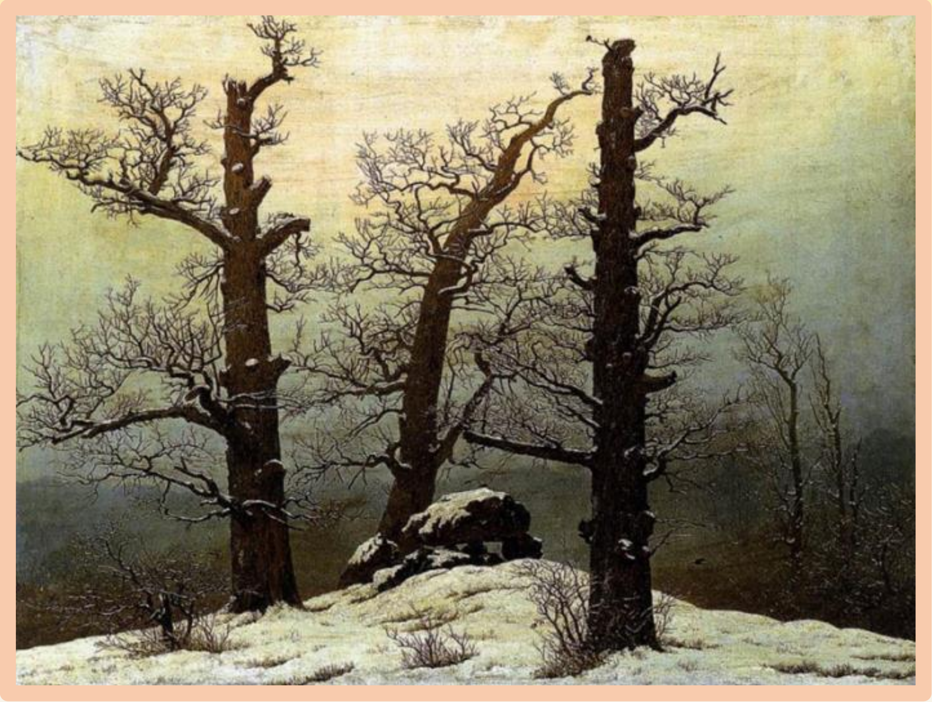
How plants and vegetation can challenge abiotic stress: a focus on adaptation and acclimation to water deficit.

In-depth seminars for students attending lessons on Geobotany Degree on Science for Nature and Environment

Thursday 23th of May

Auditorium polo di Chimica, via del Cotonificio, 108

UNIVERSITÀ DEGLI STUDI DI UDINE



Stefan Mayr ~ University of Innsbruck

Under pressure – plant hydraulics

Andrea Nardini ~ University of Trieste

The extremes of plant hydraulics – roots and leaves

Giai Petit ~ University of Padua

Xylem architecture and stress

PROGRAM AND CONTENTS

8.30-9.30. Valentino Casolo

Introduction to the seminars

Abiotic stresses plant adaptation and acclimation

9:30-11.30 Stefan Mayr – University of Innsbruck

Under pressure - plant hydraulics

Land plants have to transport water from the soil to the leaves to compensate transpirational water losses. Water transport occurs in the xylem, in which water columns are under tension (negative pressure) due to flow resistances and gravity. Drought and frost can lead to a breakage (embolism) of these water columns, and plants developed various species-specific strategies to cope with the risk of hydraulic failure.

1. **General Introduction**
1.1. Land plants - hydraulic requirements (water uptake, transport, storage, control of loss)
1.2. Transport: cohesion theory, water potential (maybe Scholander technique), example Sequoia
2. Hydraulic efficiency, transport velocities, techniques to measure it
3. **Hydraulic safety**
3.1. Drought stress (vulnerability, mechanism of failure, pit architectures, strategies)
3.2. Freezing stress
4. **Example treeline**

11.30-13.30 Andrea Nardini – University of Trieste

The extremes of plant hydraulics – roots and leaves

Roots and leaves are the entry and exit points, respectively, for water flow in terrestrial plants. These organs also contribute to the highest share of plant hydraulic resistance, because water has to cross layers of living parenchyma before entering (at root level) or leaving (at leaf level) the low-resistance xylem pathway. Efficient foraging for water requires specific adaptations of the root system morphology and physiology, while the maintenance of leaf hydration during active photosynthesis require a delicate balance between evaporative water loss and liquid water transport to leaf cells. We will explore some basic principles of water flow in roots and leaves, and we will highlight some remarkable anatomical and functional traits that allow terrestrial plants to thrive in different environments with contrasting levels of water availability.

1. **Root hydraulics**
1.1 Basics about root hydraulics and its regulation
1.2 The hidden half: the challenges of accurate quantification of root biomass and distribution
1.3 Root-to-shoot ratio and root distribution/depth in the soil profile according to climate
1.4 Some insights into the use of stable isotopes to estimate rooting depth
2. **Leaf hydraulics**
2.1 Physics of leaf-level transpiration
2.2 Leaves as the major hydraulic bottleneck in the plant
2.3 Leaf hydraulic efficiency and safety, and the importance of leaf vein density

13:30-14.30: Lunch

14.30-16.30 Giai Petit – University of Padua

The between-extremes of plant hydraulics - the xylem vascular system

In the process of photosynthesis, plants experience significant water loss through leaf transpiration. To replenish this water loss, a sophisticated transport system, comprising both dead xylem vascular elements and living parenchyma tissues, moves water from roots to leaves, also aiding in the storage of water and carbon reserves. As trees grow, the apical meristems and vascular cambium synergize to form new xylem, ensuring a steady and efficient water supply despite the increasing distance between leaves and roots. The architectural design of the xylem is key to providing an efficient water supply to leaves and preventing embolism, while also minimizing the carbon expenditure associated with its metabolism and growth. Under stress conditions, how do plants modify this system to enhance their survival prospects?

1. **The xylem tissues**
1.1 Vascular elements (tracheids, vessels, fibres)
1.2 Parenchyma cells
1.3 Primary and secondary xylem
1.4 Sapwood and heartwood
2. **Xylem hydraulics** (short recap of Darcy and Hagen-Poiseuille laws)
3. **Xylem anatomical patterns and hydraulic properties**
3.1 Vascular conduit widening
3.2 Hydraulic efficiency of sapwood rings
3.2 Sapwood/heartwood transition