Response of black poplar (Populus nigra L.) to hydrogeomorphological constraints: a semi-controlled ex situ experiment

Virginia Garófano-Gómez, Dov Jean-François Corenblit, Johannes Steiger, Bruno Moulia, Stéphane Ploquin, Patrice Chaleil, Olivier Forestier, André Evette, Eduardo González, Borbála Hortobágyi, et al.

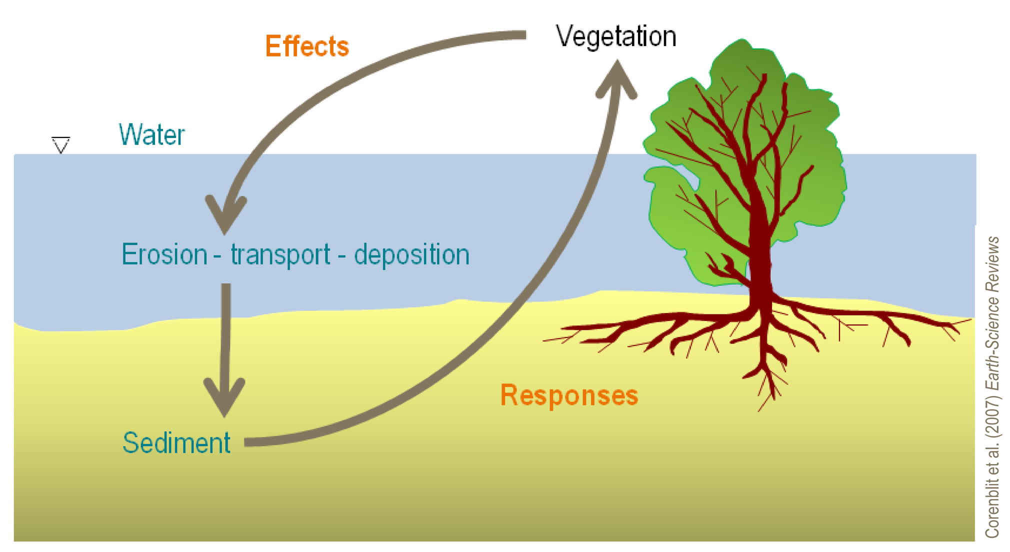
I.S.RIVERS
LYON 2015

RESPONSE OF BLACK POPLAR (*POPULUS NIGRA* L.) TO HYDROGEOMORPHOLOGICAL CONSTRAINTS: A SEMI-CONTROLLED *EX SITU* EXPERIMENT

Réponse du peuplier noir (*Populus nigra* L.) aux contraintes hydro-géomorphologiques : une expérimentation *ex situ* semi-contrôlée

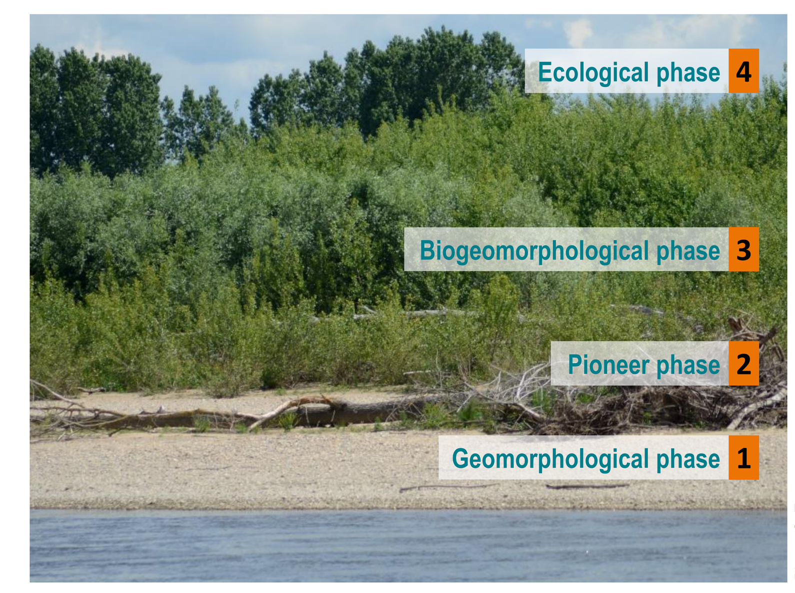
1 Evolutionary feedback between woody riparian species and hydrogeomorphological constraints

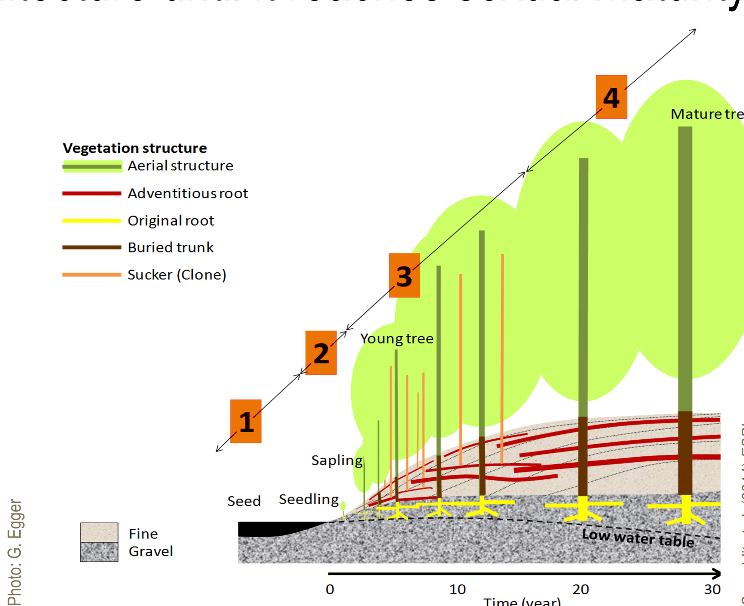
- Hydrogeomorphological factors (topography, flow and sediment transport regimes) control vegetation dynamics in riparian ecosystems → but vegetation also has an impact on these factors, which in turn causes an effect on the plant phenotype.
- **Concepts:** 'ecosystems engineers' and 'positive niche construction'.
- At an evolutionary timescale, this **reciprocal interaction** has promoted the selection of certain **plant traits** to increase the persistence of woody riparian species within fluvial environments.



2 The biogeomorphological life cycle of black poplar (*Populus nigra* L.)

- Black poplar is a keystone ecosystem engineer species. Specific ranges of hydrogeomorphological conditions control the successive phases of its entire life cycle.
- **Hypothesis:** the impact of poplars on the landform structure modulates its own growth performance, biomass and architecture until it reaches sexual maturity.

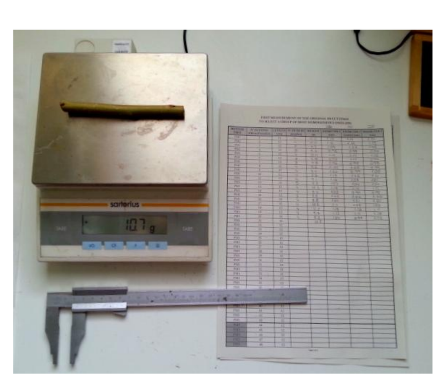




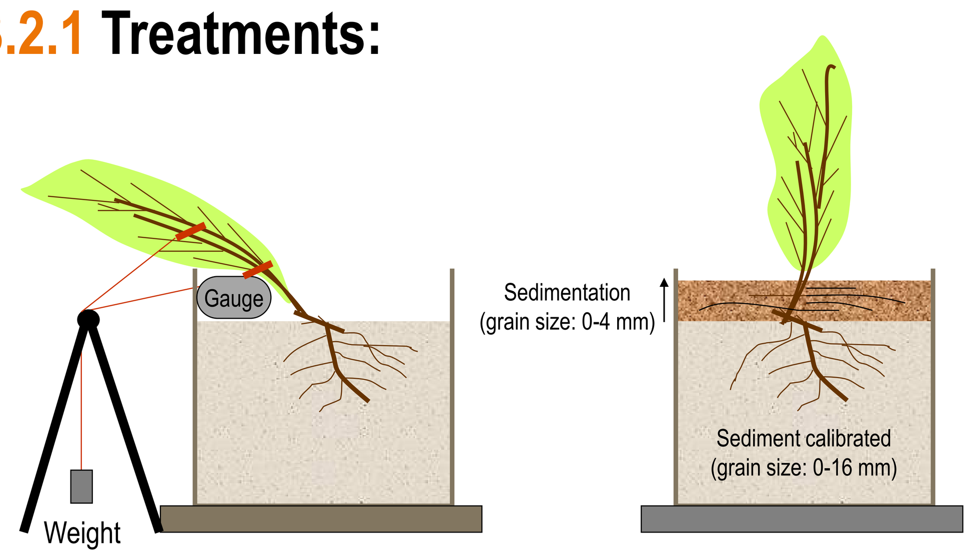
3 Semi-controlled *ex situ* experiment

3.1 Objective:
To quantify **key response functional traits** (morphological and biomechanical) of *Populus nigra* L. cuttings to simulated hydrogeomorphological constraints (**drag force** and **sediment burial**) as well as to dissociate the specific responses to them.

3.2 Experimental design:
128 stem cuttings of *P. nigra* (variety Jean Pourtet) were measured, planted in permeable bags with an irrigation system attached and randomly assigned to one of the 4 treatments.

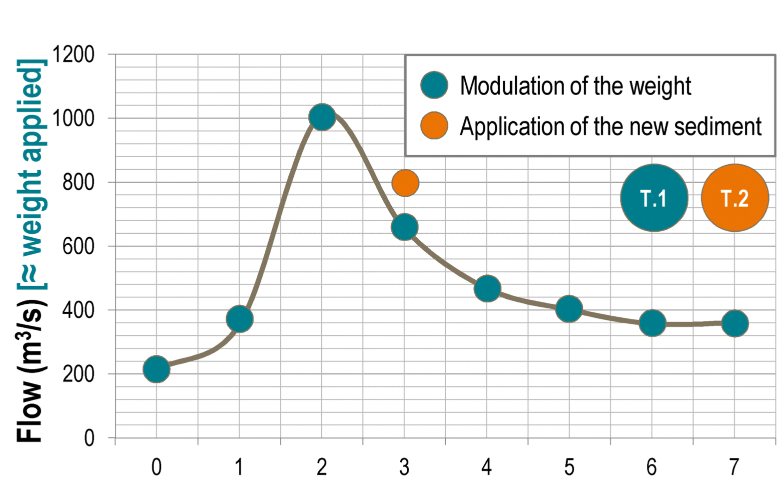


3.2.1 Treatments:



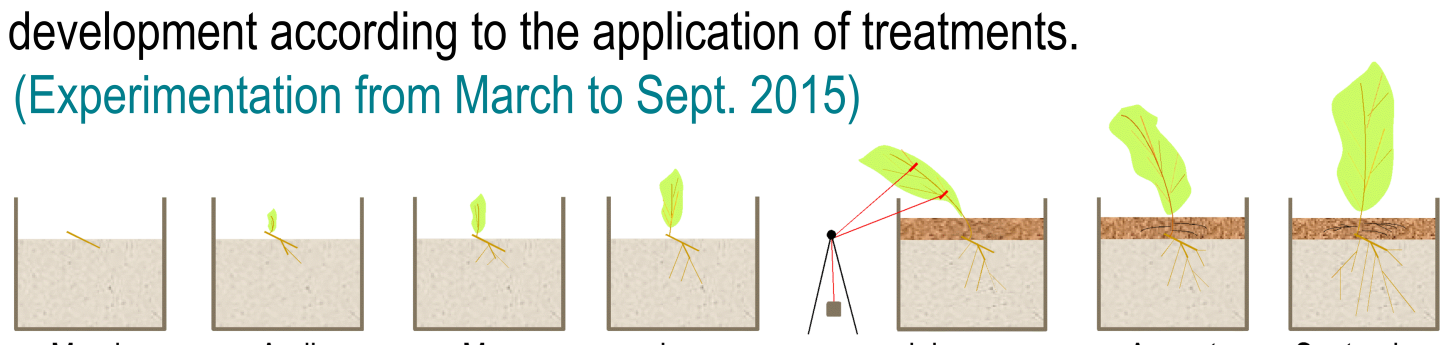
T.1: Drag force   T.2: Sediment burial

- **T.1**: Drag force
- **T.2**: Sediment burial
- **T.3**: Drag force + Burial
- **T.4**: Control



- The weight (T.1) will be modulated imitating the shape of an average hydrograph of a Spring flood in the Garonne River (where the clone Jean Pourtet comes from).
- The burial (T.2) will be applied during the recession limb of the curve.

- **Temporal sequence** of expected above-ground and below-ground plant development according to the application of treatments. (Experimentation from March to Sept. 2015)



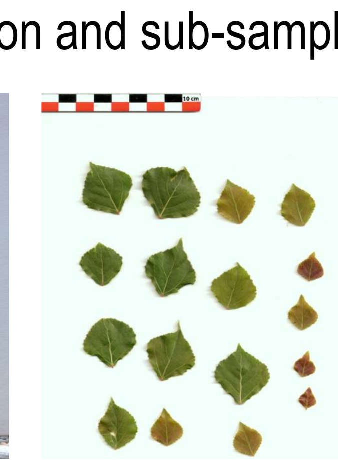
3.2.2 Morphological and biomechanical traits:

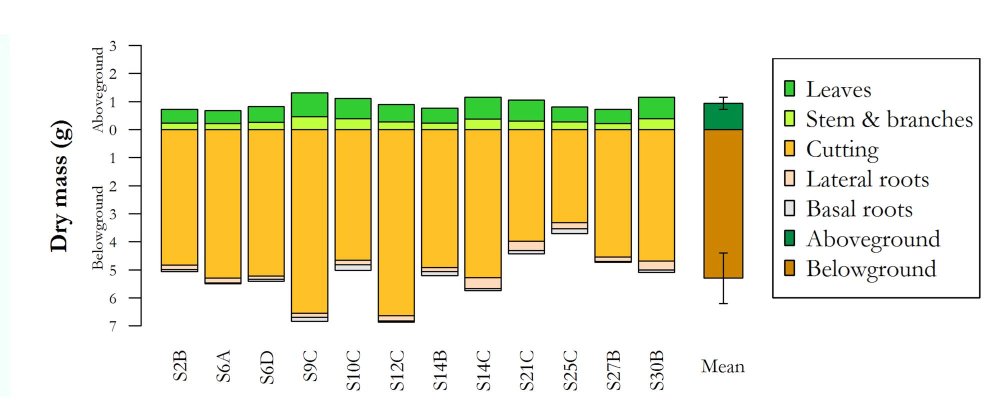
Above-ground traits	Below-ground traits	Ratios
• Number of shoots • Max. plant height • Root collar diameter • Diameter at middle mature height • Tapering • Inclination of the main stem • Average leaf area • Specific leaf area • Above-ground dry mass • Frontal surface area • Pulling force* • Flexibility*	• Initial diameter (cutting) • Initial weight (cutting) • Nº first order roots • Nº structural roots • Nº basal, lateral and superficial roots • Root diameter • Insertion angle • Root length by diameter class • Max. and mean root length • Below-ground dry mass • Nº 'shear' and 'broken' roots* • Diameter of 'shear' and 'broken' roots*	• Root mass fraction • Shoot mass fraction • Elongation ratio • Shoot to root ratio • Fine/structural roots • Leaf area to root length ratio • Root weight/nº of tips • Roots extracted/remaining in the bag*

* *Traits from **winching test**.*

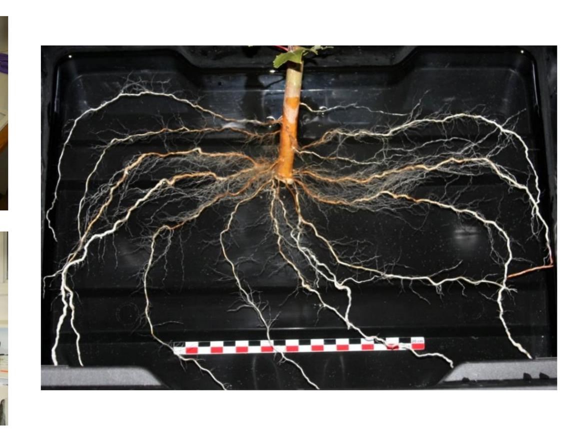
3.2.3 Preliminary results: First partial harvest

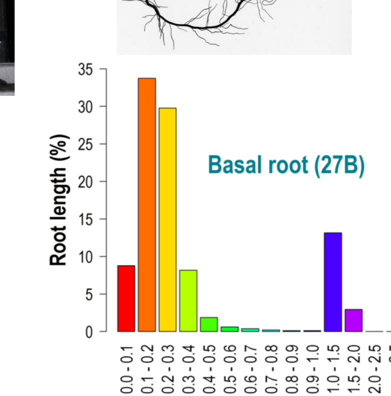
- **12 plants** were destructively sampled to test the methodology of extraction, conservation and sub-sampling.

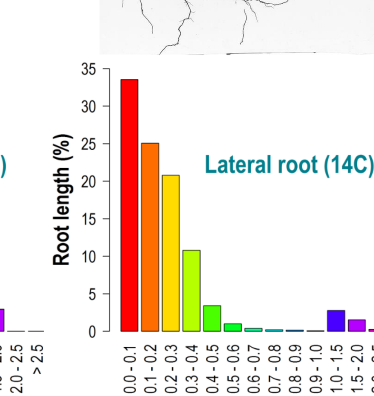




- The **growth is optimum** but some differences are evident depending on the original size of the cutting and the mother tree they come from.







- Analysis of root length confirms that roots could have different **functions**: anchorage (basal roots) and absorption (lateral roots).

The quantification of functional response traits of *P. nigra* will enhance our understanding of fundamental biogeomorphic interactions and its implication for the restoration of river systems.

Acknowledgements: to Catherine Cochard, Olivier Voldoire, Adrià Masip, Mohamed Abadi, Christophe Corona, Jérôme Lopez, Valerie Legué, Frédéric Julien and Marc Villar for their support during this experimentation.

Virginia Garófano-Gómez[1,2]; Dov Corenblit[1,2]; Johannes Steiger[1,2]; Bruno Moulia[3]; Stéphane Ploquin[3]; Patrice Chaleil[3]; Olivier Forestier[4]; André Evette[5]; Eduardo González[6,7]; Borbála Hortobágyi[1,2] and Luc Lambs[6]

[1]Université Clermont Auvergne, UBP, MSH, Clermont-Ferrand, France (corresponding author: virginia.garofano_gomez@univ-bpclermont.fr). [2]CNRS, UMR 6042, GEOLAB – Laboratoire de géographie physique et environnementale, Clermont-Ferrand, France. [3]INRA Clermont Ferrand, UMRA547 Laboratoire de physique et physiologie intégrative de l'arbre fruitier et forestier, Site de Crouël, Clermont Ferrand, France. [4]Pépinière Forestière de l'Etat, DRAAF Pays-de-la-Loire, Guémené Penfao, France. [5]Irstea, UR EMGR, Saint-Martin-d'Hères, France. [6]Ecolab CNRS, Toulouse, France. [7]Department of Biological Sciences, University of Denver, Canada.

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