance to salt stress
- ✓ present in desert (Taklamakan - China)
- ✓ phreatophyte (Gries, 2003)
- ✓ ... response to water deficit not studied

Objectives

- ✓ Study the level of drought susceptibility of *P. euphratica*
- ✓ Assess the respective **chronology of the physiological disturbances** (water status, growth, gas exchange, embolism)



- ✓ Relate it relatively to :
 - **time**
 - **volumetric soil water content (SWC)**
 - **relative extractable water (REW)**



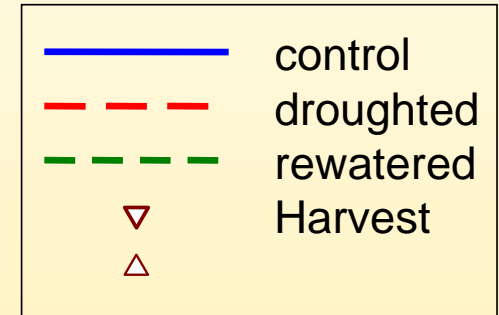
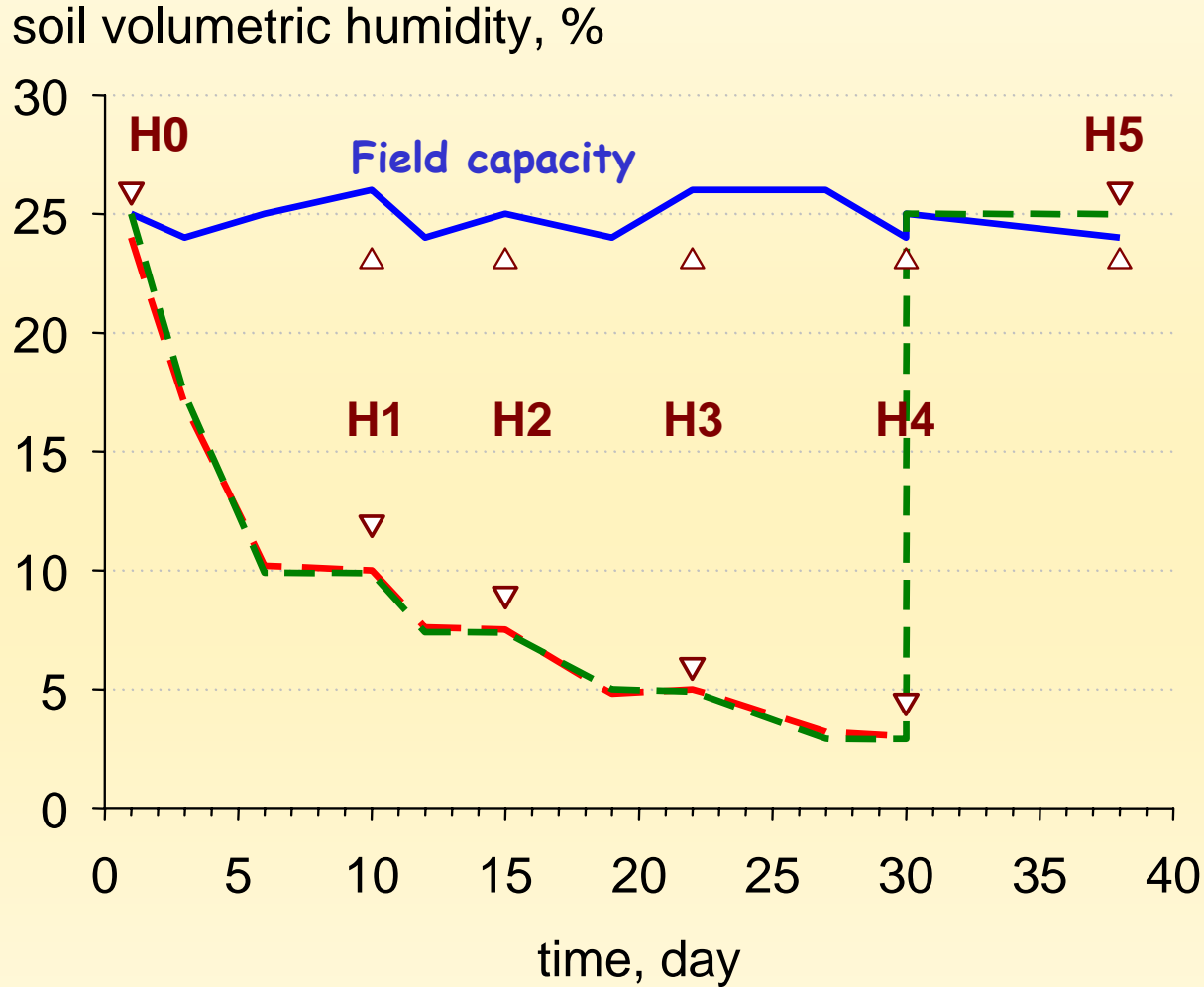
- ✓ Relate the physiological disturbances to the genes expression

Populus euphratica

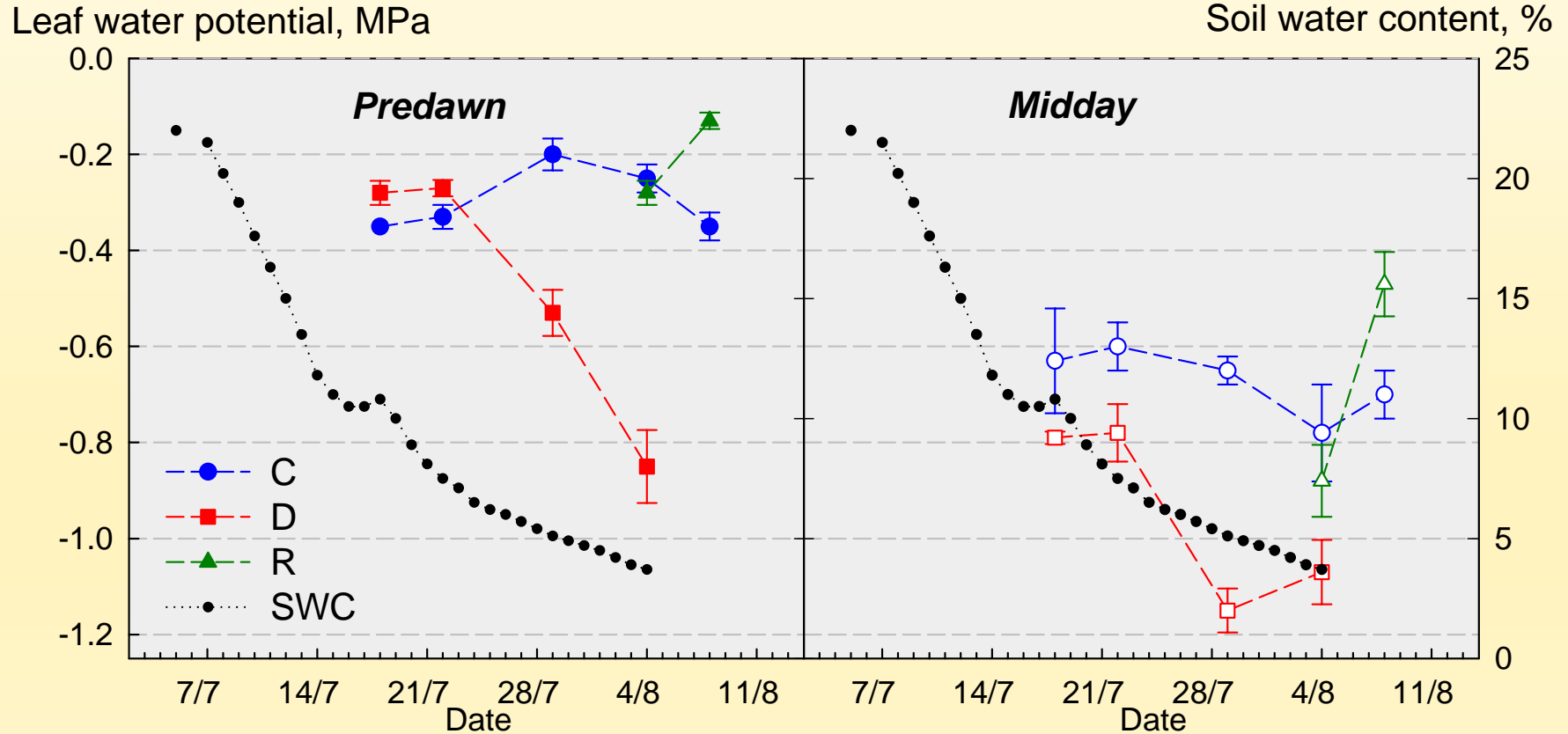


Drought in 2003
... in INRA Nancy's greenhouse !

Expected drought time course



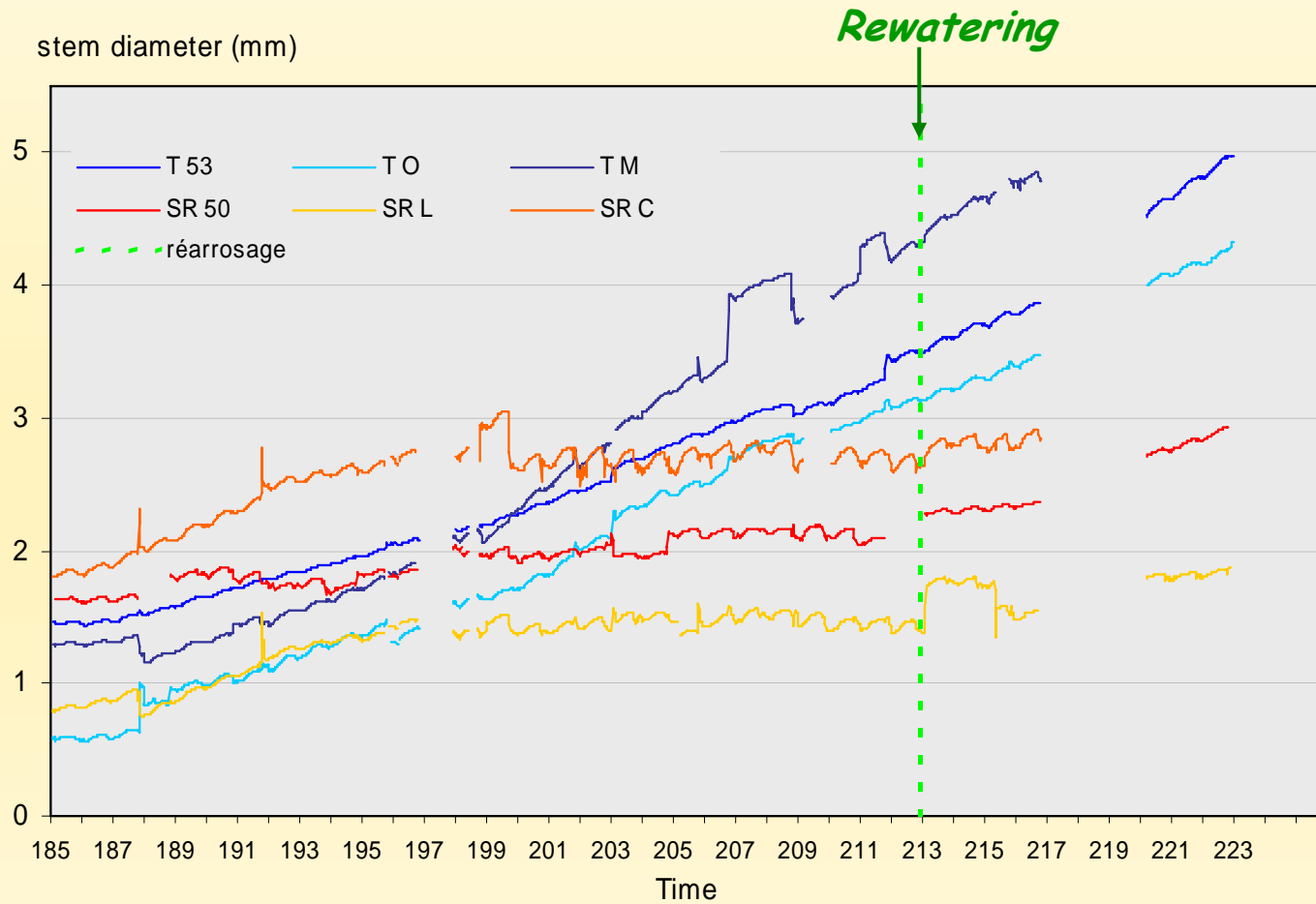
Leaf water potential



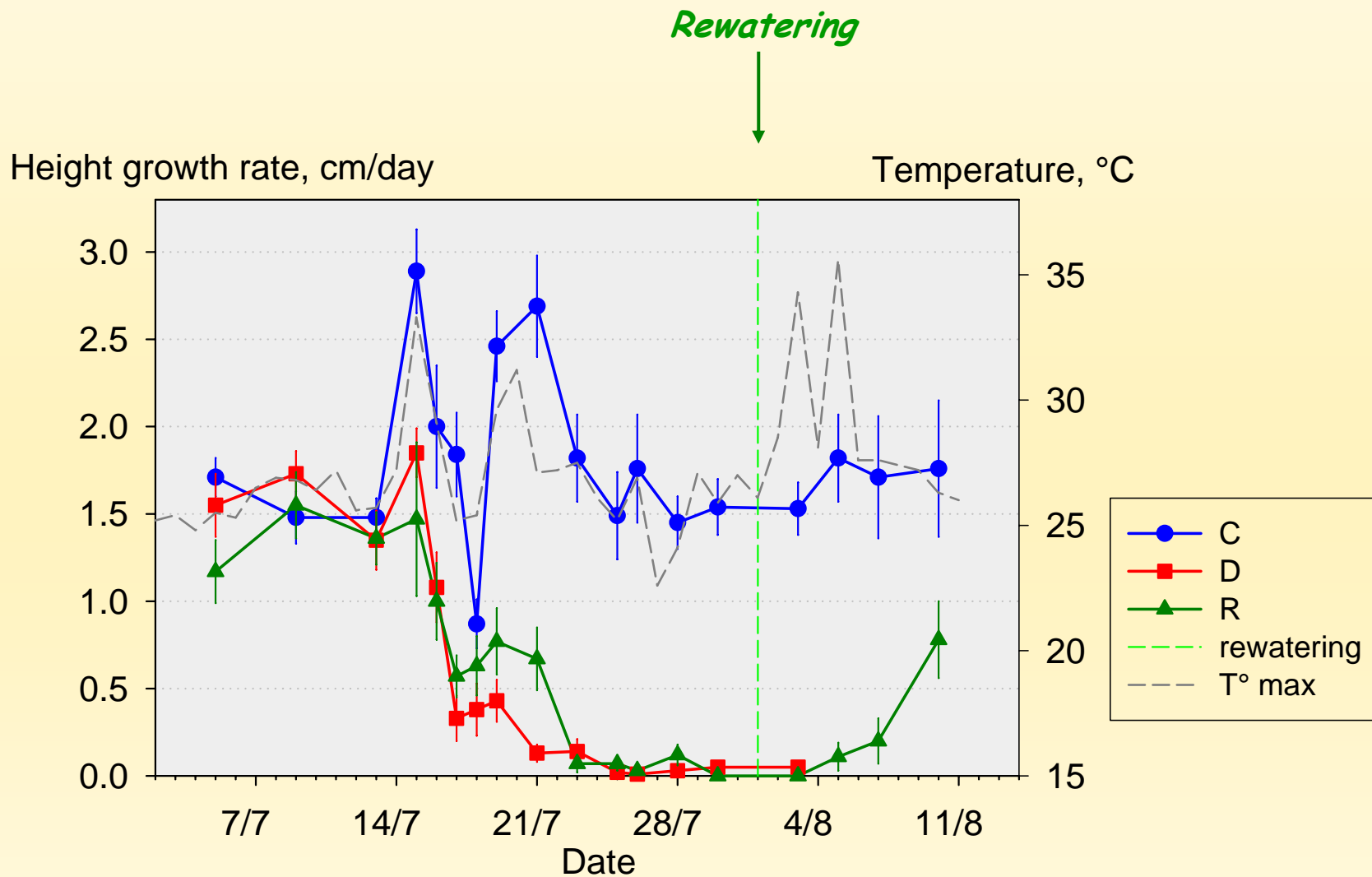
⇒ low water potential gradient (< 0.5 MPa) : hydraulic efficient

⇒ lowest Ψ_{pd} : -1 MPa

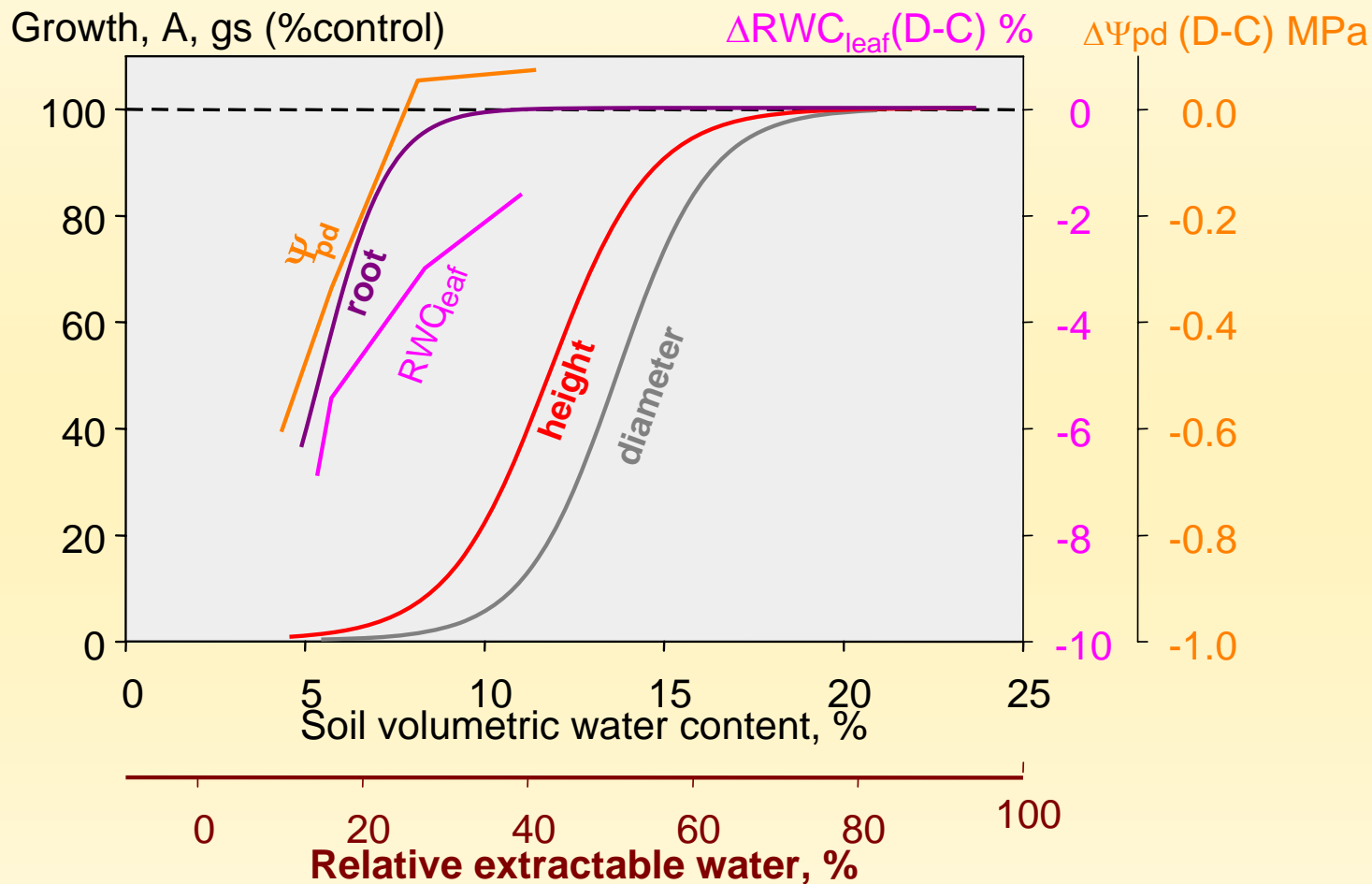
Radial increment



Height growth



Growth and water status versus soil water content



Water status and growth

- ⇒ Most sensitive parameter : diameter increment
- ⇒ Growth reduction as soon as REW < 55%
- ⇒ Fine root growth maintained till low SWC

- ⇒ Low $\Delta\Psi$: hydraulic efficient species
- ⇒ Decrease of Ψ_{pd} : very late as compared to growth reduction

Gas exchange

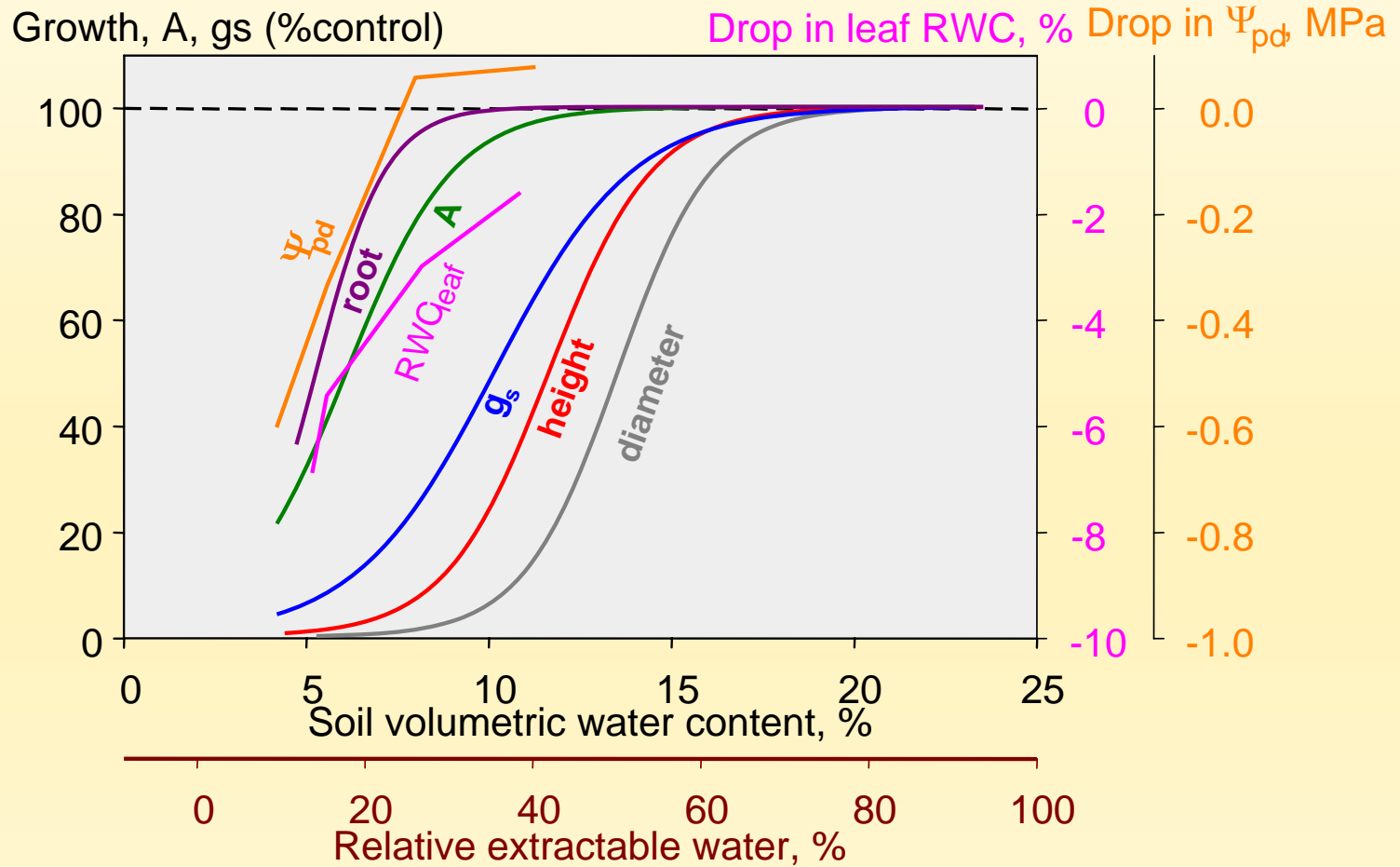
Licor 6200
4-l chambre



Leaf 15

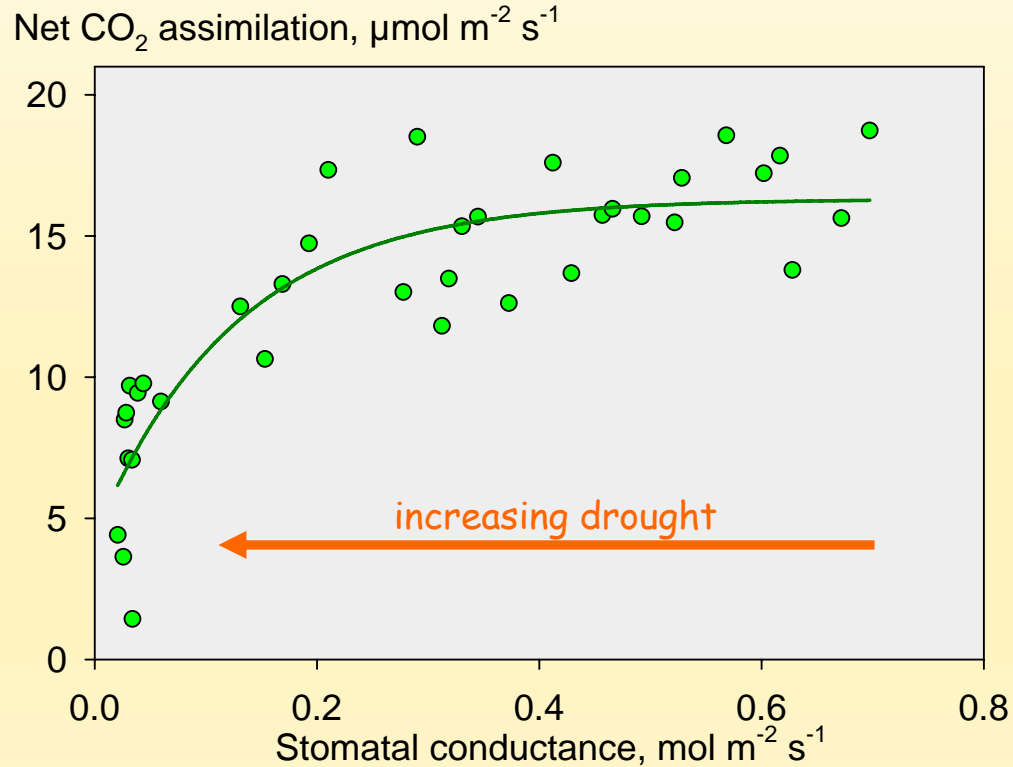


Stomatal conductance and net CO₂ assimilation vs. REW



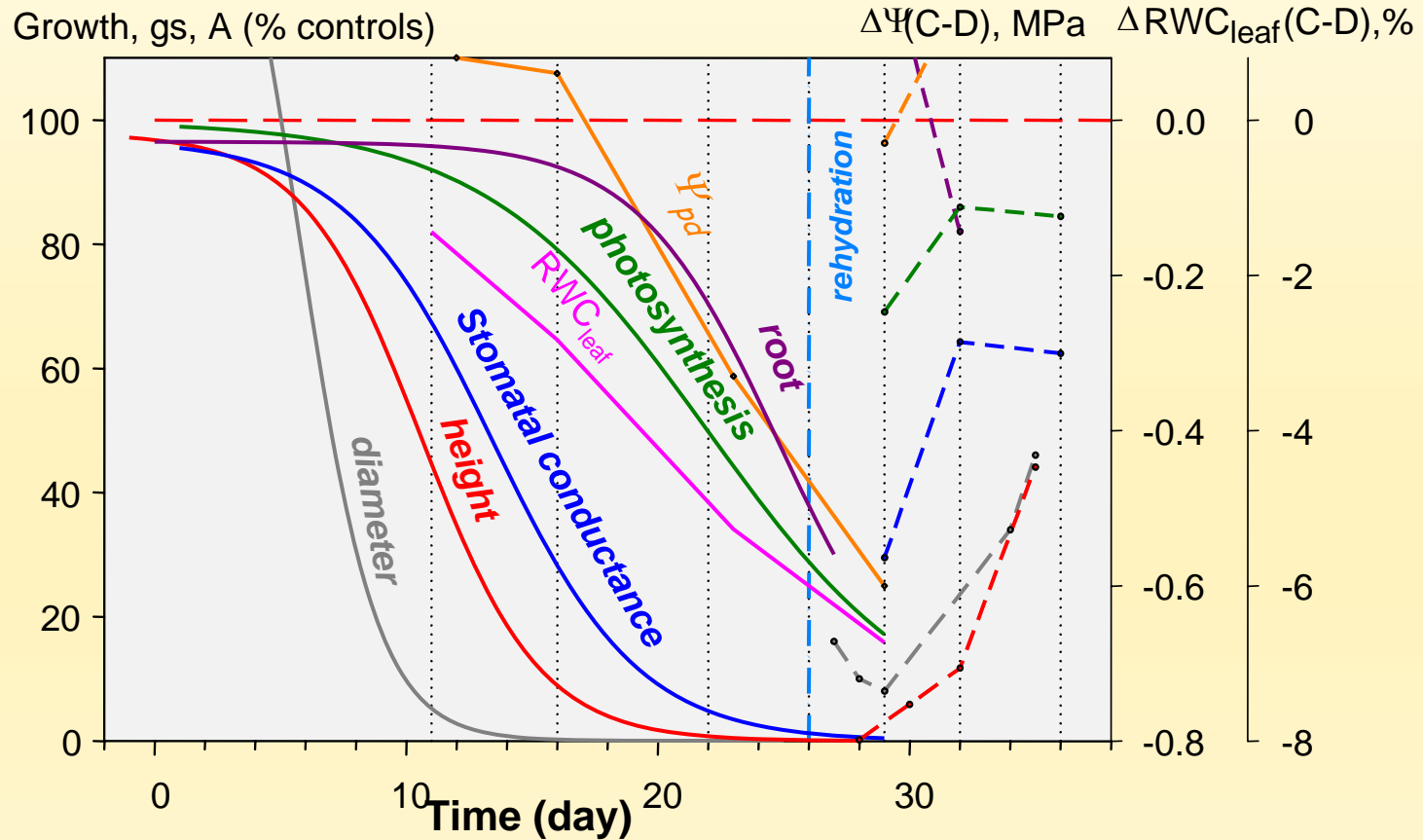
- ⇒ g_s decreased early, as soon as REW < 50%, sooner than RWC_{leaf} but later than growth
- ⇒ A decreased later than g_s (when REW < 35%)

Instantaneous water use efficiency (A/g_s)



- ⇒ high water availability : low water use efficiency ($WUE = A/g_s$)
- ⇒ WUE increased when water availability decreased

Recovery after reirrigation

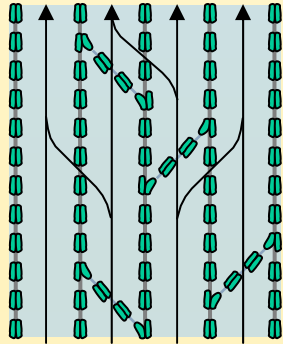


⇒ all processes recovered : reversible effects

Sensitivity to embolism

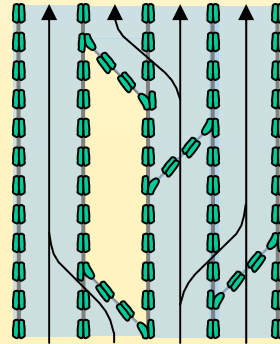
- ✓ Embolism : loss of xylem hydraulic conductivity

All vessels filled



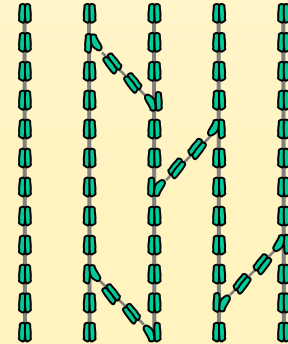
High conductivity

Cavitation begins



Conductivity reduced

Completely embolised

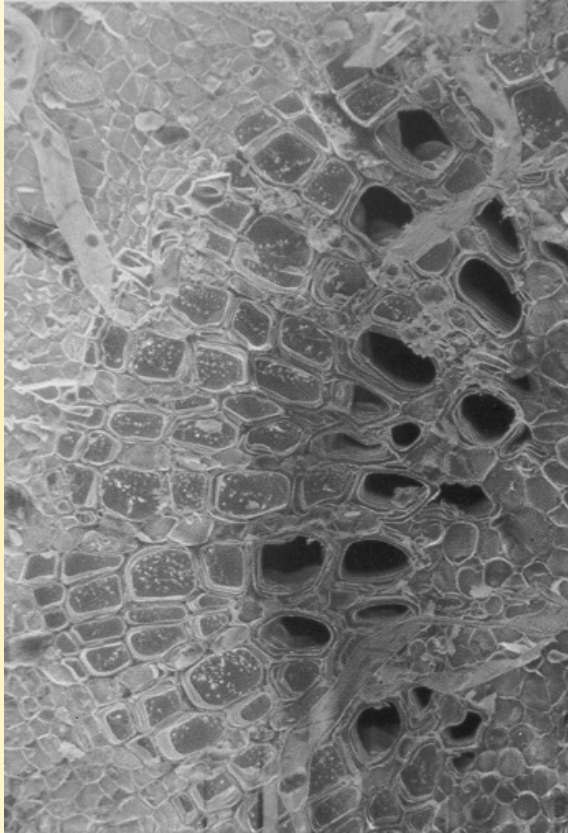


Conductivity virtually zero

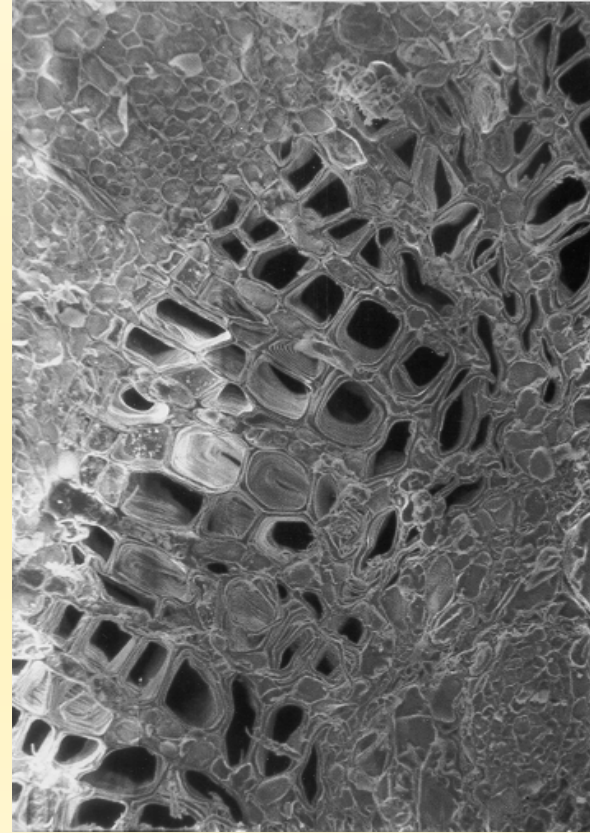
- ✓ Two techniques to measure the level of embolism :
 - Hydraulic : mesure the loss of hydraulic conductance (LPFM)
 - CryoSEM : determine the percentage of embolised vessels

Cryo-SEM images of embolised vessels

P. alba mid-rib vein

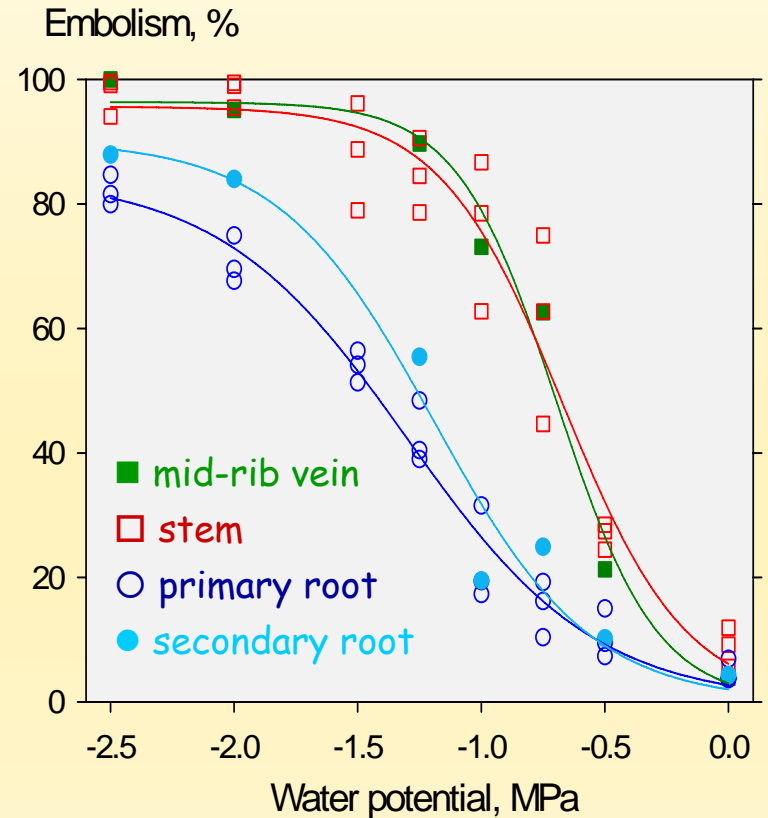
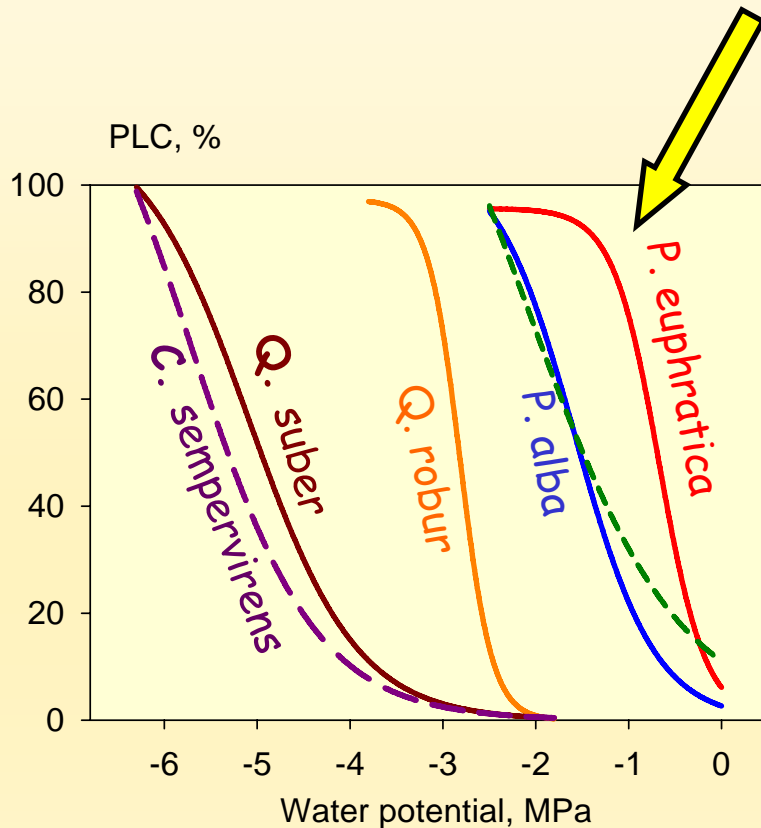


0.5 MPa pressurisation



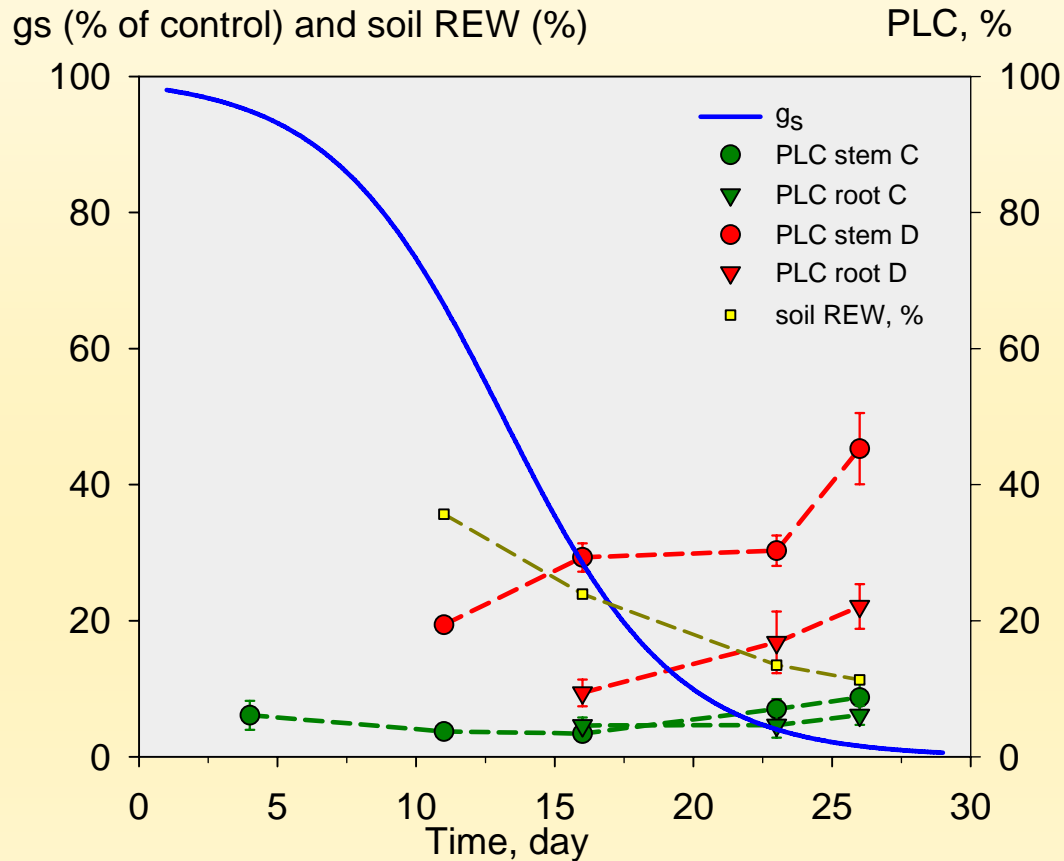
2.5 MPa pressurisation

Vulnerability curves



- ⇒ Roots less vulnerable than stem and leaf veins
- ⇒ Very vulnerable species

Embolie versus stomatal conductance



⇒ early developpement of embolism, before stomatal closure

⇒ for a given stress level, roots were less embolised than stem

Conclusions

Populus euphratica :

- **Chronology** : secondary growth, height growth, stomatal conductance, leaf RWC and photosynthesis, root growth and Ψ_{pd}
- growth very sensitive to a decrease of water availability
- xylem very sensitive to embolism
- ↳ **tolerant to salt but NOT resistant to drought !**

- Roots less vulnerable to cavitation than stems :
 - ↳ survival strategy through 'sprouting' ?

Thank you for your attention