UPSC

Umeå Plant Science Centre

Biennial report 2022-2023

A collaboration between

UMEÅ UNIVERSITY

SLU SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES

Contents

Flowers set up by UPSC's gardening group (photo: Anne Honsel)

1. Introduction

Introduction

Words from the Director

Umeå Plant Science Centre (UPSC) was formed 25 years ago with the vision of creating one common strong research environment by joining the forces of two different departments from two different universities: the Department of Plant Physiology at Umeå University and the Department of Forest Genetics and Plant Physiology at the Swedish University of Agricultural Sciences (SLU).

Today, 25 years later, UPSC has developed into one of the leading European research centres in experimental plant biology and forest biotechnology and is recognised as one of the top research environments at both universities. This has been achieved through strategic international recruitment of new research group leaders, the development of strong common technical platforms and a close collaboration in teaching and outreach activities between the two centre partners. Over the years a network of industrial collaborations has also developed into a strong innovation system, translating basic research discoveries into new solutions for sustainable forestry and agriculture, and training a new generation of academic and industrial researchers. Today, around 200 people of 45 different nationalities work at UPSC in 31 research groups covering the full range of experimental plant biology research from basic biochemistry to ecophysiology, genetics, and breeding.

The years 2022 and 2023 were characterized by a gradual return to "normality" after the Covid-19 pandemic. One of the highlights was the recruitment of four new research group leaders: Jian-Feng Mao, working on plant genomics, Laura Bacete working on plant cell wall dynamics, Stephan Wenkel investigating microProteins and Kelly Swarts, a conifer geneticist working with tree-ring genomics. Kelly was recruited as a fellow of the SciLifeLab and Wallenberg National Program for Data-Driven Life Science (DDLS). They are a strong addition and we warmly welcome them to UPSC!

UPSC researchers have been successful in attracting prestigious grants, such as an ERC Starting Grant for Petra Marhava, a Novo Nordisk Emerging Investigator Grant for Stéphane Verger and a research project grant from the Knut and Alice Wallenberg Foundation for Stéphanie Robert.

We saw a dramatic increase in the number of scientific achievement awards to UPSC group leaders, including awards to Petra Marhava, Peter Marhavý, María Rosario García Gil, Alizée Malnoë, Stefan Jansson and Karin Ljung. Three UPSC scientists were also elected to the Royal Swedish Academy of Agriculture and Forestry (KSLA): Stefan Jansson, Olivier Keech and Isabella Hallberg-Sramek.

On a scientific level, UPSC researchers have contributed new insights into conifer genetics and genomics, regulation of starch metabolism, photoprotection of conifers and regulation of aspen tree senescence, wood formation and phenology.

Looking back, 2022-2023 were another two very successful years for UPSC, marking the end of the first 25-year period. When I am writing these words, we are finalising the plans for the 25th anniversary celebrations, where we will welcome UPSC alumni and others who have been instrumental in shaping UPSC into what it is today. We are confidently looking forward to the next 25 years with an even stronger UPSC and we welcome scientific collaborators, students, and the rest of society to join us on this journey!

Ove Nilsson
Director of Umeå Plant Science Centre

Photo: Fredrik Larsson

Introduction

Perspectives from SLU and Umeå University

UPSC is a perfect example of how coordinated planning, collaboration and recruiting strategies for scientific excellence have resulted in a world-class research centre that is among the best in its field.

The strategy to concentrate on research that is relevant for tree biology and forestry, coupled to the recruitment of highly skilled academic staff introducing new competences to the centre, has shown to be very successful. The depth and breadth of the research at UPSC are both excellent, which is illustrated by the many publications in highly cited journals, covering research on model systems ranging from unicellular organisms to trees.

UPSC's research on basic tree biology has often had a direct relevance for the forestry sector and the society at large, as well as making an outstanding contribution to the quality of research and education within our faculty. It is clear that this success is founded on the collaborative efforts between SLU and Umeå University in the making of UPSC. The benefits of this collaboration for both universities cannot be overstated.

Over the past 25 years, UPSC has helped to manifest SLU:s world-leading role in agricultural and forestry research, education and outreach. A key feature of this has been the successful collaboration with other leading international and national partners. I therefore look forward to further developing synergies with Umeå University on how we can continue our joint UPSC venture into the future.

Göran Ericsson
Dean for the Faculty of Forest Sciences
Swedish University of Agricultural Sciences

Photo: Susanna Bergström, SLU

UPSC is an integrated part of the faculty, and during my years as Dean, I interacted with many of the centre's researchers. From the faculty and Umeå University, we see UPSC as an excellent example of combined efforts multiplying results. The centre's success story has been built on a strong focus on curiosity-driven basic research with great potential for applications in forestry.

Over the years, our support for UPSC has been consistent, and we have witnessed the benefits not only for plant science but also for the entire faculty. The scientific infrastructures, such as the Swedish Metabolomics Centre, the microscopy platform, and the plant growth facility, have proven useful to researchers from various departments.

The unique arrangement with two departments from different universities co-localized in the same building on Umeå University campus strengthens the connection between our universities.

Plant science is the foundation of one of the prioritized research areas of Umeå University - *Plant science, for a sustainable green transformation of the subarctic.* Here, researchers across several faculties cooperate in a transdisciplinary effort on the much-needed transformation of our region to counteract the effects of climate change and secure local food production.

I can look back on twenty-five successful years of UPSC and look forward to a future where basic plant science research is even more important for our region, faculty, and university.

Mikael Elofsson
Dean for the Faculty of Science and Technology
Umeå University

Photo: Mattias Pettersson, UMU

Joint hike in Marshfjällen at the UPSC Days 2022 in Saxnäs (photo: Anne Honsel)

2. UPSC Organisation

UPSC Organisation

About UPSC

UPSC is a centre for experimental plant biology established in 1999. It is a collaboration between the Department of Forest Genetics and Plant Physiology at the Swedish University of Agricultural Sciences and the Department of Plant Physiology at Umeå University. The centre strives to offer a research environment that allows our researchers to conduct excellent plant science.

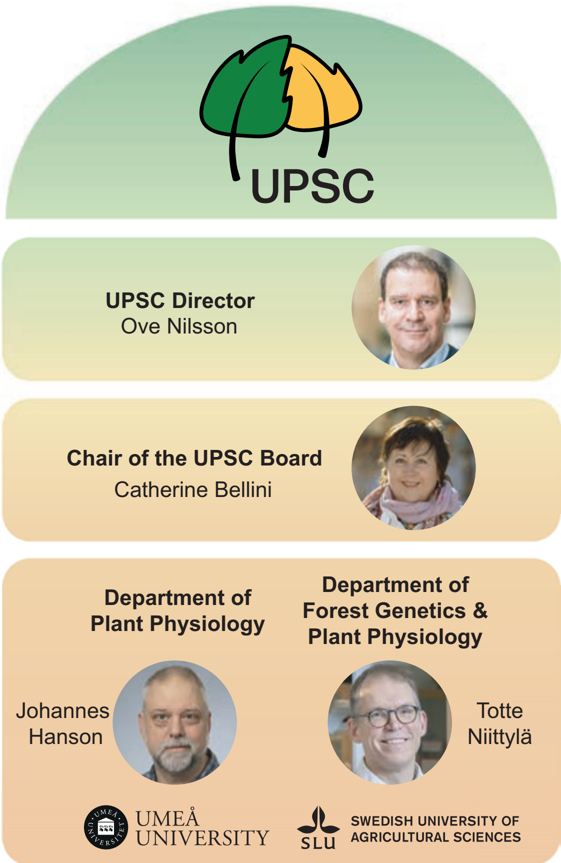
The two departments at UPSC have their own administration and leadership but coordinate their activities with each other. The centre itself has a limited common budget and administration which has been a successful model that requires very little administration. Both departments are fully committed to the success and benefit of this arrangement. What is good for UPSC is good for the departments.

The most important organisational units at UPSC are the research groups, which are led by a Principal Investigator (PI), and the research infrastructure, led by a Facility Manager. Within these units, all scientific decisions are made independently. The group leader or the Facility Manager/Facility Director, respectively, are also responsible for funding and long-term planning of the unit.

To facilitate collaboration and integration, both universities have jointly appointed a director and a steering committee, internally at UPSC referred to as the “UPSC Board” . The director deals with day-to-day coordination and manages common grants for the centre in cooperation with the heads of the two departments. In the board, common issues concerning UPSC are discussed to maximise integration and cooperation within the centre.

The board has representatives from all personnel categories represented at the centre. These groups hold individual cross-departmental meetings, and if needed discussions are raised to the board.

In the last 25 years, UPSC has been proven to be a successful model but what’s most important for our success are our excellent scientists, teachers, students, technicians, post-docs, and administrative staff that work here. Together, we have formed a critical mass of scientific activity where our combined forces have multiplied our strength. Umeå Plant Science Centre has reached a level where it is easy to perform excellent experimental plant science and where new students and staff are welcomed to a friendly and creative environment. In this way, UPSC is of benefit to both universities and the surrounding society.



Governance structure of UPSC: The management group consists of the UPSC director, the chair of the UPSC Board and the two heads of department. The responsibilities of the UPSC director involve presentation of UPSC, national and international networking and funding acquisition overarching the institutes. The “UPSC Board” is an internal advisory board advising the director and the two heads of department. It is also a forum for internal discussions. The administration and economy of the two departments comprising UPSC is separated. The two heads of department and the UPSC director have to ensure that the rules from the respective university are followed (illustration: DC SciArt).

UPSC Organisation

The UPSC Board

UPSC's governance structure is comprised of a steering committee, the "UPSC Board", and a director. The steering committee sets the overall direction, while the director manages day-to-day operations with the support of a management group including the two heads of department.

The director is responsible for planning, managing, and coordinating activities in accordance with the rules of Umeå University and SLU, as well as the strategic development, goals, and mission of the centre. The director reports to the steering committee and the heads of the host departments. The directorship is typically a four-year term, with reappointment contingent on evaluation and mutual agreement.

The steering committee has 11 members from Umeå University and SLU, including the chair. The Deans of Umeå University's Faculty of Science and Technology and SLU's Faculty of Forest Sciences appoint a joint nomination committee to propose teacher representatives for the steering committee. The nomination process considers gender balance and equal representation.

The steering committee meets at least three times per semester and more frequently if requested by at least three members. Decisions are made by a simple majority, with the chair having the casting vote in the event of a tie. The term of the steering committee is usually four years, and it appoints a vice-chair from among its members.

The director is the main liaison with the steering committee, prepares meeting agendas and implements decisions in consultation with the chair and the two heads of department. The management group or executive committee supports the steering committee and director. It consists of the chair, the vice-chair, the director, and the two heads of department. The responsibilities of the steering committee and the management group include setting the overall direction of the centre, promoting its scientific environment, overseeing the joint technical platforms, and coordinating research applications and educational programmes. It also fosters connections with industry, external funders, university management, and other research entities.

In summary, the steering committee provides strategic oversight, the director manages the day-to-day operations, and the management group is the executive committee that supports these functions. The governance structure ensures effective coordination, compliance with institutional guidelines, and promotion of the centre's mission.

Board Members	Adjunct Board Members
Chairperson	UPSC Director
Vice-Chairperson	Postdoc Representatives
Head of Department, UMU	Representative for technical and administrative personal
Head of Department, SLU	Secretary
Teacher representatives from UMU	
Teacher representatives from SLU	
PhD student representatives	

The UPSC Board is composed of Board Members and Adjunct Board Members representing the different personnel categories represented at UPSC. It is led by a chairperson. The UPSC Director and the two heads of departments are sitting in the board.

UPSC Organisation

Our Missions

The two universities – SLU and Umeå University – have given UPSC the assignment for the years 2021-2024 to develop and strengthen its strong international standing as an internationally leading environment for experimental plant biology.

The universities have specified the following three main missions for UPSC:

- **To maintain an internationally leading research environment in experimental plant biology with a special focus on forest biotechnology through collaboration between Umeå University and SLU.**

- **To contribute to the formation and maintenance of effective and efficient technology platforms and other infrastructure through collaboration with other departments and research projects.**

- **To provide leading university education in the field and actively communicate its activities to the surrounding community.**

At UPSC, we believe that the basis for achieving these missions is an open, inclusive and stimulating environment. We strive to foster a community where ideas are freely formulated and tested, and where scientific collaborations are encouraged. Our aim is to provide an efficient administrative and technical infrastructure that enables individuals and research groups to develop scientifically and reach their maximum potential, sharing resources rather than competing internally.

More specifically the leadership of UPSC aims to:

- Promote and develop the scientific environment at UPSC and stimulate open academic and scientific discussions
- Make strategic recruitments of researchers that will further strengthen the research environment
- Foster joint programs at advanced and postgraduate level and support young researchers
- Encourage joint projects and platforms e.g. through target-oriented funding
- Advance joint facilities and infrastructures
- Endorse contacts and information exchange with industry and society
- Promote contacts with external funders
- Strengthen contacts with university managements, faculties and other research environments

Umeå Plant Science Centre in autumn (photo: Anne Honsel)

UPSC Organisation

Scientific Advisory Board


Credit: Jack Woods

Sally Aitken

Professor at the University of British Columbia, Canada

Expertise: Tree population genetics and climate adaptation


Credit: UC, Riverside

Julia Bailey-Serres

Professor at the University of California, Riverside, USA

Director of the Center for Plant Cell Biology UC Riverside

Expertise: Genetic mechanisms controlling abiotic stress resilience


Credit: University of Nottingham

Malcolm Bennett

Professor at the University of Nottingham, UK

Expertise: Systems biology of root growth and development


Credit: Max -Planck Institute of Molecular Plant Physiology

Alisdair R. Fernie

Professor at Max-Planck Institute of Molecular Plant Physiology, Germany

Expertise: Plant Metabolism


Credit: VIB-UGent

Dirk Inze

Professor at Ghent University, Belgium

Scientific Director of VIB-UGent Center for Plant Systems Biology

Expertise: Plant organ growth and development

Variation in autumn leaf colour in the Swedish Aspen Collection (photo: Kathryn Robinson)

3. Research at UPSC

Research Areas

At UPSC, we research across a wide range of disciplines in plant science reaching from basic science to industrial applications. The work at UPSC is carried out at all organisation levels of the plant spanning from molecular to ecosystem level. Our common goal is to understand the plants' ability to adapt and acclimate to a changing world.

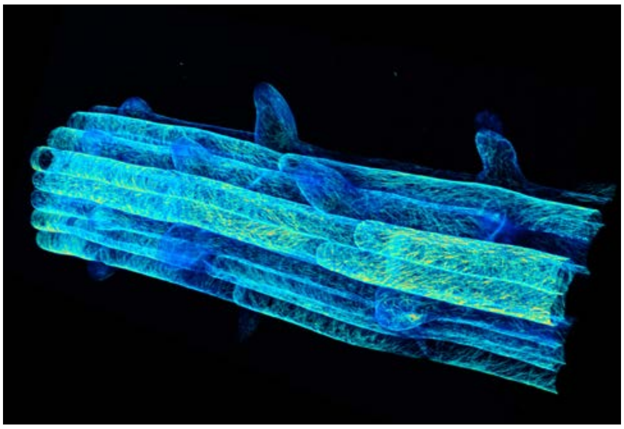
Research at UPSC focuses mainly on the following three research areas that were defined in 2023:

- **Cell- and Developmental Biology**
- **Growth and Adaptation**
- **Genetics, Genomics and Breeding**

We host about 30 principal investigators with different areas of expertise researching on questions mainly related to one or several of the three research areas. The research groups at UPSC collaborate closely with eleven associated research groups who are based in other departments at Umeå University or SLU or at other universities.

To provide an excellent research infrastructure for our research groups, we maintain nine research facilities at UPSC offering state-of-the-art instrumentation, resources and trainings.

Winter atmosphere in front of the UPSC Wallenberg greenhouse (photo: Anna Forsgren)



Cell cytoskeleton in an Arabidopsis root visualised using confocal microscopy (photo: Luciano Di Fino)

Cell- and Developmental Biology

Our research aims to elucidate the mechanisms underlying plant adaptation to environmental variables including light, temperature, day length, drought, and physical damage. We concentrate our investigations at UPSC at various levels, ranging from subcellular mechanism to cellular dynamics and organ responses.

We aim to unravel the roles of major plant signalling molecules, such as phytohormones, in orchestrating plant morphogenesis. Moreover, we place significant emphasis on understanding the cell wall, an extracellular matrix pivotal in shaping plant development, facilitating cell adhesion, and fortifying the cell against both biotic and abiotic stresses. We are working on the plant genetic models Arabidopsis thaliana and aspen but also Norway spruce. We employ a wide range of approaches including traditional biological methods but also biophysics, microfluidics, advanced cell biology and computer simulations. A key focus is the advancement of methodologies in tree biology, particularly in the domain of somatic embryogenesis for Norway spruce.

We investigate multiple processes, ranging from gene expression and protein synthesis to organelle communication, to understand how plant integrate developmental and environmental signals. Our goal is to contribute to developing plants that are resilient to the environmental consequences of the climate change.

Research Areas

Arabidopsis wild-type plant exposed to cold temperatures (photo: Vaughan Hurry)

Swedish forest (photo: Anne Honsel)

Growth and Adaptation

Plants are sessile organisms that need to continuously adjust their growth and development in response to changes in their environment, and these adjustments can come at the expense of growth. At UPSC, we study how plants balance growth and adaptation in coordination with photosynthesis, which is central for plant growth.

In our research, we investigate different factors that affect the photosynthetic and adaptive capacity of plants. We study how plants react to environmental changes like different light quality and intensities, temperature, water and nutrient availability. One important research question for us is to understand how the carbon that is assimilated during photosynthesis is used for growth and storage. We examine how the assimilated carbon is used for wood formation in trees, how cellulose, hemicelluloses and lignin synthesis is regulated, and how this shapes wood properties and tree performance. Regulation of seasonal growth is another important question, as is understanding how microbes like fungi and bacteria interact with plants, how this affects carbon storage in the forest, and how the environment influences this interaction. To do this research, we mainly use model plants such as the annual plant Arabidopsis thaliana and the model tree species such as aspen, birch, spruce and pine.

Our aim is to generate knowledge that can lead to the development of new tools and the identification of tree varieties that can cope with the changing climate, and that can lead to practical applications, such as enhancing growth conditions for spruce and pine seedlings in nurseries.

Genetics, Genomics and Breeding

Plants inherit and express traits based on their genes. Researchers at UPSC played a key role in sequencing the genomes of Populus, Scots pine and Norway spruce, and now use these resources to develop new tools for tree research and modern tree breeding.

With the help of bioinformatics, we are studying and improving the tree genome resources available. We use genome assembly, transcriptomics and co-expression network analyses to understand the genetic basis of complex traits such as leaf shape, wood formation and tree responses to abiotic and biotic stressors. To better understand the biology and evolution of different traits such as wood development, we compare the genomes of individuals within a species as well as comparing genomes across species. We are studying the function of repetitive DNA elements and non-coding RNA in different plant tissues and under stress conditions to discover how they influence genome three-dimensional structure and how this contributes to regulating which genes are activated under specific conditions. We also use metagenomics and metatranscriptomics to analyse the composition, diversity, activity and function of the microbes in and around tree roots. Along with our strong genomic and genetic research, we develop methods for genomic selection, genome wide association studies, seed orchard genetics and genome-wide population studies that are used for modern tree breeding.

Our goal is to gain comprehensive knowledge about genes, their regulation and genomic structures, and to use this knowledge for sustainable forestry.

Arabidopsis plants growing in vitro (photo Mattias Pettersson, Umeå University)

3.2 Research Groups

Benedicte Riber Albrectsen

UPSC group leader since 2005, Umeå University

Plant Physio-Ecology Group

Plants engage in continuous interactions with various organisms in their environment. Being immobile, plants have evolved sophisticated metabolic responses to deter enemies and attract beneficial organisms. Plants react to both abiotic and biotic factors. These reactions begin with rapid molecular recognition, followed by a cascade of responses that involve electrical current transfer, emergence of ion gradients, and hormonal communication within the plant. These processes can result in either growth promotion or growth inhibition.

Our research focuses on understanding the physio-chemical responses of plants to surrounding organisms (e.g., arthropod, fungal, and bacterial communities). We aim to assess mechanisms underlying these interactions that support plant health and survival. Our approach involves phenotyping plants using the most modern techniques, including physiological measurements, chemical and molecular responses. Additionally, we test resistance mechanisms through detailed behavioural observations and document these interactions with advanced microscopy.

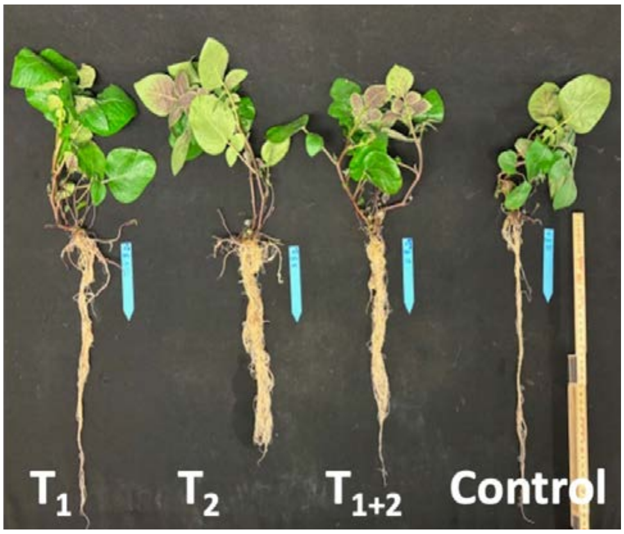
Harvesting potato in the field (photo: Lovely Maharwa)

Research goal

Our aim is to comprehensively understand plant resistance to biological stress, both at the scale of the individual plant and within the larger landscape. In the laboratory and greenhouse, we focus on individual plant responses under various kinds of biological associations and fertility conditions. Outdoors, through experimental testing, we investigate the relative effects of genotype and environment on plant-associated communities. Our goal is to elucidate their relationship to plant health and vegetation resilience.

Highlights of 2022-2023

- We built up a bioassay platform to study above- and below ground responses in potato plants at UPSC.
- We developed metagenomic and barcoding pipelines for studies of crop associated communities.
- We suggested condensed tannins to shape richness of fungal endophytes in aspen.



Exposure to defence (T1) and growth (T2) promoting rhizobacteria applied singly and together (T1+T2) enhance root development and speeds up tuber development (photo: Arti Mishra)

Future plans

In aspen to reveal biosynthetic pathways to defence compounds belonging to salicinoid phenolic glycosides. In potato to explore mechanisms behind signalling cross talk between above and below ground stress in plants with and without support from probiotic bacteria.

Group members (2022-2023)

Staff Scientist: Evgeniy Nikolaev Donev
Postdocs: Arti Mishra; Lovely Maharwa
PhD student: Amanda Mikko
Students: Abu Bakar Siddique, Matilda Andrén, Alvaro Torralba Cantero, Konstantinos Thomos, Léa Humbert, Victor Parmentier, Wondi Bekele, Laura Menke, Melis Duru Dinedurga, Emilia D. E. Regazzoni
Guest researcher: Karen Kloth

Photo on top: Mattias Pettersson

Laura Bacete

UPSC group leader since 2023, Umeå University

Plant Cell Wall Dynamics Research Group

Plants have evolved a plethora of complex and efficient mechanisms enabling them to adapt to changing environmental conditions while continuing their development. These mechanisms include diverse molecular monitoring systems that perceive stress-induced signals and trigger specific responses while integrating physiological processes. The cell wall integrity maintenance mechanism is responsible for monitoring and preserving the functional integrity of cell walls during growth, development and exposure to biotic and abiotic stress. These mechanisms are highly dynamic, allowing the plant to constantly adapt to changing conditions.

Laura Bacete in an Arabidopsis growth room (photo: Mattias Pettersson)

Research goal

We investigate how plants, via their cell wall integrity monitoring systems, perceive changes in the mechanical characteristics of their cell walls and use this information to fine-tune development and defence. Our research has three focus areas:

1. Novel methodologies for studying plant cell wall mechanics and composition.

2. Dissecting the relationship between cell wall integrity and plant growth.

3. Evolutionary insights into plant cell wall integrity mechanisms.

Highlights of 2022-2023

- The research group started in February 2023, when Laura moved to Umeå.
- Klaudia Ordyniak joined the group in September 2023 as a PhD student.
- Part of our research activities continue at NTNU (Norway), carried out by Dr Nancy Soni. She is a recurrent research guest at UPSC, especially for cell wall analyses.
- We have done a biochemical characterisation of the cell wall composition of over 30 mutants, in order to understand the transcriptional regulation of cell wall integrity and its interaction with cell cycle progression.
- We initiated the process for establishing Brillouin Microscopy as a method at UPSC.
- We have published three review papers: Baez et al 2023, Soni et al 2023, and Vukašinović et al 2023.

Future plans

We plan to have a functional Brillouin confocal microscope in 2024. We plan to narrow down the number of candidate genes to study in the cell wall – cell cycle interaction project and do in depth cell wall analyses, and we are expecting to link this project with the one focused on the transcriptional regulation of cell wall integrity. We are going to start studying the evolution of cell wall integrity monitoring across the green lineage, in collaboration with Professor Christiane Funk from the Department of Chemistry at Umeå University. Finally, we are developing molecular tools that will allow us to do precise alterations of cell walls, allowing a better understanding of cell wall integrity.

Group members (2022-2023)

PhD students: Klaudia Ordyniak
Guest researcher: Nancy Soni

Laura Bacete with group members

Photo on top: Jan Karlsson

László Bakó

UPSC group leader since 2003, Umeå University

Control of Plant Cell Division and Differentiation

Understanding regeneration at the tissue, organ and whole organism level has long been one of the major interests in the plant field. Regeneration initiates with cellular reprogramming during which cell division is reactivated in differentiated cells. Repeated rounds of cell division give rise to a mass of pluripotent cells that can differentiate into distinct cell types thereby supporting morphogenesis. The liverwort *Marchantia polymorpha* is an emerging model plant regarded not only for its simple life form and non-redundant genome but also for its outstanding regenerative capacity. The cold shock domain protein MpCSP is a single *M. polymorpha* homologue of the Lin28A protein known to have crucial roles in cellular reprogramming and differentiation in animal systems. This project aims to investigate whether the MpCSP protein plays a role in the regeneration of *M. polymorpha* and if so whether manipulation of the expression level, domain and timing of the *MpCSP* gene would enhance or compromise the regeneration capacity of the plant.

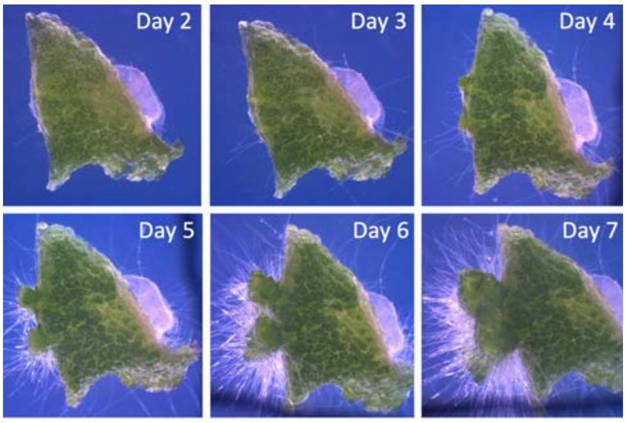
László Bakó in the UPSC growth facility (photo: Mattias Pettersson)

Research goal

Genetic modification of crops and trees as well as clonal propagation of elite lines require efficient regeneration systems. We want to better understand the molecular mechanism underlying regeneration in plants to develop regeneration protocols suitable for recalcitrant plant species.

Highlights of 2022-2023

- We showed that a specific small molecule inhibitor of the human Lin28 protein binds to MpCSP *in vitro*, application of the inhibitor modulates regeneration capacity of Marchantia thallus cuttings *in vivo*.



Regenerating *Marchantia polymorpha* thallus cuttings (photo: László Bakó)

  Biochemical assays indicate that similar to Lin28, MpCSP forms multiprotein complexes.
- Developed an antibody against MpCSP that in turned has been used to immunoaffinity purify complexes for mass spectrometry analysis of interacting proteins.
- In multiple attempts to knock-out the *MpCSP* gene via CRISPR-Cas9 we recovered transgenic lines expressing a truncated and functional CSP protein suggesting that inactivation of the gene might be lethal.

Future plans

We plan to pursue the proteomics approach further to identify MpCSP interactors and assess the role of interactors in regeneration. Since MpCSP is an RNA-binding protein that binds possibly to pre-miRNAs species too, we aim to investigate CSP-RNA interactions in RIPseq experiments. Since our initial knock-out approach failed, we will use a strategy for the conditional inactivation-downregulation of the *MpCS*P gene activity. Generation of transgenics overexpressing the *MpCSP* gene in distinct cell files of the Marchantia thallus are on the way. Finally, immunolocatization of the protein using our antibody at different stages of regeneration is still awaiting.

Group members (2022-2023)

Students: Mikaela Moskov, Samuel Lundberg

Photo on top: Mattias Pettersson

Catherine Bellini

UPSC group leader since 2002, Umeå University

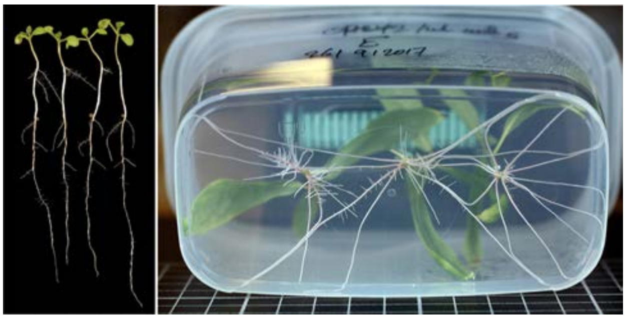
Control of Adventitious Root Initiation

Vegetative propagation through rooting of stem cuttings is economically important for forest trees as it is a cost-effective way to multiply plants from elite clones. Nevertheless, recalcitrance to rooting can result in important economic losses. The development of adventitious roots (AR) is a quantitative genetic trait with high phenotypic plasticity due to multiple endogenous and environmental regulatory factors.

In the last two decades, my group made significant progress in identifying molecular networks involved in controlling AR development in the model plant *Arabidopsis thaliana* and, more recently, in Populus and conifers.

Research goal

We have identified regulatory genes acting at several levels, including subunits of the COP9 signalosome (CSN) required for protein degradation and genes acting at the crosstalk of auxin, jasmonate and cytokinin signalling pathways. We now plan to further understand the role of these genes in controlling adventitious root development. We also want to understand how light signalling interacts with hormone signalling to regulate AR initiation.



Left: Arabidopsis etiolated seedlings showing adventitious roots on the hypocotyl (adapted from Gutierrez et al 2009, Plant Cell); right: Adventitious roots on in vitro poplar cuttings (photo: Sanaria Alallaq)

Highlights of 2022-2023

- Ranjan A., Perrone I., Alallaq S., Singh R., Rigal A., Brunoni F., Chitarra W., Guinet F., Kohler A., Martin F., Street N., Bhalerao R., Legué V., Bellini C. (2022) Molecular basis of differential adventitious rooting in poplar genotypes. Journal of Experimental Botany 73 (12) :4046-4064.
- Grant from Swedish research council VR (2022)
- Grant from Novo Nordisk foundation (2023)

Future plans

The COP9 signalosome (CSN) is a highly conserved eight-subunit protein complex required for protein degradation. In several plant species, subunits 5 and 6 are duplicated, leading to 4 different CSN complexes, the function of some of which is unknown. In collaboration with Karina Persson's group (Chemistry department), we plan to compare the structure of the different complexes to help determine their function.

We propose to exploit the natural variation of the Swedish aspen collection by characterising the rooting performance of the clones that showed variation while transferred in vitro at the phenotypic, molecular and physiologic levels to improve our understanding of AR development in aspen.

Catherine Bellini with group members (photo: Mattias Pettersson)

Group members (2022-2023)

Postdocs: Priyanka Mishra, Maria Kidwai, Dhruv Agrawal, Subash Reddy Gaddam
Students: Cloé Mesana

Photo on top: Mattias Pettersson

Rishikesh Bhalerao

UPSC group leader since 2000, SLU

Environmental Control of Seasonal Growth in Trees

Trees can live for thousands of years. Consequently trees in boreal regions are faced with extreme changes in their environment with temperatures between +25 in summer to -30°C in the winter and a day length that varies between a few hours in winter to nearly continuous light in the summer.

Research goal

My group is interested in identifying molecular mechanisms that enable trees to cope with environmental changes. Understanding these mechanisms is crucial for uncovering adaptation of tree growth to seasonal changes as well as for devising strategies for breeding trees that are better adapted to future climates.

Blue light receptor CRY2 and its interacting protein CIB regulate bud break in hybrid aspen trees. Overexpression of CIB (CIBoe) or inactivation of blue light receptor CRY2 (cry2 crispr) results in early bud break relative to hybrid aspen wild type (T89) (photo: Aswin Nair).

Highlights of 2022-2023

- Dr. Florent Velay joined the lab as a postdoctoral fellow with fellowship from Carl Trygger Foundation
- New collaborations established with Professor Leah Band on mathematical modelling
- Yuan Ma from Bhalerao group published a paper describing novel role for spatial control of DNA replication mechanism in differential cell growth in Science Advances
- Collaboration of Bhalerao group with Professor Malcolm Bennett uncovered an unrecognised role for cell-cell communication in response of root branching to water stress in a paper published in Science
- Bhalerao group published 16 papers during 2022-23 several of which in high impact journals such as Nature Plants, Current Biology, Science, Science Advances
- Dr. Bhalerao elected member of EMBO

Future plans

Temperature and photoperiod are two main environmental cues regulating seasonal growth in trees. We have recently discovered a role of temperature that is independent of photoperiod in inducing growth cessation in trees. Uncovering the molecular components that sense temperature in growth cessation response is one of the goals of the future work. We have identified transcription factor CIB and its interaction partner, the blue light receptor CRY2 as regulators of bud break. We will investigate the targets of CIB-CRY2 pathway in bud break regulation. We have also uncovered hormonal pathways and cell wall mechanics mediate temperature control of bud break in trees. We will focus our future work on identifying the components that mediate hormonal control of cell wall mechanics in bud break regulation.

Group members (2022-2023)

Postdocs: Bibek Aryal, Shashank Pandey, Aswin Nair, Florent Velay
Guest researchers: Xiaobin Wang, Yujiao Ma

Rishikesh Bhalerao in the UPSC greenhouse (photo: Andreas Palmén)

Photo on top: Andreas Palmén

Ulrika Egertsdotter

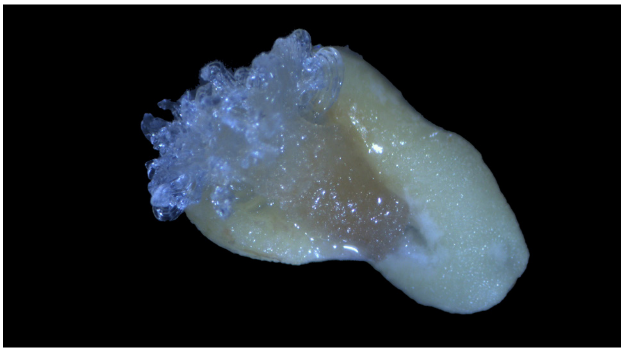
UPSC group leader since 2009, SLU

Conifer Seed Development and Somatic Embryogenesis

Some conifers like Norway spruce (*Picea abies*) does not produce seeds every year. Shortage of seeds for forest regeneration has prompted research into a better understanding of the mechanisms that control seed development. Furthermore motivated utilization of alternative propagation techniques like somatic embryogenesis (SE) for plant production. SE is an in vitro technique where the immature zygotic seed embryos can be clonally propagated and form large numbers of clonal plants. SE offers many advantages for clonal propagation of improved trees from breeding programs since molecular markers can be applied at an early stage of plant development and the plant production automated for affordable scale up. We use SE in Norway spruce as a model system to study embryo development.

Research goal

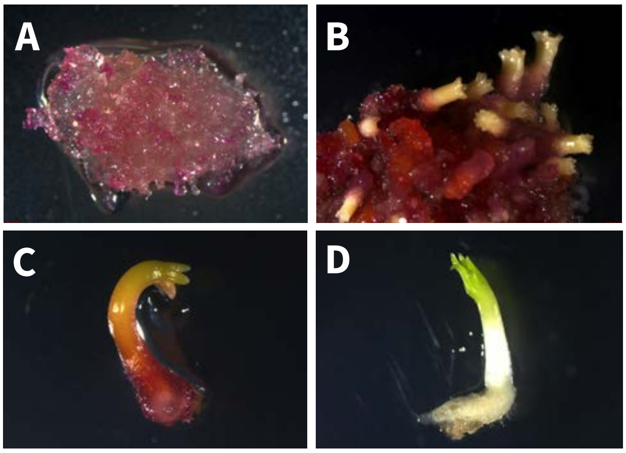
We want to understand more about the regulatory mechanisms during embryo development specifically in gymnosperms since gymnosperm embryogenesis differs in many ways from angiosperm embrygenesis. Our main approach is to study transcript and metabolite profiles during development of Norway spruce somatic embryos to identify key regulatory steps required for embryo development.



Somatic embryogenesis initiation from zygotic embryo with female gametophyte (photo: Sofie Johansson)

Highlights of 2022-2023

- We have established a method for analysing small groups of cells from the zygotic embryo during the initiation of somatic embryogenesis by cryo sectioning, laser microdissection and RNA Seq. The results can suggest genes involved in the SE initiation process.
- We report together with our collaborators at Copenhagen University for the first time the importance of accumulated effects during somatic embryo development for plant formation in Nordman fir (*Abies nordmanniana*) (Nielsen et al. 2022).
- The influence of different abiotic factors on embryo development were studied and the results suggest both novel approaches to somatic embryogenesis culture techniques and new research questions on fundamental aspects of conifer embryo development.



A) Proembryogenic masses (PEMs) transformed with a reporter construct grow on selection medium and turn pink. B) PEMs develop to mature embryos that can germinate; C) germinants show pink colour mostly in the root part; D) Untransformed control (photo: Sofie Johansson)

Future plans

We plan to continue the analyses of the sequence data obtained from the developmental series of somatic and zygotic embryogenesis by conducting more directed in depth analyses of certain developmental stages as suggested by the initial analyses. Furthermore, with the support of a new postdoc in our group Ahsan Ritzavi we are pursuing the analyses of short RNA expression during somatic and zygotic embryo development. Our goal is to test the results from the expression analyses by a reverse genetics approach utilizing the UPSC SE spruce transformation platform and conduct bioassay testing by modulating the abiotic environment during embryo development.

Group members (2022-2023)

Research engineer: Sofie Johansson
Postdoc: Ahsan Zaigam Rizvi
Students: Josefine Björs, Jonathan Sjögren

Photo on top: SweTree Technologies

Maria E. Eriksson

UPSC group leader since 2003, Umeå University

Circadian Clock Function Controlling Growth and Drought Stress Adaptation

The circa 24-h or 'circadian' clock, is a master regulator that coordinates daily and seasonal growth. Light cues perceived by red/far-red and blue light photoreceptors regulate daily and seasonal growth by acting via a set of plant hormones e.g. auxins, cytokinins and gibberellins (GAs). For instance my work has shown that GAs are instrumental for height and diameter growth of hybrid aspen, as well as length of xylem fibres. The circadian clock affects such daily rhythms of hormonally controlled growth. As trees receive short days below a certain threshold they stop growth in a way coordinated by the circadian clock, with decreased levels of GAs allowing buds to form as a preparation for achieving hardy, frost-tolerant buds and trees.

We found that the circadian clock also is essential for adaptation to drought stress. The plant hormone abscisic acid (ABA) mitigates growth and acts to preserve water by closing the leaf pores called stomata. We also found that the blue light receptor and clock component ZEITLUPE (ZTL) is needed for ABA-induced stomatal closing together with OPEN STOMATA 1 (OST1). While another clock component, PSEUDO-RESPONSE REGULATOR 5 (PRR5), acts to keep pores open. When ZTL function is compromised stomata can not close properly during midday drought stress (Figure 1). These recent studies offer a mechanistic understanding of circadian clock components in plant adaptation.

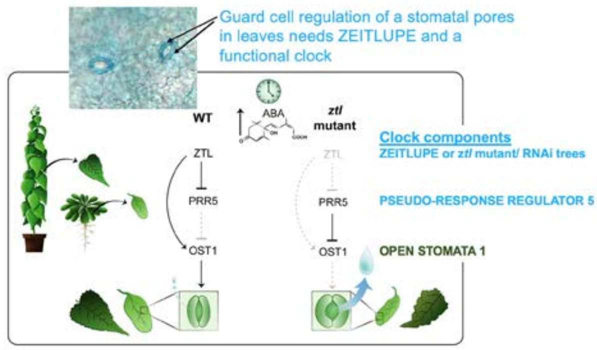


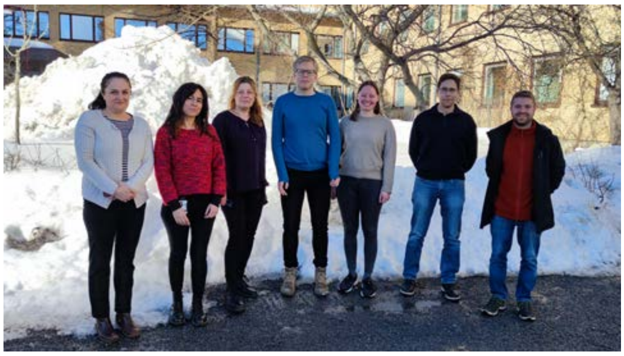
Figure 1. Circadian clock components act in regulation of gas exchange. Based on Jurca et al., 2022. (design: DC SciArt, modified by Maria E. Eriksson)

Research goal

Our work aims to better understand the molecular mechanism, metabolism and physiology of tree growth. We incorporate field trials with trees having altered photoreception, clock and hormone metabolism to understand tree growth in daily and yearly events. Such knowledge is crucial to find better ways of monitoring, reading and catering for trees using circadian clock knowledge or 'chronosilviculture'. Our work will ease decoding and modelling of responses of trees, forests and global systems under changing climates.

Highlights of 2022-2023

- Jurca M, Matrosova A, Johansson M, Ibáñez C, Kozarewa I, Bakó L, Webb AAR, Israelsson-Nordström M, and Eriksson ME (2022) ZEITLUPE promotes ABA-induced stomatal closure in Arabidopsis and Populus. Frontiers in Plant Science 13: 829121
- 2023, M.E.E. was elected member of the Daylight Academy, VELUX Stiftung, Zurich, Switzerland
- Grant from the Carl Trygger Foundation (2022)
- Grant from Kempe Foundations, IceLab (2022)



Maria E. Eriksson with group members

Future plans

Organisms adapted to conditions such as those in the Arctic are predicted to face large, abrupt climate changes in future climate scenarios. We will further explore the mechanisms of circadian clock regulation of stomata, as well as hormonal coordination of growth under controlled and natural conditions.

Group members (2022-2023)

Postdocs: Manuela Jurca, Carmen Hermida Carrera, David Lázaro-Gimeno, Bertold Mariën
PhD students: Johan Sjölander
Students: Jonas Courtalon, Luisa Schwarz, Anna Tollefsen, Paula Hausmann, Kajsa Brändström, Tjara Hortsmann

Photo on top: Happy Wilder

M. Rosario García Gil

UPSC group leader since 2004, SLU

Forest Tree Landscape Genetics

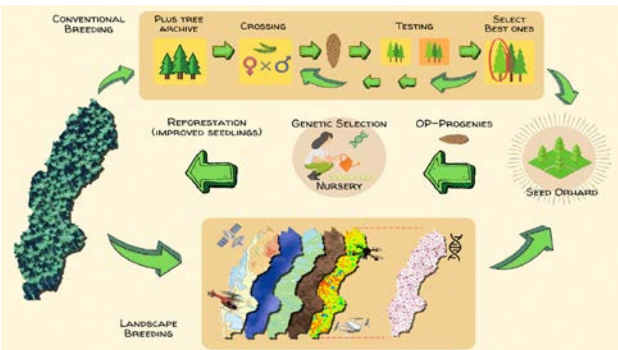
My main research interests are forest adaptation, phyllosphere biodiversity, and nature-based forest management practices, which I address by leveraging synergies between quantitative and population genetics, physiology, wood biology, genomics, transcriptomics, molecular biology, mathematics, and, more recently, metabolomics and remote sensing (digital forest). My research has made significant contributions to understanding the genetic basis of local adaptation in conifer species.

Research goal

To investigate the genetic foundations of boreal conifer trees' local adaptation as a means to develop nature-based forest management practices. These practices aim to preserve the forest's ability to adapt and evolve, while also safeguarding the biodiversity it supports.

Highlights of 2022-2023

- Grant: VR2023 grant on the genetics behind the enhanced resilience to pest attack of the most northern Norway spruce and Scots pine populations.
- Grant: SSF: Landscape breeding
- Grant: Assess4EST EU Horizon, WP leader
- Named Vice chair of the SLU breeding network 2022-
- Named member of the Swedish Forest Breeding Association 2023-
- Named board member of Evoltree (evolutionary genetics) 2023-
- Reviewer of SSF industrial PhD program
- 10 peer reviewed articles (2022-2023)



Overview of SSF project in landscape breeding (illustration: Juha Niemi)

Future plans

To develop a digitalized model for landscape genetics to improve seed orchard efficiency, accelerate superior tree selection and guide deployment. To advance our understanding on boreal tree local adaptation and the implications on ecosystem resilience. To support with knowledge and tools the development of nature-based forest management practices that protect forest adaptability and associated phyllosphere biodiversity.

SSF Landscape breeding team with M. Rosario García Gil to the right

Group members (2022-2023)

Staff scientist: Sonali Sachin Ranade
Postdocs: Haleh Hayatgheibi, Francisco Gil Muñoz
PhD student: Annica Nordström
Research assistants: Juha Niemi, Laura Morales

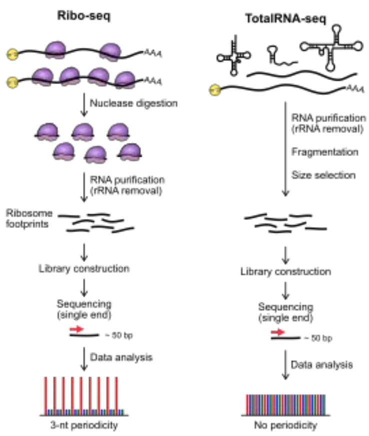
Photo on top: Juha Niemi

Johannes Hanson

UPSC group leader since 2011, Umeå University

Translational Control of Gene Expression in Response to Environmental Cues

When the environment of the plant changes, the physiology of plant cells changes to better fit the new conditions. Changed gene expression is central to this process. Traditionally have the focus been on transcriptional control and mRNA levels in the cell. However, recent data have made it clear that mRNA translational efficiency varies between transcripts and changing in response to changed conditions. We therefore focus our work on the regulation of translation. Now when we have tools to study translational efficiency of all mRNAs, we can show that thousands of mRNA is translationally regulated in response to various environmental or developmental changes.



The location of each translating ribosome in the sample can be determined by digesting all parts of the mRNA not protected by ribosomes and sequencing the protected fragments. Translational efficiency (TE) is determined by comparing the sequencing result from isolation of ribosome protected fragments (Ribo-Seq) with that of total cellular RNA (illustration: Sara Häggström).

Research goal

We want to characterize and understand how the plant dynamically regulate its translation of individual mRNAs. We currently think that the more than six-hundred yet uncharacterised mRNA binding proteins of the Arabidopsis genome is playing a huge role. We use model transcript with clear and defined regulatory patterns and dissect their regulatory mechanism using biochemical, molecular, and genetic tools.

Highlights of 2022-2023

- Our long efforts in establishing molecular techniques to study translation on a global level have been successful. Amir and Sara have established the lab as a centre for Ribo-Seq and ribosomal profiling with guest from Sweden, Finland, Germany and the United States. Several high-profile manuscripts are already published and more to come.
- Jamil has characterized the importance of the transcription factor bZIP11 in the reprogramming of metabolism in response to pathogen attack.
- We have identified translational regulated mRNA in response to several aspects of developmental phase changes such as seed and bud development. Some mRNAs are very stable and are kept intact during seed dormancy to be translated immediately after dormancy release, often even before transcriptional activation, in contrast to the general belief of mRNAs as being labile intermediates.

Future plans

We have by using Ribo-Seq and other techniques identified several mRNAs that are translationally regulated in response to environmental or developmental cellular changes. Most of our current projects are focusing on characterizing the molecular mechanism underlying translational regulation of individual mRNAs. We also continue to optimize Ribo-Seq methodology, on the bioinformatic analytical level as well as in the laboratory.

Johannes Hanson with group members

Group members (2022-2023)

Staff scientist: Amir Mahboubi
Postdocs: Dhriti Singh, Sunita Kushwar, Jamil Chouwdhurry, Marta Petrez Alonzo
PhD students: Sara Häggström
Students: Christoffer Löved, Kenny Tille
Guest researchers: Pinky Dutta, Gesa Hoffman, Sjors van der Horst

Photo on top: Mattias Pettersson

Vaughan Hurry

UPSC group leader since 1999, SLU

Plant Adaptation to Sub-Optimal Environments

In the boreal and nemoboreal zones that make up Sweden's forest estate, ongoing climate change is increasing the exposure of plant communities to biotic and abiotic stresses. Key climate drivers include: 1) increasing atmospheric temperatures are altering the timing of spring growth initiation and autumn growth cessation, leading to increased growth opportunities for plants but also exposing them to increased risk of mistiming acclimation and deacclimation for winter freezing; 2) increasing temperatures increases the risk to plant communities from changing rainfall patterns and drought. How the different components of these complex plant communities respond to these stressors will determine the long-term stability of these ecosystems.

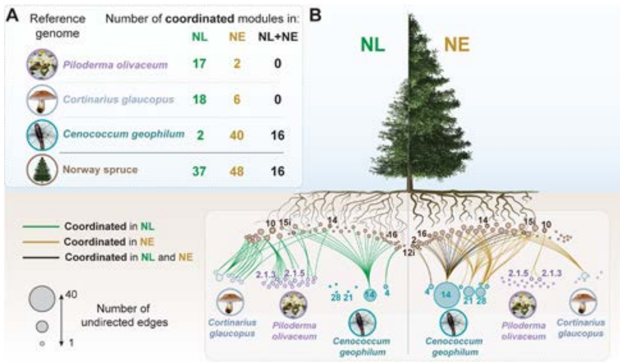
Research goal

Our goals are to understand how Scots pine and Norway spruce respond to changes in their thermal environment and to changes in water availability; and determine whether there is genetic variability in these responses within these species that can be captured into breeding programs. We also want to understand the complex relationship between forest trees and their associated soil microbiome, to determine the role this relationship has in increasing the resilience of the forest to environmental change.

Norway spruce shoots at this early stage of development (insert) are particularly sensitive to damage from late spring frosts, here at the field site Kulbäcksliden (photo: Vaughan Hurry)

Highlights of 2022-2023

- As a compliment to earlier studies on drought, we established the gene regulatory networks that enable Norway spruce needles and roots to acclimate to cold stress and subsequent freezing.
- Using a breeding population of Norway spruce, we have established that there is genetic variation in basal (non-acclimated) tolerance to freeze injury in developing spring buds and that this is a heritable trait. This trait is inversely linked with bud break, suggesting that there is selection pressure on genotypes that break bud early to be more tolerant to freeze damage, whereas late bud breaking genotypes avoid injury.
- We established protocols for studying coordinated gene expression of host tree and linked ectomycorrhizal fungal species. This approach makes it possible to study how changing environmental parameters and changing forest management impacts on communication between the tree and the hosted microbiome, and how this in turn changes the soil community composition and biodiversity.



Coordination between the host Norway spruce tree and the three most dominant root associated mycorrhizal fungi in nutrient limited (NL) and nutrient enriched (NE) conditions. Under NE conditions, most of the gene expression linkages of the dominant ectomycorrhiza (Cortinarius and Piloderma) are lost and those fungal species lose their dominance within the soil community, while a more versatile species (Cenococcum) takes their place. (Figure taken from Law et al, 2022 (https://doi.org/10.1073/pnas.2118852119).

Future plans

We will continue this two-pronged approach of studying how forests respond to climate challenges. First identifying the responses of individual trees and the responses of tree populations to key abiotic stressors with the aim of aiding ongoing tree breeding programs; and second, to understand the consequences of plant stress responses not only for tree growth, but also the consequences of altered tree vitality for the link microbiomes, and effects this interplay has on biodiversity and forest resilience.

Group members (2022-2023)

Staff scientist: Alonso Serrano
Postdocs: Simon Law, David Castro
PhD students: David Castro, Tuuli Aro

Photo on top: Mattias Pettersson

Stefan Jansson

UPSC group leader since 1999, Umeå University

How do Trees Survive the Winter?

Trees have evolved to survive the harsh winters of the boreal forests, but deciduous trees and conifers have chosen different strategies and we study the molecular details behind them. We study autumn senescence using aspen as a model system. We use metabolomics, transcriptomics and natural variation and have developed genomic and genetic resources for aspen (*P. tremula*) in particular, for example clone collections. To study how the photosynthetic apparatus of conifers have been adapted to make it possible for conifers to keep their leaves (needles) green over the winter combine molecular biology, biochemistry, biophysics etc.

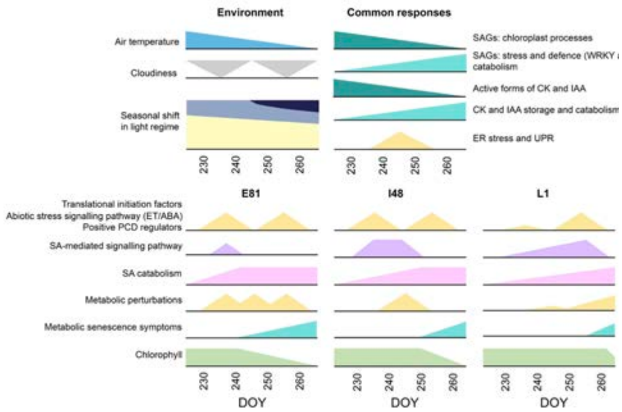
Research goal

Our goals are to understand tree phenology, develop the tools to identify genes governing important traits in trees and also to understand the mechanisms regulating photosynthesis. But in addition, we are also trying to improve photosynthesis and plant growth using biotechnology. In all our projects, we strive to make studies on plant grown under natural conditions, not just in the lab.

How can conifer needles be green in winter? (photo: Tomas E Johanson)

Highlights of 2022-2023

- We have shown that Flavodiiron-mediated O_2 photoreduction at photosystem I acceptor-side provides photoprotection to conifer thylakoids in early spring (Bag et al. 2023, Nature Communications, 14(1): 3210). This is the second mechanism regulating conifer needle photosynthesis (the other is Direct energy transfer from PSII to PSI, Bag et al. 2020) that we have shown operate in conifers but that (at least not so far) have been identified in angiosperms. We believe that these mechanisms provide the answer to the question: How could conifer needles be green in winter?
- We have, using natural variation and profiling of metabolites, hormones and gene expression, demonstrated the enormous complexity behind regulation of autumn senescence in aspen (Lihavainen et al. 2023, Nature Communications, 14(1): 4288)



Environmental parameters and transcriptional and metabolic responses in aspen leaves in autumn 2018. From Lihavainen et al. 2023.

Future plans

We are at present exploiting the possibilities of a novel advanced instrument (Chlorospec) for studies of photosynthetic regulation. We use it to study collections of targeted photosynthetic mutants of Arabidopsis and aspen. We will also continue to work towards an understanding of the elusive mechanisms behind regulation of autumn senescence in trees. Finally, our project to create trees that grow better, to be used for example in bioenergy plantations, using biotechnology, including genome editing, is progressing.

Group members (2022-2023)

Staff scientists: Kathryn Robinson, Tatyana Shutova
Postdocs: Nazeer Fataftah, Maximiliano Cainzos, Jenna Lihavainen
PhD students: Sanchali Nanda

Photo on top: Fredrik Larsson

Olivier Keech

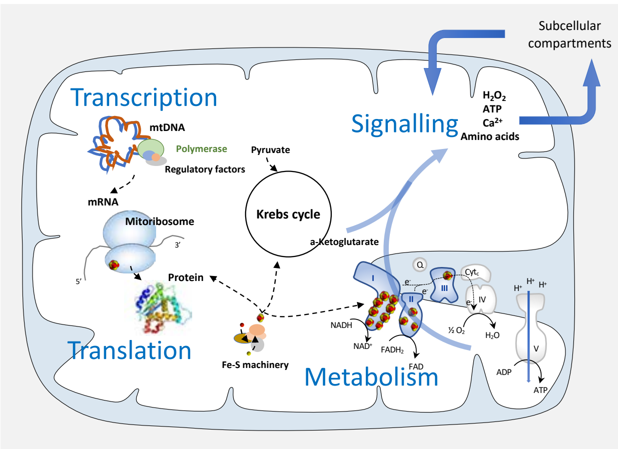
UPSC group leader since 2014, Umeå University

Metabolic Regulations in Response to Stress

Plants are constantly subject to multiple stresses, and years of evolution have tailored them to adapt to many environmental cues such as drought, salinity or low nutrient availability. Yet, many molecular aspects of this adaptation remain unclear. For instance, when a stress is applied, a plant has the possibility to sacrifice certain organs to support the survival of the entire organism. How is this choice made? And can it be used for breeding and biotechnological improvements with the aim to prolong life span of crops and trees in response to severe stress episodes as we will likely face with a fast changing climate? These are the questions we are addressing in my lab by using a multi-disciplinary approach combining genetics, biochemistry, molecular biology, bioinformatics and physiology.

Research goal

Our research explores several aspects of the regulation of plant metabolism in response to stress, with a particular emphasis on mitochondrial metabolism. We have identified key regulators controlling cell death in response to stress, and we are now investigating the different molecular regulations conferring this incredible ability for survival.



Mitochondrial metabolic functions essential for growth and stress response (illustration: Olivier Keech)

Highlights of 2022-2023

- We have setup two novel method to isolate and study plant energy organelles in a spatio-temporal manner (Boussardon and Keech 2022, 2023).
- We discovered a novel regulatory loop associated with the control of cell death in which polyamines repress an ethylene-dependent signalling pathway (Liebsch et al 2022).
- In a collaborative effort, we discovered a mitochondrial protein essential for the assembly of super complexes (Röhricht et al 2023).
- Organizer of International Conference of Plant Mitochondrial Biology in Malmö, ICPMB 2022.
- Member of the KSLA general section.

Keech's group members refuelling their mitochondrial metabolism (photo: Robert Andersson)

Future plans

We will follow our investigations on several key mitochondrial proteins, involved notably in Fe-S clusters assembly and post-translational modifications. These functions, essential for plant growth, are regulated by molecular mechanisms that are still unknown. We will also carry out a couple of biotechnological assays, in which certain growth and stress-resistance features will be transferred to trees and tested.

Group members (2022-2023)

Staff scientists: Clément Boussardon
Postdocs: Marta Juvany, Shah Hussain
PhD students: Alicia Lopez-Lopez, Barnabás Cseh
Students: Ahmet Gökcebel

Photo on top: Fredrik Larsson

Peter Kindgren

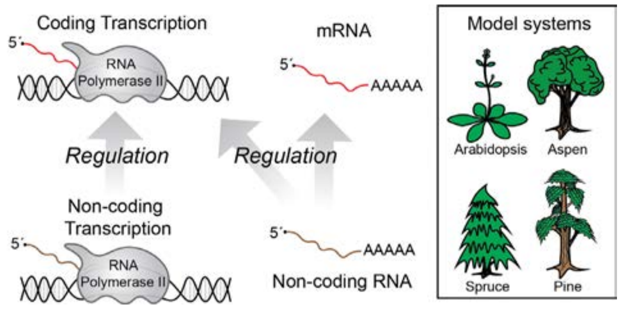
UPSC group leader since 2020, SLU

Coding versus Non-Coding Transcription in Plants

The DNA is the blue-print for how a living organism should develop and respond to different environmental cues. It does so by activating and repressing coding regions of the genome. Surprisingly, most of the DNA in genomes do not encode for proteins but is non-coding. With the development of new sequencing technologies, it is apparent that much of this non-coding DNA is transcribed into RNA. A key question in modern biology is therefore why organisms spend so much energy to transcribe something that is not used as template for protein synthesis. We use Arabidopsis, aspen, pine, and spruce to bridge the knowledge gap we have today of how non-coding transcription regulate coding transcription.

Research goal

My research group tries to find and characterise the functions for transcription of long non-coding RNAs, especially those that occur on the complementary strand of coding genes. We have a special interest in how plant responds to cold temperatures and how the coding transcriptional output is determined by the crosstalk of non-coding transcription and the transcription machinery itself.



In the research group, we are working on four model systems: Arabidopsis, aspen, spruce, and pine. Our interest concerns transcription, how RNA is synthesized from genomic DNA. Our primary aim is to understand of non-coding transcription and its role of regulating the level coding messenger RNA during stress conditions for the plant (illustration: Peter Kindgren).

Highlights of 2022-2023

- Zacharaki V, Kumar Meena S, Kindgren P (2023) The non-coding RNA SVALKA locus produces a cis-natural antisense transcript that negatively regulates the expression of CBF1 and biomass production at normal temperatures. Plant Communications, Vol 4, Issue 4, 100551.
- Grant from Olle Engkvist Foundation (2023)
- Grant from Kempe Foundation (2022)

Future plans

We will continue our work in trees to identify and classify long non-coding RNAs. Preliminary data from our group show that trees regulate their transcription differently than other plants. In Arabidopsis, we will focus on antisense transcription and present general roles for different classes of long non-coding transcripts. The group have identified a number of transcription factors elongation factors with associated antisense transcript that are important for the cold acclimation process. These will be further characterised.

Peter Kindgren with group members (photo: Alexandra Rouillard)

Group members (2022-2023)

Postdocs: Shiv Kumar Meena, Sarah Mermet, Mishaneh Asgari, Sagar Susheel Bhat, Vasiliki Zacharaki
PhD students: Isabell Rosenkranz
Students: Priyanka Mishra, Mathilde Brot, Daniela Döben, Eveline Bosman, Clement Verez, Anna-Maria Sandler
Guest researcher: Dawid Bielewicz

Photo on top: Fredrik Larsson

Karin Ljung

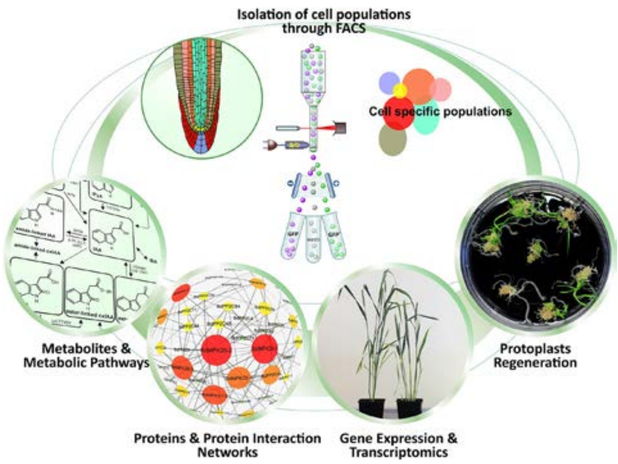
UPSC group leader since 2005, SLU

Root Development and Shoot-Root Communication

Plants coordinate growth and development using external and internal signals in order to cope with different growth conditions and environmental constraints. Auxins and cytokinins are plant hormones that are essential throughout the whole life cycle of higher plants. They play pivotal roles in key growth and developmental processes, and they are central to coordinate responses to different environmental variables. In my group, we are studying auxin and cytokinin metabolism, transport and signalling, how these processes are regulated by internal and external signals, and how they influence primary and secondary root development.

Research goal

My research is focused on mechanisms regulating plant growth and development, especially root development. We are particularly interested in the roles played by plant hormones in the developmental processes that lead to the formation of the root system, as well as their roles in the integrative coordination of root and shoot growth.



Isolation of specific root cell populations by FACS followed by downstream applications in protoplast regeneration and different omics technologies such as transcriptomics, proteomics, and metabolomics (adapted from Antoniadi et al. 2022, Cytometry Part A, 101: 725-736) (illustration: Ota Blahousek).

Highlights of 2022-2023

- We have established Fluorescence-Activated multi-Organelle Sorting (FAmOS), an innovative subcellular fractionation technique based on flow cytometric principles, Skalický et al. 2023, Plant Journal 116: 1825-1841. Our data showed different subcellular distribution of auxin and cytokinins, confirming the formation of intracellular phytohormone gradients that have been suggested based on subcellular localization of auxin and cytokinin transporters, receptors, and metabolic enzymes.
- We have established single-cell RNA sequencing using FACS at UPSC, and we are currently using this method to study gene expression during lateral root initiation.
- We could show that deactivation of a group of IAA conjugating enzymes, the group II GH3s, lead to resistance to salinity and water deficit, Casanova-Sáez et al. 2022, New Phytologist 235: 263-275.
- We could show that IPT9, a cis-zeatin cytokinin biosynthesis gene, promotes root growth, Antoniadi et al. 2022, Frontiers in Plant Science Oct 14:13:932008.

Karin Ljung with group members (photo: Stéphanie Robert)

Future plans

Our focus during the coming years will be to better understand the processes that regulate lateral root initiation and development. We are especially interested in the roles that different sources of nitrogen, inorganic and organic, play during these processes. We plan to use a combination of cell type specific transcriptomics, metabolomics and hormone profiling to understand the molecular mechanisms behind the striking differences we have observed in root architecture and biomass depending on the nitrogen source.

Group members (2022-2023)

Staff scientist: Ioanna Antoniadi
Postdocs: Barbara Pařízková, Vladimir Skalický
Student: Priyanka Mishra
Guest researchers: Ondřej Novák, Karel Doležal, Anita Ament, Beata Budíková, Pavel Hladík

Photo on top: Elisabeth Ohlson Wallin

Alizée Malnoë

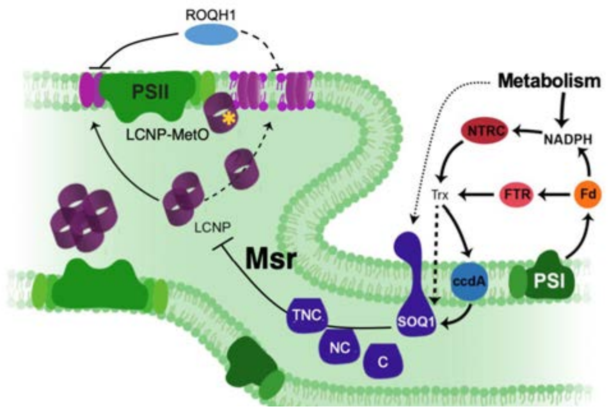
UPSC group leader since 2018, Umeå University

Molecular Mechanisms of Plant Photoprotection

Photosynthesis is a biological process of primary importance, as it provides the energy that drives food, feedstock and biofuel production and mitigates climate change. Light in excess of photosynthetic capacity can be damaging, thus ways to protect against damage have evolved, including ways to minimize light absorption, detoxify reactive oxygen species generated by excess light, and dissipate excess absorbed light. Together, these processes are known as photoprotection. Despite the physiological importance of photoprotection, the molecular mechanisms that protect against light stress remain largely unknown, especially those that protect from prolonged light stress.

Research goal

The objective of our research is to solve molecular mechanisms of photoprotection in plants combining genetics, biochemistry, biophysics and physiological approaches.



Working model for qH. Under non-stress conditions qH is prevented by SOQ1 through its methionine sulfoxide reductase (Msr) activity; under stress conditions such as cold and high light, or drought, LCNP methionines become oxidised (MetO) thereby inducing qH at the thylakoid membrane in the antenna of photosystem II (PSII). Adapted from Malnoë, A., Environmental and Experimental Botany, 154, pp. 123-33 (2018).

Highlights of 2022-2023

- PhD defence of Pierrick Bru with opponent Stefano Caffarri
- Hao J, & Malnoë A (2023) Bio-protocol 13(15):e4756
- Master student Ahmet Gökçebel from Umeå University, Sweden
- PhD student Yuka Fukushi from Tokyo Institute of Technology, Japan
- Bru P, et al. (2022) J Biol Chem 298(11):102519
- Early Career Prize from the Scandinavian Plant Physiology Society to Alizée
- Yu G, et al. (2022) Nat Plants 8:840–855
- Erasmus+ PhD Fadime Demirel from Akdeniz University, Turkey
- STINT mobility grant for internationalisation with the Mei Li laboratory, Chinese Academy of Sciences, China

Alizée Malnoë with group members

Future plans

Energy dissipation protects photosynthetic organisms from excess light. Previously in Arabidopsis, we have identified factors which modulate a sustained form of energy dissipation that we termed qH. We are investigating the function of these factors, and newly identified ones, in repressing, turning on or off qH at the transcriptional, structural and post-translational levels. Specifically our research will advance knowledge of: 1) protein translocation, redox regulation and post translational regulation within the thylakoid lumen, 2) light harvesting protein structure-function, and 3) underexplored chloroplast pathways including trans-thylakoid thiol-metabolism and sugar-mediated feedback on photoprotection.

Group members (2022-2023)

Postdocs: Jingfang Hao, Aurélie Crepin, Paola Puggioni
PhD student: Pierrick Bru
Student: Ahmet Gökçebel

Photo on top: Fredrik Larsson

Jian-Feng Mao

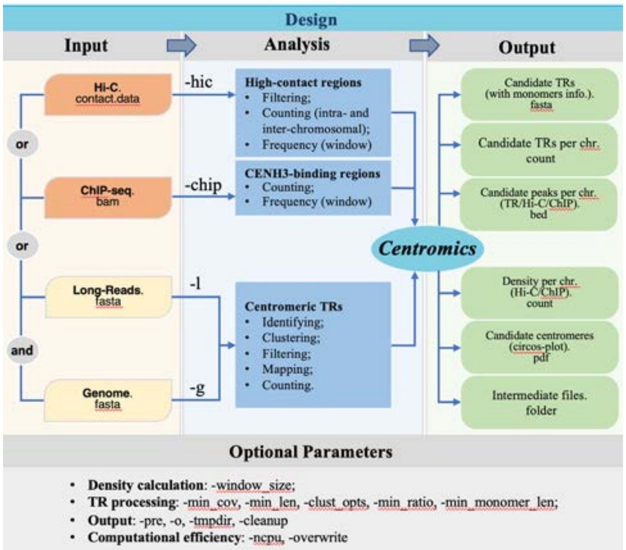
UPSC group leader since 2023, Umeå University

Plant Genomics

The integration of genomics, multi-omics, and computational biology is crucial for contemporary biological breakthroughs. Advanced computation, particularly in artificial intelligence (AI), is transforming the analysis of complex biological datasets, enabling rapid, precise insights that drive research and therapeutic innovations. Our focus is to devise and implement computationally efficient methodologies for dissecting biological intricacies, including genome annotation, transposon dynamics, gene expression patterns etc..

Research goal

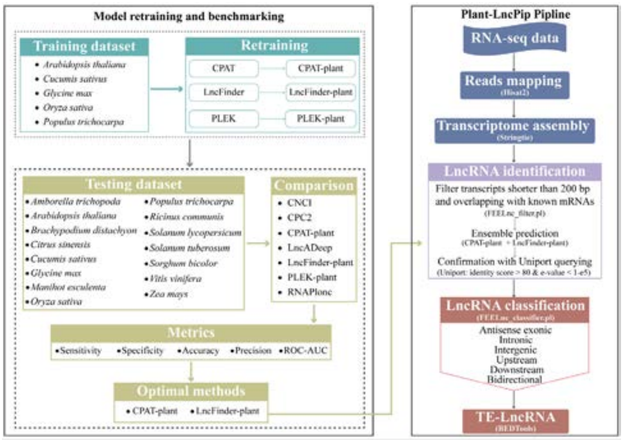
Our research aims to pioneer computational approaches for genome and data-intensive analysis by harnessing AI and other efficient computational techniques. We are dedicated to overcoming the complexities of vast genomes, such as those of conifers. Our objectives include refining computational methods for sequence read mapping, identifying transposons and long non-coding RNAs (lncRNAs), conducting genome-wide association studies (GWAS), and advancing genomic prediction. Additionally, we aspire to unravel the genetic underpinnings of heterosis, exemplified in hybrid poplars, through the lens of allele-specific gene expression.



Workflow of the centromere identification pipeline (illustration: Shuai Nie)

Highlights of 2022-2023

- We generated a computational method (available at: https://github.com/ShuaiNIEgithub/Centromics) to locate centromere sequence in genome assembly by checking multiple evidences, such tandem repeats and Hi-C chromatin contact.
- We generated a computational pipeline (https://github.com/xuechantian/Plant-LncRNA-pipeline) in plant lncRNA identification by providing significant improvement (Tian et al., 2024).
- We generated a computation pipeline (https://github.com/shitianle77/Allele_auto) to identify allele pairs from haplotype-resolved genome assembly and to automate allelic differential gene expression analysis.
- We generated a deep-learning driven method (https://github.com/morningsun77/ltr_checker) to identify LTR retrotransposon from genome assembly. This method brings fast speed and high accuracy, runs efficiently for conifer large genomes.



Workflow of the lncRNA identification pipeline (illustration: Xue-Chan Tian)

Future plans

We aim to harness AI-driven modelling to develop efficient tools for transposon identification from genome sequence, and to establish a k-mer-based computational framework for GWAS and genomic predictions, tailored for conifers with their voluminous datasets and intricate genetics. Our objective extends to enhancing our just-developed pipelines for broader applicability and disseminating our advancements through publication.

Group members (2022-2023)

PhD student: Shi-Wei Zhao
Student: Irda Pateriku

Photo on top: Mattias Pettersson

Petra Marhava

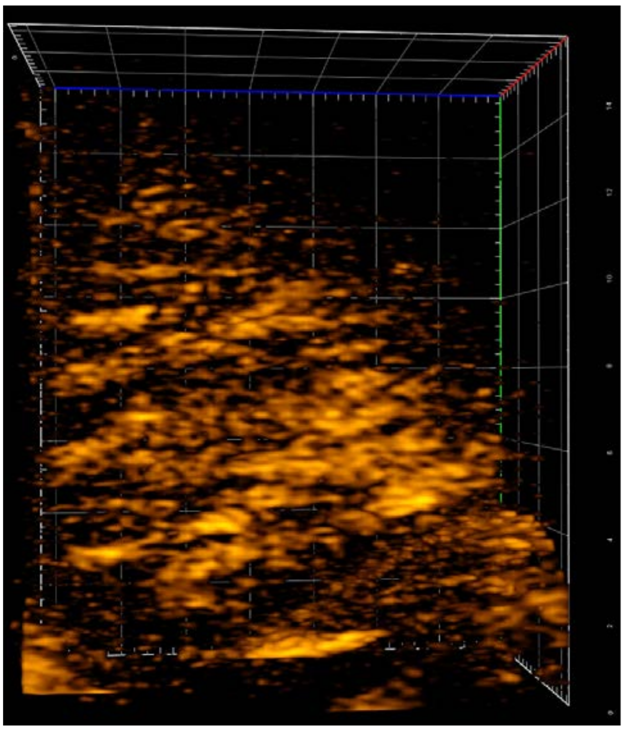
UPSC group leader since 2022, SLU

Plant Acclimation to Heat and Cold Stress

Our planet is warming, and extreme-weather events such as sudden heat waves or cold waves will only become more frequent. Unlike animals, plants are sedentary organisms and cannot run away from adverse environmental conditions. Consequently, they have developed sophisticated signalling and protective mechanisms to cope with sub-lethal stress situations. While most studies to date have primarily focused on broader aspects of plant responses to climate change (such as biomass), future research needs to focus on molecular and cellular responses to improve our mechanistic understanding of plant acclimation and adaptation to heat and cold stress.

Research goal

The plasma membrane is the primary target of environmental stress, and maintaining its integrity and fluidity is essential for plant survival. Temperature directly alters the fluidity of bio-membranes and the remodelling of membrane microdomains. Hence, our aim is to uncover the link between changes in membrane fluidity and (i) the dynamics of hormonal transport (such as auxin in HOT-AND-COLD project - ERC StG) and (ii) cell-to-cell communication to reveal how cells talk to each other to spread the signals in response to temperature stress.



The PIN2 protein exhibits a clustered (unequal) localization on the plasma membrane (image: Jasim Basheer)

Highlights of 2022-2023

- We identified temperature-responsive phosphoproteome of membrane proteins, providing valuable insights into the overall root-specific response to the earliest drop or increase in temperature (collaboration with W. Schulze, Hohenheim in Germany).
- We established the collaboration with E. Bayer (Bordeaux, France) to reveal cell-to-cell communication in response to temperature stress and P. Marhava obtained funding from *Kempestiftelserna* (main applicant)
- Acquired funding from *Kempestiftelserna* as a main applicant to purchase a super-resolution confocal with temperature-controlled stage system and spectroscopic techniques to assess membrane fluidity and plasma membrane microdomain visualization.
- We published invited reviews in Current Opinion in Plant Biology and New Phytologist
- Awards: The Skyttean Society's award to younger researchers, member of AcademiaNet - the expert database for outstanding female academics

Future plans

We want to continue to study the plant responses to temperature stress, focusing on how plasma membrane fluidity affects active auxin transport via its transporters and passive diffusion via plasmodesmata (cell-to-cell communication). Moreover, we aim to reveal root's cell-type specific translatome and identify molecular players involved in temperature stress pathways through a chemical genomic screen (in progress). Additionally, we intend to investigate how combined heat and draught stress affects membrane fluidity, considering that these stressors exert opposite effects on the plasma membrane (fluidity vs rigidity).

Group members (2022-2023)

Postdocs: Jasim Basheer, Ling Cheng, Manvi Sharma, Sonhita Chakraborty
PhD student: Jarl Kjellström
Student: Cynthia Desharbes (Erasmus)

Photo on top: Andreas Palmén

Peter Marhavý

UPSC group leader since 2020, SLU

Short Distance Communication in Responses to Wound Stress

Plants possess the remarkable ability to detect various stress factors, whether they be biotic, abiotic, or physical, and to activate specific signalling pathways in response. While much attention has been devoted to understanding the signals that trigger defensive responses in plants, the precise processes through which cells perceive these signals and transmit them to neighbouring cells remain largely elusive.

Research goal

Our investigation aims to shed light on the molecular mechanisms governing intercellular communication, focusing on the initial responses to root damage in plants. Through our research, we aim to enhance our understanding of how plants coordinate their defensive and regenerative strategies at the cellular level. Additionally, we aim to explore how minimal damage in one plant can elicit a response from neighbouring, uninjured plants, unravelling the intricacies of plant-to-plant communication.

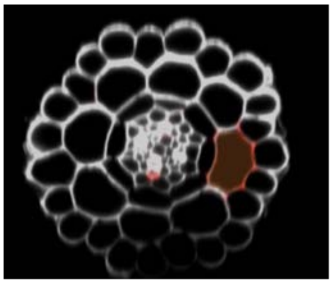
Nematodes in pink (image: Peter Marhavý)

Highlights of 2022-2023

- We discovered that in deep tissue in the plant pericycle has a unique cell wall property that is important during wound induced regeneration
- We published a review article with focus on the intricate mechanisms of plant defence. (Guerreiro, J., & Marhavý, P, 2023)
- We discovered how wounded plant hormones ethylene and jasmonate regulate their responses to single cell damage
- We identified how plants build a barrier as a response to invasion of plant parasitic nematodes
- We obtained funding from the Wallenberg Foundation and *Kempestiftelserna*.

Future plans

We will be expanding our efforts in the field of plant single-cell wound damage research. Our goal is to develop comprehensive mechanistic models that elucidate the intricate responses of plants to wounds. These models have the potential to significantly bolster the capacity of plants to regenerate and defend themselves, especially amidst the ongoing global climate crises. By deepening our understanding of how plants respond to wound at the cellular level, we aim to contribute to the development of strategies that can enhance their resilience and survival in challenging environmental conditions.



Cross section of Arabidopsis root showing single cell damage in red (image: Peter Marhavý)

Group members (2022-2023)

Postdocs: Xuemin Ma, Luciano Martin Di Fino, Nagenna Zhahid, Muhammad Anjam
PhD student: Julie Guerreiro
Student: Diego Tazueco

Photo on top: Fredrik Larsson

Ewa Mellerowicz

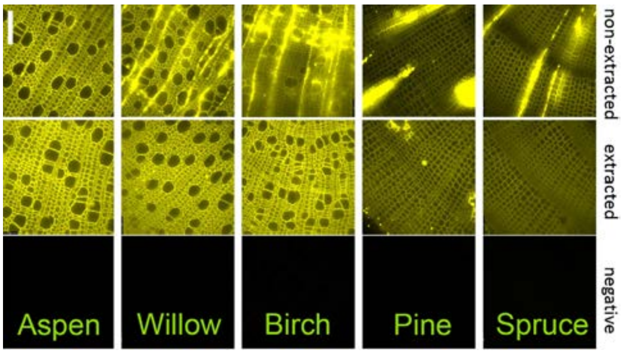
UPSC group leader since 2005, SLU

Wood Matrix Polysaccharides

Approximately one quarter of carbon bound in the wood biomass is in the form of non-cellulosic polysaccharides commonly called "matrix polysaccharides". The matrix polysaccharides play an important role in wood development; they are responsible for regulation of cell wall properties during cell growth, thus mediating wood cell size and shape, and they regulate properties of mature wood cell wall, thus affecting mature wood function as water conducting and crown supporting tissue of trees. Matrix polysaccharides have backbones made of hundreds of sugar units, some of which are decorated with different side chains. Their contents and structures are strictly controlled by plant cells, both during their biosynthesis in cell protoplasts, and during their carriers in the cell wall.

Research goal

Our goal is to understand how matrix polysaccharides mediate cell wall properties in the wood and how they affect tree growth and development, as well as wood traits important for wood utilization. We study these questions not only in controlled environment but also in natural environment in the field.



Lipids remaining in the wood cell walls after removal of extractives. Negative - autofluorescence. Size bar = 100 um (photo: Marta Derba-Maceluch)

Highlights of 2022-2023

- We discovered that wood cell wall binds part of lipidic-suberin-like extractives, and that xylan side chain – methyl-glucuronic acid – is responsible for fastening them to the cell wall
- We identified a novel player in xylan biosynthesis which is an aspartic protease AP1 that affects xylan content in the field-grown aspen
- We found that stem flexing improves tree growth and we identified molecular players responsible for flexure wood formation.
- We demonstrated superior growth or saccharification properties for several transgenic aspen lines grown in the field. One line was tested in semi-industrial pretreatment conditions and showed expected saccharification improvement.
- We obtained NOVA funding to organize the PhD course in Wood Biology and Biotechnology, and FORMAS grant for Indo-Swedish cooperation project
- We initiated a new collaboration with Luleå Technical University on wood nanocellulose

Field trial of transgenic aspen (photo: Marta Derba-Maceluch)

Future plans

We plan to chemically characterize the wood lipids and identify linkage between the methyl-glucuronic acid and lignin. We would like to investigate if a similar linkage is involved in attaching the cuticle to the cell wall in leaves. We will continue investigating the nature of xylan-lignin interaction in the wood, in particular the ester link between methyl-glucuronic acid and lignin. Since the xylan modification expectedly affects cell wall integrity, we aim to investigate if secondary cell wall integrity signalling can be detected in different transgenic aspen lines with altered xylan, and if such plants have an altered response to drought.

Group members (2022-2023)

Postdocs: Evgeniy Donev, Madhusree Mitra, Garima Pandey
PhD student: Félix Barbut
Guest researcher: Dr. Pramod Sivan

Photo on top: Ewa Mellerowicz

Johannes Messinger

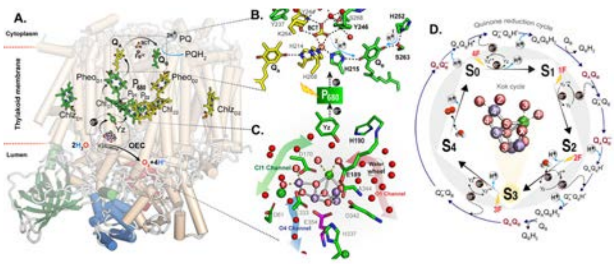
UPSC group leader since 2024, Umeå University

Biophysics of Photosynthesis

We employ a large range of biophysical techniques for investigating catalytic reactions in photosynthesis. Our main focus is water splitting in photosystem II, but we have also projects concerning photosystem I, Rubisco and carbonic anhydrases. The biophysical techniques include time-resolved membrane inlet mass spectrometry, cryo-EM, serial crystallography at free electron lasers, x-ray spectroscopy, neutron scattering, electron paramagnetic resonance and fluorescence. We are also interested in the assembly and repair processes of photosystem II and its regulation via cellular processes.

Research goal

My goal is to understand the design principles of biological redox catalysis, such as water oxidation in photosystem II. Of specific interest is how protein-water-cofactor interactions can be utilized to activate base metals such as Mn or Fe for complex conversion reactions of small molecules (H_2O, O_2, CO_2, N_2, H_2).



Overview of photosystem II with its cofactors (A) and zoom into the acceptor (B) and donor (C) sides. Panel D shows shows the reaction cycle of the Mn_4CaO_5 cluster, which is displayed in the center in its S_3 state. From: Cryo-EM insight into hydrogen positions and water networks in photosystem II: Hussein R et al. (2024) BioRxiv 2024.04. 02.586245.

Highlights of 2022-2023

- Identification of the substrate water binding sites in the oxygen evolving complex of photosystem II. *See:* Assignment of the slowly exchanging substrate water of nature's water-splitting cofactor: de Lichtenberg C et al. (2024) Proc Natl Acad Sci USA 121, e2319374121.
- We obtained structures of transient states of photosystem II during O_2 formation. *See:* Structural evidence for intermediates during O_2 formation in photosystem II: Bhowmick A et al. (2023) Nature 617, 629-636.
- We published an educational review that summarizes the present state of knowledge regarding water oxidation by photosystem II in an understandable and comprehensive way. *See:* Solar energy conversion by photosystem II: principles and structures: Shevela D, Kern J, Govindjee G, Messinger J (2023) Photosynth. Res. 156, 279-307.

Future plans

Within national and international collaboration, we will combine cryo-EM, serial crystallography at XFELs, EPR, neutron scattering, membrane inlet mass spectrometry and advanced calculations to unravel the design principles of protein-water-cofactor interactions in photosystem II. Another focus will be on the regulation of photosystem II by cellular mechanisms such as CO_2/HCO_3^- and the mechanism of Rubisco.

Johannes Messinger with group members (photo: Luca D'Amario)

Group members

I joined UPSC in 2024 and I am in the process of recruiting co-workers. Below, I list my present co-workers at the Molecular Biomimetics program, Department of Chemistry, Uppsala University and the Department of Chemistry, Umeå University.

Staff scientists: Ping Huang, Petko Chernev, Dmitry Shevela
Postdocs and Researchers: Sergii Shylin, Luca D'Amario, Jack Forsman (co-supervision)
PhD students: Abuzer Orkun Aydin, Nicholas Cox, Larissa Kurth, André Graça (co-supervision)

Photo on top: Felizitas Messinger

Totte Niittylä

UPSC group leader since 2009, SLU

Carbon Allocation and Metabolism

My group investigates plant metabolism, carbon allocation and growth with focus on trees and the formation of wood. Carbon allocation is a fundamental physiological process in tree growth which cascades across scales to ecosystems and the global carbon cycle. We apply a combination of genomics, metabolomics and fluxomics tools to identify genes, enzymes and pathways which are central in converting CO_2 to woody biomass. We use aspen as a model system for tree and wood biology, and Arabidopsis as a model to address fundamental cell biology mechanisms linked to cell wall biosynthesis and plant growth.

Wild type (left) and CRISPR-cas9 generated starchless *Populus tremula* trees (photo: Wei Wang)

Research goal

Our goal is to understand the metabolic mechanisms of photosynthetic carbon assimilation and subsequent partitioning of carbon to wood. We envision that this work will identify factors limiting the capacity of trees to assimilate atmospheric carbon, and improve our ability to interpret and predict responses of forest ecosystems to climate change. The goal of our Arabidopsis research is to identify overlooked fundamental cellular processes and to elucidate essential plant growth mechanisms.

Highlights of 2022-2023

- We discovered that young aspen trees employ a passive saving strategy to save carbon for future needs and that aspen growth is not carbon limited under benign growth conditions (Wang et al. 2022).
- We showed that sucrose synthase makes no significant contribution to transitory starch synthesis in Arabidopsis leaves, resolving a 20-year old controversy about one of the most important pathways of photosynthetic metabolism (Fuenfgeld et al. 2022).
- We identified two new Golgi localized ß-1,3-galactosyl transferases involved in cell wall and cellulose biosynthesis (Nibbering et al. 2022).
- We obtained funding from the Swedish Research Council, *Kempestiftelserna* and Carl Trygger Foundation.

Cross section of aspen stem (photo: Anne Bünder)

Future plans

We plan to continue to expand our activities in plant metabolism research. We hope to develop mechanistic models of metabolism and carbon assimilation capacity of trees, which could be used to address and predict trees' role in the global carbon cycle and climate change mitigation. We will also continue our work on the previously uncharacterised essential genes coupled to plant growth processes.

Group members (2022-2023)

Staff scientist: Wei Wang
Postdocs: Loic Talide, Pratibha Kumar, Thomas Wieloch, Jingjing Zhou
PhD student: Sonja Viljamaa
Students: Merijn Smit, Ylva Bruce, Xin Gong
Guest researchers: Huiling Li and Changyu Liu, South China Agricultural University

Photo on top: Johan Gunséus

Ove Nilsson

UPSC group leader since 1999, SLU

Regulation of Tree Flowering and Phenology

For trees, especially for those growing at higher latitudes, it is important to adapt life cycles and growth to the varying day lengths and temperatures that occur over the year. In autumn they need to set bud well in time to be able to develop frost hardiness before winter arrives and in spring they have to ensure that they do not break their buds too early in the season to avoid frost damage. Because of the importance of this correctly tuned annual growth cycle, climate change can severely affect the fitness of forest trees. Trees are also the latest flowering plants that we know of since they typically want to delay their flowering for many years until they are firmly established in the forest. We still know very little about the mechanisms controlling the timing of first flowering in trees.

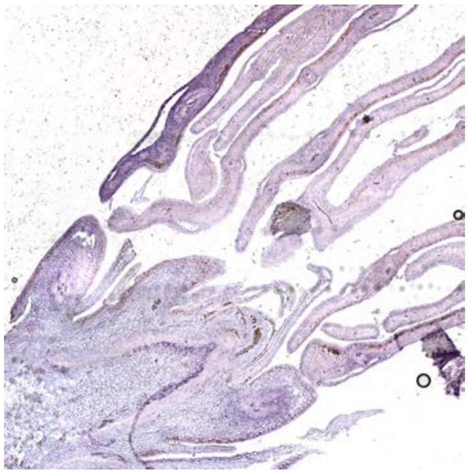
Flowering transgenic aspen (photo: Laura García Romañach)

Research goal

We want to understand the mechanism behind the regulation of flowering time and phenology in trees as well as the mechanism underlying latitudinal adaptation. My group is mainly focusing on the role of *FT/TFL1*-like genes. After our initial finding that *FT*-like genes in Populus are not only potent inducers of flowering, as they are in most plants studied so far, but are also controlling the length of the growing season, we have focused on the regulation of these genes, as well as their role in local latitudinal adaptation. We have found many similarities, but also differences, between the genetic pathways controlling photoperiodic regulation of flowering in annual plants and phenology in trees. We want to understand how the same type of genes can be involved in controlling both phenology and tree flowering during the juvenility-to-maturity transition.

Highlights of 2022-2023

- We showed that the *FT*-like genes have sub-functionalized to control the annual growth cycle in Populus trees; one controlling vegetative growth during summer and the timing of bud set, and the other being required for spring bud break. (André et al. 2022).
- Together with the Sundström lab in Uppsala we made a breakthrough discovery regarding the regulation of "flowering" in conifer trees by identifying a key regulator of reproductive development and timing of cone formation in Norway spruce (Akhter et al. 2022)
- In collaboration with a previous post-doc, Jihua Ding, we described the mechanism underlying differences in phenology between juvenile and mature trees. (Liao et al. 2023)
- Ove Nilsson was elected as member of the Formas Research Council (*Forskarrådet*), the Board of the Government Research Council for Sustainable Development.



In situ-hybridisation *CENL1* expression (photo by Alice Marcon)

Future plans

We want to continue to study the sub-functionalization of the *FT*-like genes and their roles in the regulation of flowering and phenology. What is the mechanism underlying their regulation? How do they interact with other important regulators such as *TFL1*-like genes and *SPL* genes. We also want to understand the mechanistic basis for the central role of the *FT2* gene in latitudinal adaptation in Populus trees. What is causing the difference between northern and southern trees? We also plan to continue our research on the role of *FT/TFL1*-like genes and *SPL*-like genes in the control of flowering in Norway spruce and Populus trees.

Group members (2022-2023)

Staff scientists: Bo Zhang, Keh Chien Lee
PhD students: Domenique André, Alice Marcon, Laura Garcia Romañach

Photo on top: Fredrik Larsson

Annika Nordin

UPSC group leader since 2001, SLU

Ecophysiological Aspects of Forest Management in a Forest Governance Context

Forest management practices rests on a fundament of ecophsyiological knowledge. In today's changing climate it is necessary to revist the basis of some forest management practices to ensure future forests' resilience. In our research we have focused on 1) forest regeneration in a changing climate, 2) how forest sector stakeholders' approach the changing climate, and 3) basic ecophysiological processes related to forest ecosystem nitrogen and carbon cycling, e.g. i) endophytic and heterogenous nitrogen fixation, ii) nitrogen uptake by tree seedlings and iii) forest management's impact on soil carbon accumulation.

Research goal

Our goal is to contribute to practical knowledge grounded in ecophysiolgoical science on forest regeneration and basics in forests' nitrogen and carbon cycling.

Collaborative process between researchers and stakeholders in Västerbotten to address climate change in local contexts. The process was part of Hallberg-Sramek's doctoral thesis (photo: Andreas Palmén)

Highlights of 2022-2023

- Matej Domevscik successfully defended his LicD thesis January 28 in 2022. The title of his thesis was "Adapting Scots pine regeneration to the changing climate – an investigation of the effects of seed coating, arginine addition, and planting position".
- Isabella Hallberg Sramek successfully defended her PhD thesis May 24 in 2023. The title of her thesis was "Tailoring forest management to local socio-ecological contexts – addressing the climate change and local stakeholders' expectations of forests".
- The PhD students' have all accomplished their work according to their Individual Study Plans. They have all been highly productive and all papers they have produced have been welcomed for publishing in good quality peer reviewed scientific journals in forestry.

Fieldwork by Bodil Häggström, measuring a pine seedling. The field work was part of the first article of her doctoral thesis (photo: Matej Domevscik)

Future plans

During 2024 to 25 Bodil Häggström and Tinkara Bizjak will defend their PhD theses. Marcus Larsson's PhD project will be finalised in 2026. The research formed in our group will continue within the individual and future engagements of the PhD students the group has produced over the years. Isabella Hallberg Sramek has moved on to a researcher position with another department within SLU focusing on forest planning and management under climate change. Matej Domevscik moved to southern Sweden and has joined antother SLU department to finalise his PhD thesis on forest regeneration under a changing climate. Bodil Häggström has successfully defended her thesis in early 2024 and thereafter moved on to a practical training period at Sveaskog.

Group members (2022-2023)

PhD students: Matej Domevscik, Isabella Hallberg Sramek, Bodil Häggström, Tinkara Bizjak and Marcus Larsson.
Student: Anne Braunroth

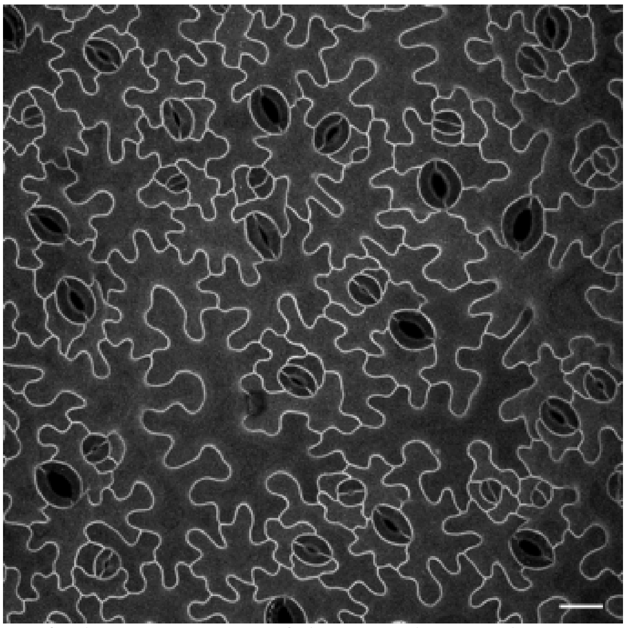
Photo on top: Fredrik Larsson

Stéphanie Robert

UPSC group leader since 2010, SLU

Regulation of Plant Morphogenesis Coordination

Understanding how various cell types precisely emerge in optimal forms at the right time and location is one of the most important questions in developmental biology. This process serves as the foundation of morphogenesis in multicellular organisms. Plants, in particular, exhibit remarkable adaptability, enabling them to adjust their developmental patterns to swiftly changing environments. This adaptability is facilitated by a series of morphological modifications governing the growth of organs like leaves, roots, and stems. Achieving proper morphogenesis is based on the synchronised orchestration of cell expansion, shape acquisition, and fate determination within individual cells.



Confocal microscopy image of plasma membrane marker PIP2:GFP in 3rd true leaf of 12-day-old *Arabidopsis thaliana* seedling. Scale bar: 20 µm (image: Sandeep Yadav).

Research goal

The aim of our research is to elucidate the molecular mechanisms underlying the regulation of plant morphogenesis via understanding the process of cell shape acquisition and its associated signalling pathways. We are particularly focusing our studies on auxin transport and signalling, endomembrane trafficking and cell wall/cuticle function in cell shape acquisition. Most of our work is established on the model plant *Arabidopsis thaliana* but we also work on spruce, poplar, lupin and tomato.

Highlights of 2022-2023

- Jobert F, Soriano A, Brottier L, Casset C, Divol F, Safran J, Lefebvre V, Pelloux J, Robert S†, Peret B† (2022) Auxin triggers pectin modification during rootlet emergence in white lupin. The Plant Journal 112:1127-1140.
- We received a grant from the Knut and Alice Wallenberg Foundation -"FATE" (Main applicant)- shared with four principal investigators (Stéphane Verger, Peter Marhavý, Eleni Stavrinidou, and Maria Tenje).
- Stéphanie became Assistant Head of Department for infrastructure at the Department of Forest Genetics and Plant Physiology, SLU.
- We received funding from Kempestiftelserna and the Carl Trygger Foundation.
- Stéphanie gave the 2023 honorary lecture for the SLU doctoral award ceremony in Uppsala.

Future plans

We aim to now focus on the understanding of the developmental processes regulated by extracellular layers (such as cell wall or cuticle) or by the cell sublayer, which govern plant growth and development.

Stéphanie Robert with group members (photo: Stéphane Verger)

Group members (2022-2023)

Staff scientists: Siamsa Doyle, Sara Raggi
Postdocs: Sandeep Yadav, Vinod Kumar, Adrien Heymans, François Jobert
PhD student: Hemamshu Ratnakaram
Students: Tanguy Mouton, Dimitri Ducrocq

Photo on top: Erik Abel

Markus Schmid

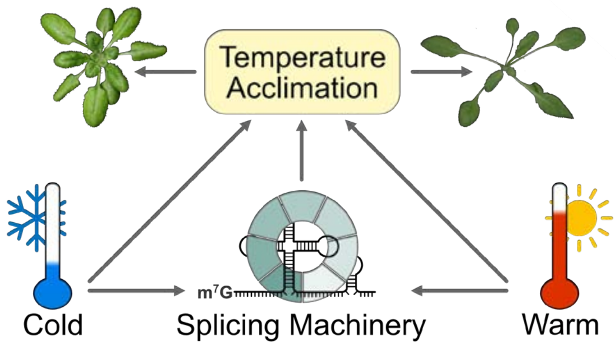
UPSC group leader since 2015, Umeå University

Regulation of Plant Growth & Development by the Environment

Plants have the amazing capacity to generate organs throughout their entire life. The regulatory circuits that control organogenesis are quite robust but still allow plants to adjust their growth and development to environmental signals. One environmental factor that strongly influences essentially all aspects of plant growth and development is temperature. Despite intensive research, which has identified numerous genes and signalling pathways involved in environmental sensing, our understanding of how plants perceive and respond to temperature is still far from complete. However, in a time when the climate is changing globally, understanding the consequences these changes will have on plants is essential to ensure sustainable agriculture and forestry in the future.

Research goal

Our goal is to enhance our understanding of how ambient temperature regulates growth and development in the model plant species Arabidopsis thaliana through the processes of transcription and subsequent alternative mRNA processing. To achieve this objective, we are adopting and developing innovative high-throughput analysis methods.



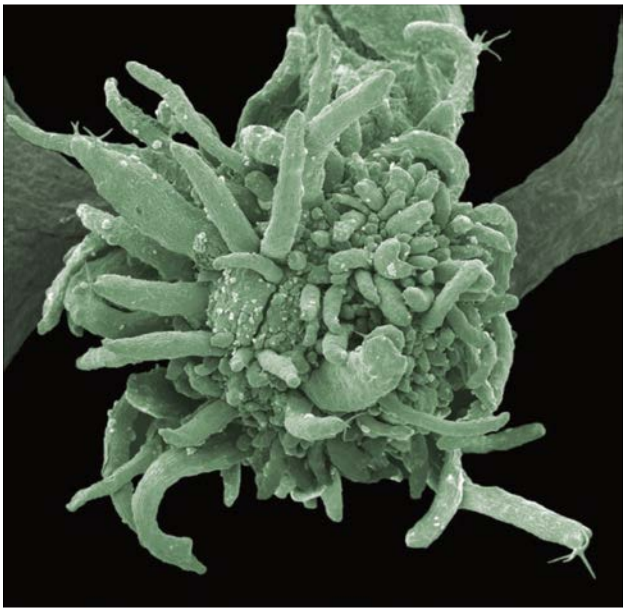
Graphical Abstract: Alternative RNA splicing plays a central role in plant temperature responses (illustration: Markus Schmid).

Highlights of 2022-2023

- We characterized the importance of alternative pre-mRNA splicing for *Arabidopsis thaliana* temperature acclimation at the level of individual genes and genome-wide.
- We established SoPPIs (Sequencing of Protein-Protein-Interactions), a novel innovative method that enables multiplexed protein-protein interaction analyses at low cost and minimal hands-on time (patent pending).
- We published or contributed to three research papers in peer-reviewed journals (André et al., 2022; Mateos et al., 2022; Zacharaki et al., 2022;) and one book chapter (Benstein et al., 2023).
- We obtained a research grant from Formas (2023).

Future plans

We will continue studying the role of alternative splicing in plant temperature acclimation but plan to include crops and trees in our analyses. We also plan to establish the genome-wide interaction network for Arabidopsis thaliana splicing proteins using SoPPIs and connect splicing to other molecular cellular processes. We will also continue our work regarding the role of transcription factors in the regulation of flowering time and flower development.



Scanning electron microscopy image of an *Arabidopsis thaliana porcupine* mutant at low ambient temperature (image: Giovanna Capovilla, editing: Markus Schmid)

Group members (2022-2023)

Staff scientist: Silvio Collani
Postdocs: Daniela Goretti, Irene Martinez Fernandez, Nelson Rojas-Murcia, Ruben Benstein, Sam van Es, Sarah Muniz Nardeli
PhD students: Nabila El Arbi, Varvara Dikaya
Students: Isak Ingerholt, Isa Hollop

Photo on top: Fredrik Larsson

Åsa Strand

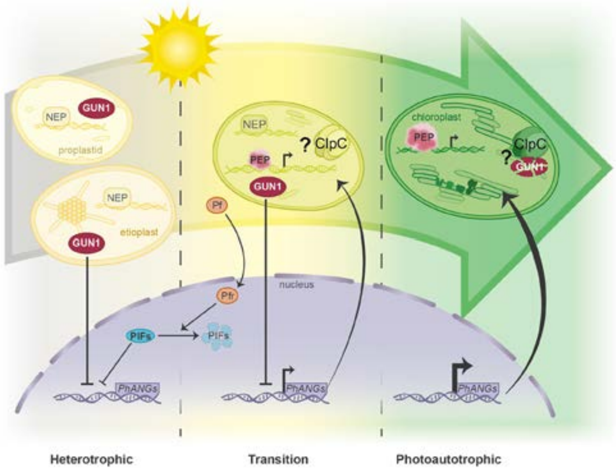
UPSC group leader since 2003, Umeå University

Regulation and Control of Cellular Energy Metabolism

Mitochondria and chloroplasts are the powerhouses of the cell and exposure to stress inhibits metabolic activities leading to severe constraints on cellular energy homoeostasis. Failure to restore either respiration or photosynthesis severely affects vigour, and possibly survival, of the organism. Communication between the organelles and the nucleus, so called retrograde signalling networks, are essential for the recovery of energy metabolism following stress but also for the establishment of cellular energy metabolism. To address the regulatory mechanisms that control the dynamic interaction between the different genomes we take an integrative approach using a combination of genetics, molecular biology, biochemistry, cell biology and biological modelling.

Research goal

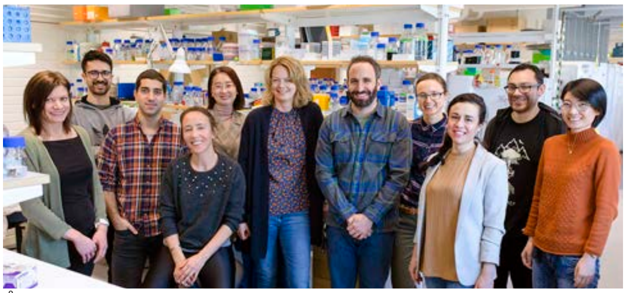
The overall goal of the research in my group is to understand the regulation and control of cellular energy metabolism. Our projects endeavour to identify the intracellular signalling mechanisms that coordinate the dynamic interaction between the different genomes during major cellular metabolic transitions.



Chloroplast development proceeds in two regulatory phases. Where the first phase is initiated by nuclear events and the second phase is dependent on removal of the suppressive GUN1-mediated retrograde signal. The dependency of PhANG expression on plastid activity provides a clear checkpoint which enables the plant to synchronize expression from the nuclear and chloroplast genomes during seedling establishment (illustration: Daria Chobrok, DC SciArt).

Highlights of 2022-2023

- My group has shown that GENOMES UNCOUPLED 1 (GUN1) acts as a safeguard during the critical step of seedling emergence from darkness. GUN1 suppresses expression of many critical transcription factors linked to photomorphogenesis and greening. As plastid development proceeds, GUN1 levels are reduced lifting the repression and giving rise to the second, plastid dependent, increase of nuclear gene expression (Hernández-Verdeja et al., 2022).
- We have shown the transcription factors bZIP16, bZIP6 and GBF1 are novel interaction partners of CRY1 that regulate a subset of photosynthesis associated genes in response to blue light critical for a proper greening process in Arabidopsis. (Norén Lindbäck et al., 2023.)
- Our Agenda 2030 Advanced Research Center from the Swedish Foundation for Strategic Research, SSF, "Redesigning Photosynthesis for Future Food Security" was awarded continued funding for the remaining 3 years.
- Together with Martin Rosvall, I was awarded the Centre of Excellence funded by the Swedish Research Foundation, VR, "Modelling adaptive mechanisms in living systems under stress".



Åsa Strand with group members (photo: Mattias Pettersson)

Future plans

I will direct my research focus into a new area, the epigenome. I have spent my entire career working on different aspects of energy metabolism and the emphasis on the epigenome is a natural progression from the comprehensive models my research has so far provided. The metabolism-epigenome relationship is fundamental to cellular function. We will determine how a dynamic metabolic state is translated into changes in the histone code, altering chromatin structure and DNA accessibility and giving rise to new cellular activities.

Group members (2022-2023)

Staff scientist: Xu Jin
Postdocs: Linda Vuorijoki, Luis Cervela, Marti Quevedo, Leonor Ramirez, Robert Calderon, Ivona Kubalova, Carmen Hermida-Carrera, Jing-Jing Zhu, Alex Vergara, Alexis Brun
Student: Luis Sterling

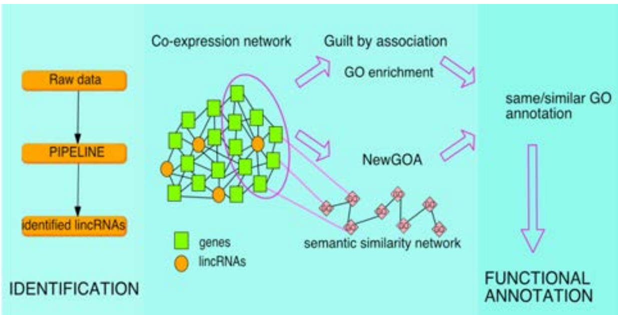
Photo on top: Mattias Pettersson

Nathaniel Street

UPSC group leader since 2011, Umeå University

Genomics of Forest Trees

The DNA sequence of a genome contains all instructions for the development of organisms and controlling how they monitor and respond to their external environment. Differences in the DNA sequence among individuals result in differences in characteristics such as biomass, flowering time, stress response and resistance to pathogens. Access to the genome sequence is therefore essential to understanding the biology of a species. The genomes of Norway spruce and Scots pine, the most important forestry species in Sweden, are ~10X bigger than the human genome and are challenging to sequence and assemble (reconstruct the sequence of DNA). Aspen is an important host of biodiversity in Swedish forests and an important tool for tree genomics research, making access to its genome sequence highly valuable.



A schematic overview of the pipeline used to identify and annotate long non-coding RNAs in Norway spruce and aspen (illustration: Camilla Canovi)

Research goal

We are producing genomics resources for Norway spruce, Scots pine and aspen. We use these resources to determine the genetic basis of within and between species variation in wood and leaf development, abiotic stress response and the production of defence compounds. We also use genomics methods to explore the interaction between trees in the forest and their associated microbial communities. We develop the PlantGenIE.org web resource to host the genomics data produced by us and others at UPSC.

Highlights of 2022-2023

- We identified how large genomic regions in conifer genomes have been copied leading to genome size increase.
- We generated the first 3-dimensional view of the Norway spruce genome, revealing how this differs between organs.
- We established a community resource of metabolomics and gene expression data for multiple organs and leaf development stages in genotypes of aspen and used this to identify candidate genes for the biosynthesis of defence compounds.
- We characterised the long non-coding RNA population of Norway spruce and aspen.

Sampling ectomycorrhizal fungi sporocarps of species associated with Norway spruce that lack available genome assemblies for DNA extraction and genome sequencing (photo: Nathaniel Street)

Future plans

We will want to further explore how the 3-dimensional shape of DNA is controlled and changes during development and in response to environmental stress in conifers and how this influences gene regulation. We also want to explain the mystery of not just how, but why conifer genomes grew to be so large. We will also continue work to explore the importance of interaction between trees in forests and their associated microbial communities.

Group members (2022-2023)

Staff scientists: Vikash Kumar, Suomyadeep Nano
PhD students: Teitur Ahlgren Kalman, Camilla Canovi, Eduardo Rodriguez, Sara Westman, Elena van Zalen

Photo on top: Fredrik Larsson

Kelly Swarts

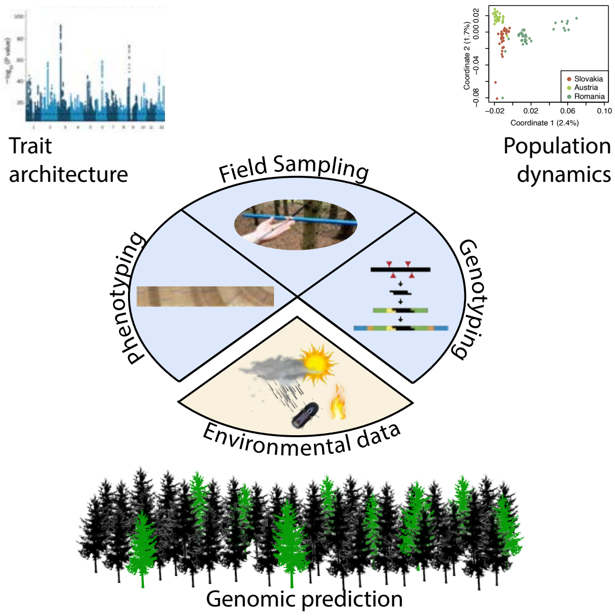
UPSC group leader since 2023, SLU

Tree-Ring Genomics

Conifers are ecologically dominant and economically important, but are globally succumbing to drought, disease, early-budding and other challenges due to climate change, as mature trees are no longer adapted to their environment. If we could predict how individual tree genotypes would respond to different environments, we could - given environmental predictions - plant the right tree in the right space.

Research goal

Measuring annual growth from tree increment cores allows us to assess an individual genotype's performance in different environments across its lifespan. Combining annual growth measurements with environmental data from weather stations and other historical records, we can begin to understand the genetics underlying adaptation to environment. As interannual variation is often as great or greater than between location variation across much of Europe, we can also use the associations to make predictions for the best adapted individuals to plant in environments across Europe.



Research overview of Tree-ring Genomics (illustration: Kelly Swarts)

Highlights of 2022-2023

- Preliminary modelling suggests that we are indeed able to extract comparable, highly heritable variation from our tree-ring samples that can be used for association genomics.
- Grant ERC STG #101078208 (TREE-RING GENOMICS)
- Data Driven Life Sciences - Biodiversity Fellowship
- Grant FWF SFB #F9109 (Polygenic adaptation)
- Grant NSF DISES #2307175 (Coevolutionary dynamics of humans and maize in the Americas)
- M. Poláček, A. Arizpe, P. Hüther, L. Weidlich, S. Steindl, K. Swarts, Automation of tree-ring detection and measurements using deep learning. Methods Ecol. Evol. 14, 2233–2242 (2023).
- M. Vallebueno-Estrada, G. G. Hernández-Robles, E. González-Orozco, I. Lopez-Valdivia, T. Rosales Tham, V. Vásquez Sánchez, K. Swarts, T. D. Dillehay, J.-P. Vielle-Calzada, R. Montiel, Domestication and lowland adaptation of coastal preceramic maize from Paredones, Peru. Elife 12 (2023).

Kelly Swarts and group members

Future plans

We are currently writing a manuscript describing the model and the basic approach, which is expected to be completed in 2024. Ongoing projects include development of apps to facilitate ring measurements, which will be augmented by the recruitment of three new postdoctoral fellows, and finalizing projects in understanding maize dynamics across the Americas incorporating ancient DNA, the genetic basis of growth habit in *Pinus mugo* and the genetic basis of virulence and resistance in the Pica abies-Ips typographus pathosystem. The move in early 2024 by the group to Umeå promises new collaborations within UPSC but also with Skogforsk.

Group members (2022-2023 - Vienna)

Staff scientists: Alexis Arizpe, Lucyna Slusarz, Miroslav Polacek, Giulia Micai, Anni Nurmisto, Kirill Akulov
Postdocs: Miguel Vallebueno, Miroslav Polacek
PhD student: Vasilina Akulova
Students: Paige Guevarra, Lisa Weidlich, Anna Gsteu, Chun Chieh Yen
Guest researcher: Giovanni Guzman

Photo on top: Johan Gunséus

Hannele Tuominen

UPSC group leader since 2001, SLU

Xylem Differentiation and Wood Properties

Deciduous trees, like aspen, offer a sustainable source of bioenergy and biomaterials. This resource is likely to become even more important in the face of emerging changes in silvicultural practices and the need for increased biodiversity. Understanding of the molecular regulation of traits, such as xylem properties of woody tissues, is needed to provide tools for breeding of deciduous trees for diversified use of the wood in the future.

Xylem properties are largely influenced by deposition of the secondary cell wall constituents of cellulose, hemicelluloses and lignin. The deposition of polysaccharidic cell wall is finalised by death of the xylem elements, while lignification continues even post mortem. These processes are controlled by developmental cues but are also significantly influenced by external cues. For instance, increased availability of nitrogen tends to lower lignin content and density of wood. The molecular regulation of xylem differentiation in response to the external cues is poorly understood.

Harvest of the collection of the Swedish Aspen (SwAsp) trees in Ekebo (photo: Kathryn Robinson)

Research goal

The goal is to dissect molecular regulation of xylem differentiation, xylem cell death and post mortem lignification as a part of normal xylem development but also in response to external cues such as light, temperature and nitrogen. Ultimately, we want to understand how xylem differentiation influences properties of wood, xylem functioning in water transport, and the use of aspen wood as a biorefinery feedstock.

Highlights of 2022-2023

- We characterised variation in 65 wood traits, including growth, enzymatic saccharification and wood chemistry, among a representative collection of aspen trees (SwAsp) in Sweden. Genetic markers were found for saccharification of wood, which can be utilised for early selection of trees that are suitable for biorefinery type of applications of deciduous trees.
- New collaboration was initiated with experts in hybrid aspen cultivation and biorefinery use; Hardi Tullus (Estonia), Bjarne Diðrik Sigurðsson (Iceland) and Tuula Jyske (Finland)
- We developed a method for the analysis of gene expression in single wood cells by single cell RNA sequencing.
- We published a comprehensive review on lignification in plants

Postdoc Maxime Chantreau measures chlorophyll content in the collection of the Swedish Aspen (SwAsp) trees after severe nitrogen starvation in the UPSC phenotyping platform (photo: Hannele Tuominen)

Future plans

We will investigate the molecular and genetic basis of xylem differentiation by reverse genetic and genome wide association approaches in aspen and hybrid aspen in greenhouse conditions and in the field. We will focus on the regulation of secondary cell wall deposition by light, drought, cold temperatures and nitrogen fertilisation. We also continue our studies on xylem cell death and how it impacts wood properties and functioning.

Group members (2022-2023)

Staff scientist: Pal Miskolczi
Postdocs: Maxime Chantreau, Isura Nagahage, Angela Carrio Segui, Shruti Choudhary, Manoj Kumar Mandal
PhD students: Mikko Luomaranta, Anna Renström
Students: Enrico Tampelloni, Camille Bernard

Photo on top: Fredrik Larsson

Stéphane Verger

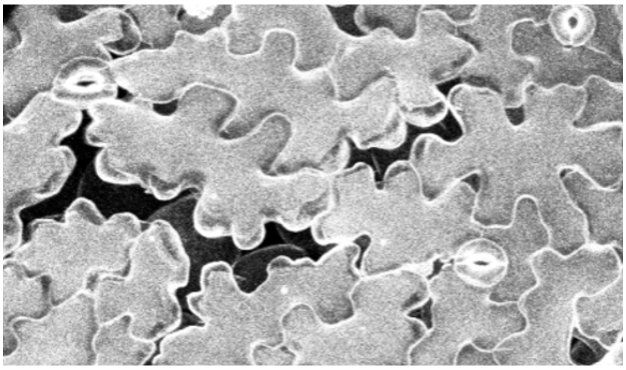
UPSC group leader since 2019, Umeå University

Mechanics and Dynamics of Cell-Cell Adhesion in Plants

Cells are the basic structural units of all known living organisms, coming together in millions or even trillions to form multicellular organisms. Fine-tuned control of cell adhesion is thus critical for the integrity, development, and physiology of such organisms. In contrast to animals, we still know very little about how adhesion is dynamically regulated in plants. Adhesion dynamics also plays an important role during hardwood formation where fibre cells elongate by a mechanism called intrusive tip growth which requires cells to separate and re-adhere during growth. Understanding how wood fibres grow intrusively by modulating their adhesion could ultimately help us make trees with fast-growing high-quality wood.

Research goal

Our main goal is to identify and characterize the molecular regulators and the physical features that contribute to cell adhesion in plants. In turn we aim to apply this knowledge in the context of fibre growth during wood formation to progress toward the establishment of fast growing trees with high-quality wood.



Cell adhesion defect in the cotyledon epidermis of *Arabidopsis quaimodo2-1* mutant. Confocal maximal intensity projection from propidium Iodide stained sample (image: Stéphane Verger).

Highlights of 2022-2023

- We have characterized the supracellular nature of the outer epidermal cell wall and unveiled its contribution to cell adhesion.
- We have discovered the contribution of RGII pectins and brassinosteroid signalling in cell adhesion regulation.
- We have developed and established new micromechanical methods to measure samples mechanical properties at multiple scales.
- We have developed novel image processing methods to study cytoskeleton dynamics and for the high-throughput characterization of wood fibres.

Stéphane Verger with group members

- Emerging Investigator grant from the NovoNordisk Foundation for research within Plant Science, Agriculture and Food Biotechnology.
- Project grant from the Knut and Alice Wallenberg Foundation (co-applicant).

Future plans

We will continue to study the regulation of adhesion dynamics with a focus on understanding how mechanical signal are perceived and influence adhesion but also cell fate. After the past few years establishing micromechanical devices, we will now dive into the characterization of the mechanics of cell adhesion in plants in order to uncover how the ultrastructure of the cell-cell connections actually contribute to keeping cells attach to each other. We will also continue to apply this knowledge to wood formation, in particular by exploiting recently generated Crispr mutants, transgenic reporter lines as well as the SwAsp genetic resource for Genome Wide Association Studies on wood fibre length and wood mechanics.

Group members (2022-2023)

Staff scientists: Asal Atakhani, Marta Derba Maceluch.
Postdocs: Abu Imran Baba, Elsa Demes, Adrien Heymans, Saqib Qamar, Ioannis Theodorou.
PhD students: Léa Bogdziewiez, Lucija Lisica, Özer Erguvan.
Students: Keal Lissarague, David Rapoport, Camille Martin Debouis.
Guest researcher: Anita Ament (Olomoucz, CZ).

Photo on top: Johan Gunséus

Stephan Wenkel

UPSC group leader since 2023, Umeå University

Small Proteins Controlling Development and Adaptation

Our group has pioneered the identification and characterization of microProteins. We employ molecular pathway analysis using *Arabidopsis thaliana* as a model organism for basic research and crop plants such as tomato and alfalfa for translational approaches. Through genome engineering, we can create novel pathways in crop plants to overcome the challenges of complex genomes. Our research spans basic science to applied genetics and aims to understand and modify traits such as flowering time and plant architecture. Employing genomics, proteomics and computational methods, we aim to precision engineer plants to adapt to changing climates.

Word cloud depicting our research (source: scholargoggler.com)

Research goal

The aim of our research is to gain a comprehensive understanding of microProtein-controlled growth processes across different species and environments. This understanding will enable us to predict and engineer precise changes that can affect plant growth and development. The ultimate goal is to develop new plant varieties that can withstand environmental challenges and contribute to global food security in the face of climate change.

Highlights of 2022-2023

- We have discovered ATHB2miP, an alternative transcript of the *ATHB2* gene that interacts with the full-length ATHB2 protein to inhibit its activity. This discovery plays a crucial role in regulating shade avoidance responses and root development in Arabidopsis.
- In tomato, we discovered a transcript isoform of the *AFP3* gene that antagonizes the AFP3 protein. This protein can induce an autoimmune response in a dosage-dependent manner.
- We have organised the first Keystone Micropeptides conference in Utah in 2022 and the Microproteins2023 conference in Denmark.
- The group has received funding from the Novo Nordisk Foundation.

Future plans

We are expanding our portfolio of techniques and have successfully completed the first Ribo-seq experiments (with Johannes Hanson's group) in combination with a deep proteomics experiment. By using this riboproteomics approach, we aim to discover novel microProtein species. Our long-term goal is to unravel molecular mechanisms to convert this knowledge into biotechnological strategies. In Arabidopsis, we have successfully converted the *CONSTANS* gene into a microProtein-coding gene, which significantly delayed flowering. The approach has been successfully transferred to alfalfa, and we are currently regenerating genome-engineered plants.

Group members (2022-2023)

Staff scientist: Manuela Jurca
Postdocs: Maurizio J. Chiurazzi, Adity Majee, Naveen Shankar
PhD students: Ashleigh Edwards, Ylenia Vittozzi, Louise Petri, Anne van Humbeek, Huanying Niu, Casper ter Warbeek
Guest researcher: Federica Pennisi, Jannis Stollenwerck

Tomato plants showing a gene dosage-dependent autoimmune response (photo: Ylenia Vitozzi)

Photo on top: Mattias Pettersson

Harry Xiaming Wu

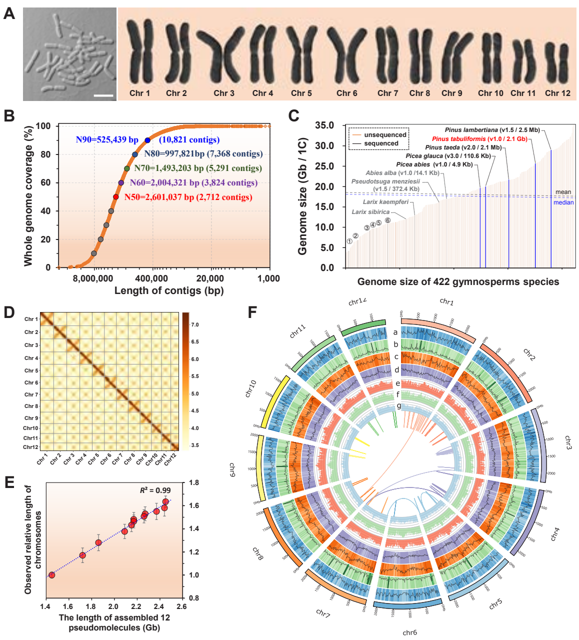
UPSC group leader since 2010, SLU

Forest Genetics and Breeding

My group investigates genetic variation of quantitative traits in forest trees and their underlying genetic base. We use quantitative genetics and genomic tools to dissect the genomic base of phenotypic variation, genotype by environmental interaction and local climate adaptation for commercial and fitness related traits. Based on the knowledge of the genetic bases, we design most effective selection and breeding methods to produce new germplasm of higher quality and productivity for commercial production and for climate adaptation. Recent advances in genome sequencing, re-sequencing, GWAS and genomic selection made it possible to accelerate breeding process and increase genetic gain.

Research goal

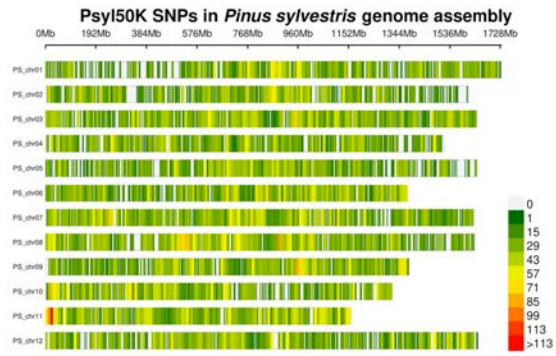
Our goal is to use genomics and quantitative genetics to shorten breeding cycle and to manage inbreeding depression and unfavourable genetic correlation between growth and wood quality traits in advanced breeding generations. We also focus on selective breeding to identify populations for future climate adaptation



Genome assembly of *Pinus tabuleformis* (from Niu et al, 2022, Cell *185*, p. 206, https://doi.org/10.1016/j.cell.2021.006)

Highlights of 2022-2023

- We assembled and published first chromosome level genome in conifer (Niu et al 2022).
- Two 50K SNPs genotyping arrays (Norway spruce and Scots pine) were developed for population genomics and genomic selection (Estravis Barcala et al 2023).
- Genetic architecture behind developmental and seasonal control of tree growth and wood properties in Norway spruce were revealed (Chen et al 2022).
- Grants from Kempe and Föreningen Skogsträdsförädling Foundations.



Scots pine 50K SNP array on Scots pine genome assembly (from Estravis Barcala et al, the Plant Journal, 2024, *117*, p 948, https://doi.org./10.1111/tpj.16535)

Future plans

We will continue to investigate the genomic base of quantitative trait variation and climate adaptation for major Swedish tree species using genomic tools. Advanced genomic selection methods including cross-generation, cross-populations will be developed for Swedish national tree breeding program. We will also focus on development of breeding strategy to overcome inbreeding depression and negative genetic correlations in advanced tree breeding program.

Group members (2022-2023)

Staff scientists: Tomas Funda, Zhiqiang Chen
Postdocs: Rajiv Chaudharry, Maximiliano Estravis Barcala, Chenjui Yang, Yanjin Zan
PhD students: Adam Klingberg, Edward Carlsson
Guest researchers: Xianying Ding, Mikel Gonzalez

Photo on top: Anne Honsel

Biotic interaction at a field trial (Photo: Marta Derba-Maceluch)

Associated Research Groups

Associated group leaders are employed by other departments but interact strongly in their research projects with research groups at UPSC. They benefit from the UPSC scientific environment and infrastructure and bring other competences and adjoining research fields to UPSC.

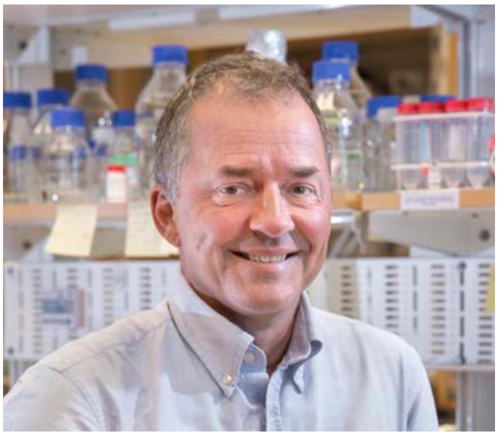


Photo by Johan Gunséus

Stefan Björklund

Professor at Umeå University - Associated research group leader

Functional studies of Mediator in plants

"Our group studies the Mediator complex and its function in transcriptional regulation at the molecular level in order to understand (and to influence) how transcription of genes is regulated. We work with two different model systems: the yeast *Saccharomyces cerevisiae* and the plant *Arabidopsis thaliana*."


Photo by Mattias Pettersson

Christiane Funk

Professor at Umeå University - Associated research group leader

Unlocking the value of Nordic microalgae

In my research group we perform basic science on microalgae with the aim to solve challenges in microalgal biotechnology. Our studies range from proteases involved in cell death of microalgal cultures to studies of the algal cell wall to improve harvesting and extraction. We further investigate the potential of native, Nordic microalgae in wastewater reclamation and biomass generation in Northern Sweden.


Photo by Håkon Sparre/NMBU

Torgeir R. Hvisten

Professor and BIAS group leader at the Norwegian University of Life Sciences (NMBU) - Associated research group leader

Evolutionary analysis of gene regulatory networks

"In my research group, we use machine learning methods and large-scale genomics datasets to model how genes interact in regulatory networks, how regulatory networks evolve and how they give rise to complex properties characteristic to individuals and species."

Photo by Andreas Palmén

Sandra Jämtgård

Researcher at the Swedish University of Agricultural Sciences - Associated research group leade

Plant nitrogen availability

“My group’s research revolves around understanding the mechanisms governing plant nitrogen availability at the root-soil interface. Our main aim is to develop the sampling technique microdialysis as a tool for root simulation, investigating key aspects of root physiology and plant-microbial interactions and how that influence plant nitrogen availability at the root surface, in a root growing in undisturbed soil.”

Photo by Johanna Leppälä

Johanna Leppälä

Senior scientist at Natural Resources Institute Finland (LUKE) - Associated research group leader

Genetics of speciation

“In my research, I am interested in both sexual and asexual reproduction of plants. Related to sexual reproduction, I study genetics of speciation – i.e. genes involved in development of reproductive isolation. Regarding asexual reproduction, my main interest is in clonality and its relation to sexual reproduction.”

Photo by Johan Gunséus

Judith Lundberg-Felten

Senior Lecturer at the Swedish University of Agricultural Sciences - Associated research group leader, previously group leader at UPSC

Ectomycorrhiza for forest tree resilience

“We are studying the molecular dialogue during symbiosis development between ectomycorrhizal soil fungi and forest trees with regards to effect on tree resilience to drought and on plant defence metabolites. Our aim is to understand how the symbiosis supports forest trees in a more challenging climate.”

Photo by Fredrik Larsson

Thomas Moritz

Professor at the University of Copenhagen, Denmark - Associated research group leader, previously group leader at UPSC

Metabolomic control of shoot elongation and wood formation

“The aim of my research is to understand how plant hormones and other metabolites are involved in the control of plant development, and how different environmental cues, such as photoperiod, affect the metabolic control of growth and development. We are using both targeted and untargeted metabolomics approaches to study the metabolic control of growth and development.”

Photo by Torgny Näsholm

Torgny Näsholm

Professor at the Swedish University of Agricultural Sciences - Associated research group leader

Ecophysiology and molecular biology of plant organic nutrition

“My research deals with plant nitrogen physiology, particularly nitrogen acquisition and metabolism of forest plants. This research spans from detailed studies of uptake processes to forest fertilization and environmental effects of nitrogen.”

Photo by Thomas Kieselbach

Wolfgang P. Schröder

Professor at Umeå University - Associated research group leader

Structure and function of Photosystem II from higher plants

“My research has been devoted to biochemical and biophysical analyses of various parts of higher plant chloroplasts. The focus of my research is on the structure and function of the photosynthetic protein complex photosystem II and of the thylakoid lumen.”

Photo by Thor Balkhed

Eleni Stavrinidou

Senior Associate Professor at Linköping University - Associated research group leader

Plant bioelectronics

“The research in my group focuses on developing bioelectronic technologies for real time monitoring and dynamic modulation of plant physiology to overcome limitations of conventional methods and establish bioelectronics in plant biology. Focus is given on understanding and enhancing plant responses to environmental stress.”

Photo by Mattias Pettersson

Xiao-Ru Wang

Professor at Umeå University - Associated research group leader

Ecological genomics of speciation and adaptation

“The ability of a species to sustain environmental change is primarily determined by its genetic reservoir, which is shaped over the course of history through demography and selection. We apply ecological and genomics tools to understand the origin and distribution of genetic diversity across landscapes in Eurasian conifer species.”

In the UPSC greenhouse (Photo: Johan Gunséus)

3.3 Research Infrastructures

Biopolymer Analytical Platform (BAP)

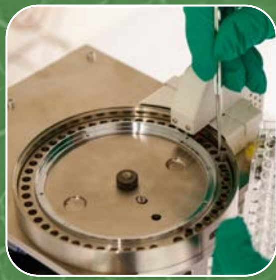


Photo: Florian Schmidt

Biopolymer Analytical Platform (BAP)

The Biopolymer Analytical Platform (BAP) is dedicated to support research among UPSC groups on cell walls of terrestrial and aquatic plants, and biopolymer materials as well as soil and sediment . It offers cutting-edge knowledge and analytical methods/tools to examine cell wall polymers such as lignin, cellulose and hemicellulose, as well as detection and quantification of other carbohydrates such as soluble mono- and oligo-saccharides and organic compounds by applying a large range of conventional wet chemistry methods and analytical instruments such as pyrolysis (Py, Fig. 1), gas chromatography/ mass spectrometry (GC/MS, Fig. 2) and size exclusion chromatography (SEC).

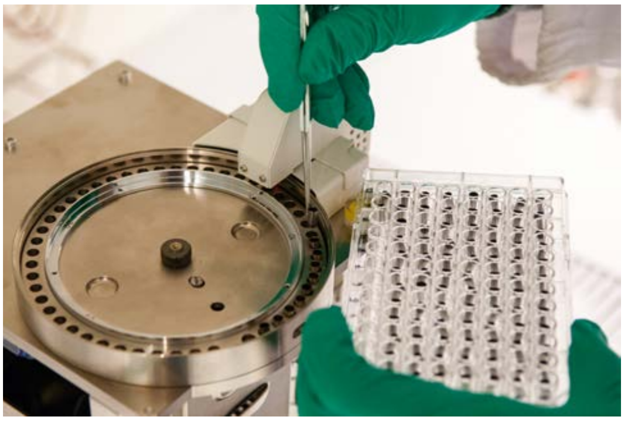


Figure 1. Loading samples to the Frontier Lab pyrolysis autosampler (photo: Florian Schmidt)

Highlights of 2022-2023

- We supported eight UPSC research groups by analysing a wide range of sample materials from algae, Arabidopsis, grass, hybrid aspen, spruce, pine, fermented wood to soil and sediment.
- A new accelerated solvent extractor (ASE) 350 was purchased in 2021 and became in operation in 2022 to increase the capacity for extractives analysis.
- A new Py-GC/MS method to detect *p*-coumaric acid and ferulic acid in cell walls was developed.
- An improved method for *p*-hydroxybenzoic acid analysis in aspen cell walls in Py-GC/MS data was established.

Future plans

We plan to purchase a new pyrolyzer, PY-2020iD and AS-1020E for the Py-GC/MS system in 2025/2026. Our Py-GC/MS data-processing program will also be updated with our new peak identification findings. We plan to further increase the platform interaction with UPSC groups working on plant cell wall structure and mechanics to link these properties with chemical analysis. There is also increasing demand of analysing polymer structures of algae and bacteria cell walls, including carbohydrate linkage analysis. These will be developed as part of postdoc/PhD projects and as a project for method development at the platform.

Figure 2. The Agilent GC/MS instruments for composition analysis (photo: Florian Schmidt)

Personnel (2022-2023)

Director: Totte Niittylä
Manager: Junko Takahashi-Schmidt
Staff: Sonja Viljamaa (since 2023 April)

Photo: M. Derba-Maceluch

Microscopy Facility

Microscopy Facility

The infrastructure hosts several light microscopes, 6 advanced confocal microscopes with a range of cutting-edge features (e.g. Airyscan, FLIM, Dynamic profiling, multiphoton, spinning disk, etc.), an Atomic Force Microscope, a FACS instrument, an automated sample preparation system (for immuno-labelling, in situ hybridization, dehydration series, etc.) as well as sectioning equipment (vibratome, rotary microtome and cryostat).

The platform provides access, training for and maintenance of the equipment. Users are trained and primarily use the equipment independently after training. Staff can also provide support for sample preparation, basic image processing and methods development for plant material. Our activities also include service by Marta Derba-Maceluch with sectioning, light microscopy and AFM.

Zeiss LSM 980 confocal microscope (photo: Marta Derba-Maceluch)

Highlights of 2022-2023

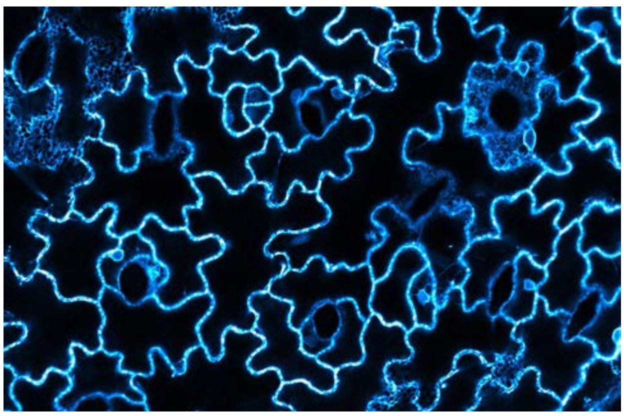
- During 2022 we purchased new equipment: Rotary microtome, NanocutR Leica; Leica Thunder Imager Model Organism; Heating/cooling insert to Zeiss LSM 880; 2 new stereomicroscopes for greenhouse 2nd floor work.
- We organized a course in advanced microscopy and analysis, 3 ECTS (PFS0183).
- We started offering a service where users can commission Marta Derba-Maceluch to perform a set of experiments within her competences.
- During 2023 we purchased a new type of confocal microscope (Nikon LV100ND microscope with CrEST Cicero Spinning Disk). This simple and robust, upright, spinning disk-based confocal microscope will provide high speed 3D imaging particularly adapted for cell level live morphological characterization of plant samples.
- We also purchased the latest Zeiss LSM 980 confocal which will provide most of the latest advanced features available in state-of-the-art Zeiss confocal microscopes as well as the dynamics profiling feature to study the dynamics and diffusion of molecules in live samples.
- We upgraded the Thunder Imager Organism stereomicroscope with a colour camera, equipped with automated stage and upgraded Navigator licences, which made it possible to use the stitching option.

Future plans

From 2024 Stéphanie Robert will be replaced by Stéphane Verger as facility director. In the coming year we will aim to increase our links with the UPSC bioinformatics facility and the UPSC high-throughput tree phenotyping platform to increase knowledge exchange regarding bioinformatic approaches for image processing. A potential future development depending on future staff availability, will be to contribute to establish image processing pipelines (as service or user training) for the automated and reproducible analysis of images coming from the microscopy facility and UPSC tree phenotyping platform. We are also planning to increase the involvement of "advanced users" at the platform to provide additional support, training and advice for specific advanced functions of our equipment.

Personnel (2022-2023)

Director: Stéphanie Robert
Manager: Anna Gustavsson and Marta Derba-Maceluch
Staff: Anna Gustavsson, Marta Derba-Maceluch, Ioanna Antoniadi, Siamsa Doyle



Epidermal cells of an Arabidopsis seedling leaf, visualized using cell type-specific ER-targeted GFP (photo: Siamsa Doyle)

Photosynthesis and Respiration Facility

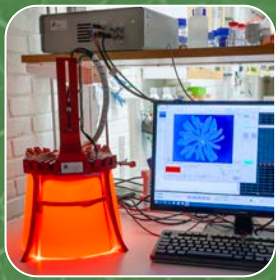


Photo: Anne Honsel

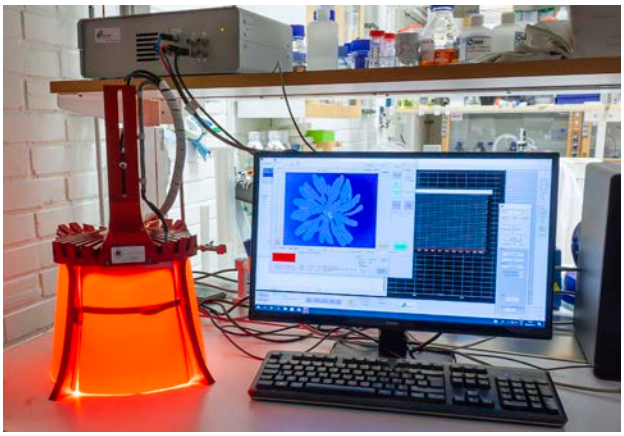
Photosynthesis and Respiration Facility

The facility provides a wide range of approaches and instruments to assay the photosynthetic and respiratory activities in different plant matherials ranging from intact plants to isolated pigment-protein complexes. All the equipment is available for UPSC members free of charge. We are responsible for the evaluating, purchasing and maintenance of our photosynthetic apparatus. We organize training, introduction and provide all kind of support required for our users.

Fluoromax spectrofluorometer (photo: Tatyana Shutova)

Highlights of 2022-2023

- FluoroMax spectrofluorometer purchased and installed, training course organized. Different removable attachments are tested, and short manual prepared and introduced to users.
- Portable photosynthesis system LiCor 6800 purchased, on-site training organized. The old version LiCor 6400 was calibrated and reset, both are available for users.
- First version of chlorophyll spectroflorometer, ChloroSpec purchased, and experiments conducted including test in phenotyping facility and paper describing ChloroSpec is published.
- Minilite laser for the Joliot type spectrometer sent for repair.



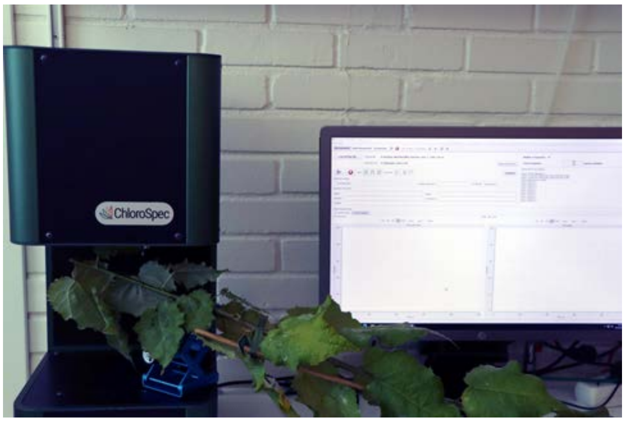
Video Fluorescence Camera SpeedZen 200 from JBeambio (photo: Anne Honsel)

Future plans

Introducing ChloroSpec for the users at UPSC, maintenance and calibration of instruments, purchasing supplies, evaluation and ordering of new equipment, updating platform webpage, training and support.

Personnel (2022-2023)

Director: Stefan Jansson, Olivier Keech
Manager: Tatyana Shutova 25%



ChloroSpec (photo: Tatyana Shutova)

Photo: Johan Gunséus

Plant Growth Facilities at UPSC and SLU Umeå

Plant Growth Facilities at UPSC and SLU Umeå

UPSC researchers have access to state of the art growth facilities that allow growth and analysis of non-transgenic and transgenic flowering plants in controlled environments. These include several walk-in climate chambers, controlled growth rooms, and cabinets that can be programmed to cover a wide range of growth conditions and light regimes. A dedicated team of experienced personnel ensure most optimal conditions for plant growth by watering, fertilizing and pest control. Smooth running of facilities is achieved by automated booking system managed by greenhouse personal and complemented by a team of experienced researchers imparting training for new users.

A new growth facility at UPSC opened in 2022 (photo: Anne Honsel)

Highlights of 2022-2023

- 8 new growth cabinets with programmable temperatures and light quality were acquired with monetary support from Kempestiftelserna

Arabidopsis grown in a growth cabinet (photo: Anne Honsel)

Future plans

Currently with new PIs joining UPSC and many more researchers intending to working on trees, growth facilities especially for tree growth will be revamped and extended. Feasibility analysis has been performed and possibilities to build additional 10 walk-in chambers is being explored subject to funding from SLU.

Hybrid aspen grown in the UPSC green house (photo: Åsa Gavelin)

Personnel (2022-2023)

Director: Rishikesh P. Bhalerao

Staff: Anna Forsgren, Åsa Gavelin, Ann Sehlstedt, Jed Biocati-Brennan

Poplar Transgenics Facility

Photo:Verena Fleig

Poplar Transgenics Facility

The Populus transformation facility serves all groups at UPSC with Agrobacterium-mediated transformations, maintenance, and amplification of our laboratory hybrid aspen clone *Populus tremula x tremuloides*, (T89). The facility also maintains 116 clones of the Swedish Aspen (SweAsp) collection of aspen (*Populus tremula*) in tissue culture, and offers transformations of these clones.

The facility employs 5 full-time employees, who during 2022 and 2023, performed 100 and 120 transformations, respectively. Hundreds of transgenic constructs are maintained in tissue-culture and almost two thousand trees are amplified every month for experiments.

CRISPR-Cas9-mediated gene editing is an important tool for Populus research and accounted for about 40 percent of the transformations conducted during 2022 and 2023.

Poplar in vitro room (photo: Verena Fleig)

Highlights of 2022-2023

- Changed from gas burners to bead sterilizers, which are both safer for the person working and also more efficient.
- Extended our database to connect amplification requests, resulting in a more efficient and controlled handling of requests.
- Rearranged the labs and the way we make media.
- Incorporated several digital tools to make work and communication within and outside the platform more efficient and transparent.
- Applied suggestions from team members to improve platform service and work efficiency.
- Designed a logo to improve team spirit.
- In the end of 2023 we had a Kick-off with discussions/ ideas for the future and team building activities.

Visible roots of a plant grown in a plastic jar containing Murashige-Skoog growth media (photo: Mattias Pettersson)

Future plans

In 2024 the platform will expand the transformation service to include a larger part of the transformation process, which was previously handled by the researchers. This expansion will reduce the necessary workload of researchers at UPSC and allow the platform to offer a more controlled and consistent service. An additional advantage from the expansion is that employees will have more varied work responsibilities, reducing potential long-term injuries. We are also in the process of purchasing a new LAF bench to streamline day to day work within the platform.

Personnel (2022-2023)

Director: Ove Nilsson
Manager: Veronica Bourquin
Staff: Iftikhar Ahmad, Sonia Olmedo Diaz, Ruben Casanova Saez, Sarah Lundgren, Kristýna Hladka, Romain Castilleux Manuela Jurca, Emelie Dahlgren

Photo: Ulrika Egertsdotter

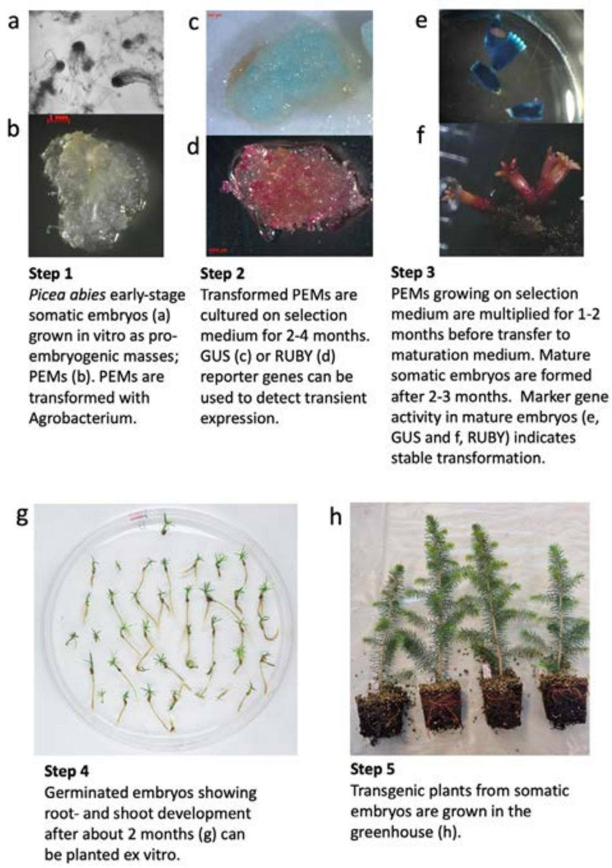
Spruce Transformation Facility

Spruce Transformation Facility (SE lab)

The SE lab primarily uses Agrobacterium for transformation to generate transgenic plants from transformed early-stage somatic embryos (proembryogenic masses, PEMs). The PEMs are maintained and multiplied in vitro as SE cultures. The lab is equipped to support maintenance and development of conifer somatic embryos from in vitro multiplication of PEMs in SE-cultures to plants in the greenhouse. Specific equipment includes temporary-immersion bioreactors for scale up of embryo production, filtration system for large volume sterile filtration of liquid culture medium and an automated system (SE fluidics system) for selection of mature embryos. There is also equipment for biolistic transformation available.

Highlights of 2022-2023

- The RUBY marker works for early detection of transformants.



The process of regenerating spruce somatic embryos from in vitro multiplication of proembryogenic masses in SE cultures to plants in the green house (images: Sofie Johansson)

- The 'Artifical suspension' method appear to give significantly better transformation yields.
- Approx. 25% of more than ten new cell-lines from 2022 responded positively to transformation.
- The first CRISPR transformations have been successful verified by the selectable marker gene (for hygromycin resistance).
- 63 transformations were performed, where 23 transformations were for UPSC research groups.
- Several transformed SE-cultures have tested positive for the transgene and the cultures are being amplified for production of transgenic plants.

Future plans

Structural improvements: Build a robust pipeline for early PCR testing of transformed SE cultures. This will reduce the amount of SE cultures kept over time and enable more transformation to be performed. Implement digital lab books to enable better follow up of long-term experiments and provide searchable results across experiments.

Specific goals: Complete evaluation of ternary vector system for transformation. Finalize the set up of a workable CRISPR transformation system for Norway spruce.

Personnel (2022-2023)

Director: Ove Nilsson

Manager: Ulrika Egertsdotter

Staff: Iftikhar Ahmad, Thomas Dobrenel, Sofie Johansson

Swedish Metabolomics Centre

Photo: Mikael Wallerstedt

Swedish Metabolomics Centre

Metabolomics is the global measurement of small molecules, or metabolites, in a given biological system. The Swedish Metabolomics Centre (SMC) is based in Umeå and is a joint venture between Umeå University and SLU. The centre has operated nationally since 2013 on a fee-for-service basis and is open to all Swedish academic scientists as well as private companies. Since 2016, SMC is a unit within SciLifeLab. SMC performs untargeted and targeted metabolite and lipid profiling, quantitative panels of selected metabolites as well as method development support. About 100 metabolomics service projects, represented by ~90 individual PIs from all major Swedish universities are handled every year. In addition to the metabolomics service, the centre also offers an "open access lab" where the instruments (mass spectrometers) can be rented on a "per day" basis.

Highlights of 2022-2023

- Formation of the SMC research and development team that includes 7 PIs representing different research areas, all with a strong interest in Metabolomics and methodology development.
- UPSC supported post-doc, started in October 2023, working on method development in plant metabolomics.
- Introduced plant hormone analysis, as fee-for-service, implemented and updated the methods developed by the group of Karin Ljung.
- Replacement of two LC-QqQ-MS systems, funded through our current KAW grant.

Swedish Metabolomics Centre performs mass spectrometry based metabolite analysis (photo: Mikael Wallerstedt)

About 100 metabolomics service projects are handled by the skilled staff each year (photo: Mikael Wallerstedt)

Future plans

In 2024-2028 we will continue the ongoing method development of mass spectrometry-based flux tracer/stable isotope incorporation studies, to start with in collaboration with UPSC researchers and the research group of Thomas Moritz at Copenhagen University. We will also continue to expand our targeted panels according to the requests and needs of the scientific community. We see a great interest in many of the key metabolites not detected using ordinary C18 LC-MS technologies. In 2021-2024 SMC has developed HILIC-LC-MS, both for untargeted metabolomics and for targeted panels of unstable key metabolites such as ATP/ADP, NAD/ NADH and other phosphate-containing metabolites. The setup of these panels will be used as a starting point for future targeted panels of polar metabolites.

Personnel (2022-2023)

Directors: Johan Trygg and Stefan Jansson
Manager: Annika Johansson
Staff: Hans Stenlund, Elin Näsström, Krister Lundgren, Cecilia Pettersson, Maria Ahnlund, Annika Sjöström (retired June 2023), Christine Wegler (recruited September 2023), Jenna Lihavainen (25%)
Affiliated postdoctoral researchers: Ondrej Hodek, Mareike Gutensohn, Marta Juvany

Photo: Anne Honsel

Tree Phenotyping Platform at UPSC

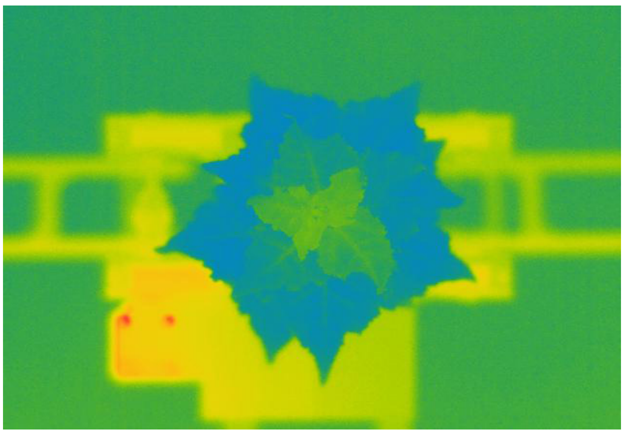
Tree Phenotyping Platform

The tree Phenotyping platform automatically monitors and records the growth parameters of trees. A custom conveyor belt system is used for plant delivery to and from the imaging cabinets and watering stations. Weighing and watering stations deliver the water/fertilizer by volume or weight. Trees are measured and imaged by RGB cameras from side(s) and top and with infrared camera from top. The construction is exclusively lightened by artificial LED lights and allows the adjustments of light as well as the temperature/humidity. The platform it is routinely used for growing 364 tall trees up to 2.5 meters of height but can accommodate a total of 728 smaller trees.

A growth experiment with aspen trees in the phenotyping platform (photo: Ioana Gaboreanu)

Highlights of 2022-2023

- Eight full runs were performed on the platform including three drought stress experiments, four growth rate experiments, one day-length experiment and a nutrient uptake experiment.
- A total of 2912 trees were grown on the platform involving seven research groups at UPSC.
- The platform software was updated with new features which improves the overall performance of the machine and allows the integration of new cameras.
- A compensation for the tree weight when applying the water was introduced based on wild type growth curves.
- The system for temperature control was improved and will be beneficial to those having drought stress experiments on the platform.
- A large oven was installed at the phenotyping platform allowing the researchers to dry the samples collected from their experiments.
- The platform was presented to numerous groups of pupils from schools as well as for students/researchers from other universities.



A thermal image depicting temperature variation acquired by WIWAM system equipped with an infrared FLIR A655sc camera

Future plans

A new feature of the software will be tested and will allow more flexibility when programming the imaging/ fertilization treatments.

A new system for measuring leaf photosynthetic activity will be tested this year.

We are investigating the growth of the trees in different soil types.

Automatic watering with pot rotation (photo: Ioana Gaboreanu)

Personnel (2022-2023)

Director: Ove Nilsson
Manager: Ioana Gaboreanu
Staff: Jan Karlsson

UPSC Bioinformatics Facility

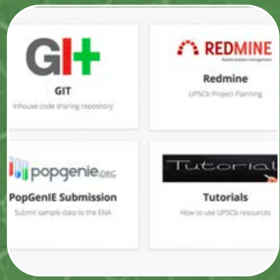


Photo:Bioinf. Facility

Bioinformatics facility

The facility undertakes projects of two types: training or service. Training projects remain the most common and follow a model where a PhD student or PostDoc is trained to perform the data analysis required for their project under the supervision and training of the facility. Service contracts are also offered, which are particularly popular for standardised pipelines to perform e.g. data processing and quality control or submission to public repositories. The facility also maintains and offers access to compute and storage capacity. The facility currently comprises a staff of one manager, two staff scientists and one research engineer. The facility also contributes to teaching and organising training workshops.

Highlights of 2022-2023

- Initiated a new 'Bioinformatics in Umeå' workshop series and held the first training workshop cover the use of analysis pipeline systems (Nextflow and nf-core).
- Undertook 55 projects
- Expanded storage infrastructure
- Recruited a new staff scientist


Meeting at the UPSC Bioinformatics Facility with Kristina Benevides, Theerarat Kochakarn and Edoardo Piombi (photo: Nathaniel Street)

Future plans

The facility will continue to develop analysis pipelines and expand the expertise of the facility staff. As computational resources are increasingly in demand and the need for storage is rapidly increase there are in-progress discussions to utilise the local high performance computing service High Performance Computing to the North (HPC2N) hosted at Umeå University. The facility will also work to expand its available resource for self-directed training by improving the available guidelines and materials the facility website. Furthermore, there will be continued effort to further integrate and harmonise the local bioinformatics community located in Umeå including links to the local National Bioinformatics Infrastructure Sweden (NBIS) staff and newly recruited Data Science Node (DSN) staff within the Data Driven Life Science (DDLS) initiative. This is greatly facility by the recent location of those staff within the UPSC premises.

Personnel (2022-2023)

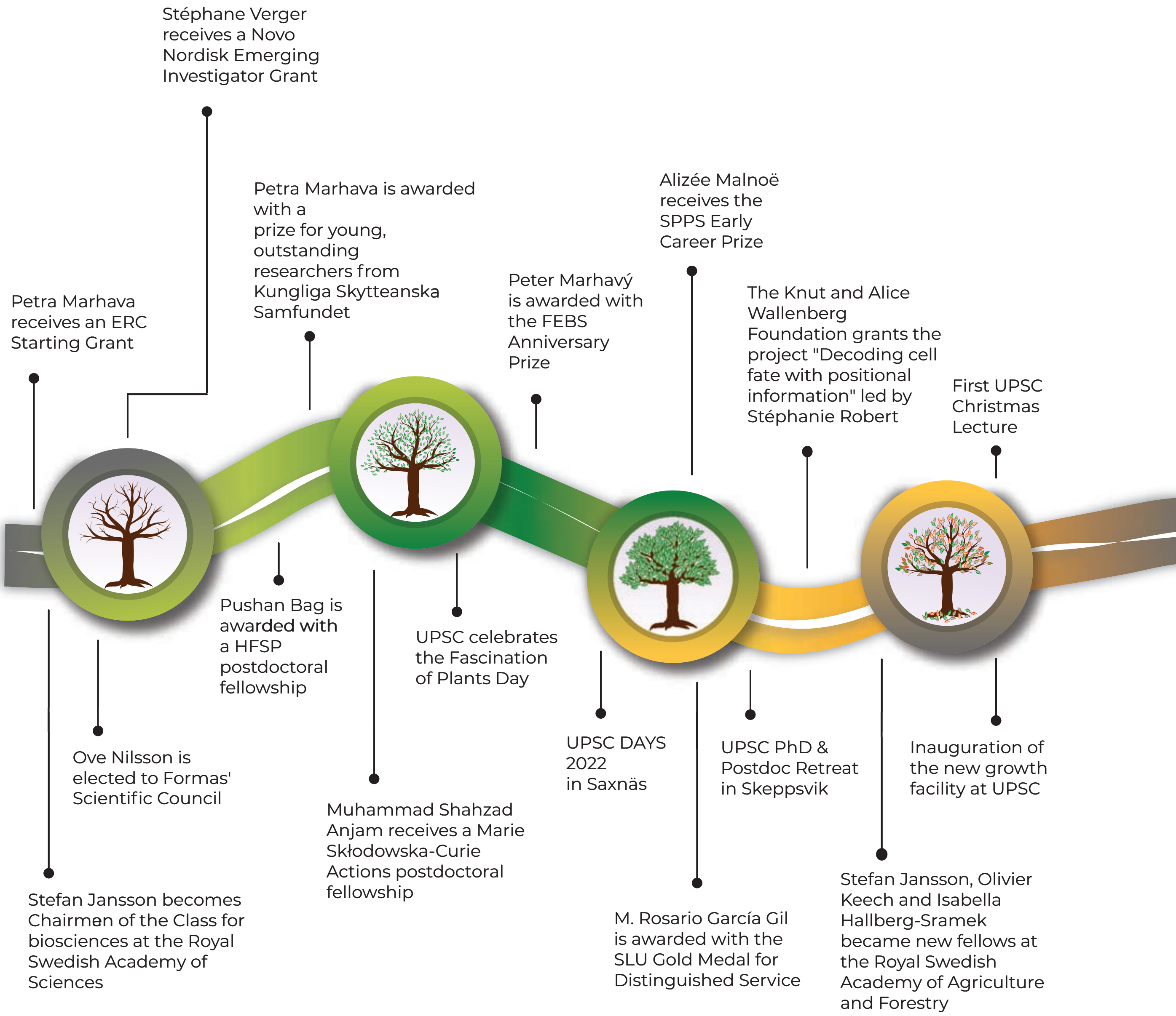
Director: Nathaniel Street
Manager: Nicolas Delhomme
Staff: Kristina Benevides, Theerarat Kochakarn, Edoardo Piombo

At the aspen biobank at UPSC (photo: Johan Gunséus)

Group discussions at the UPSC DAYS 2022 in Saxnäs (photo: Maria Israelsson Nordström)

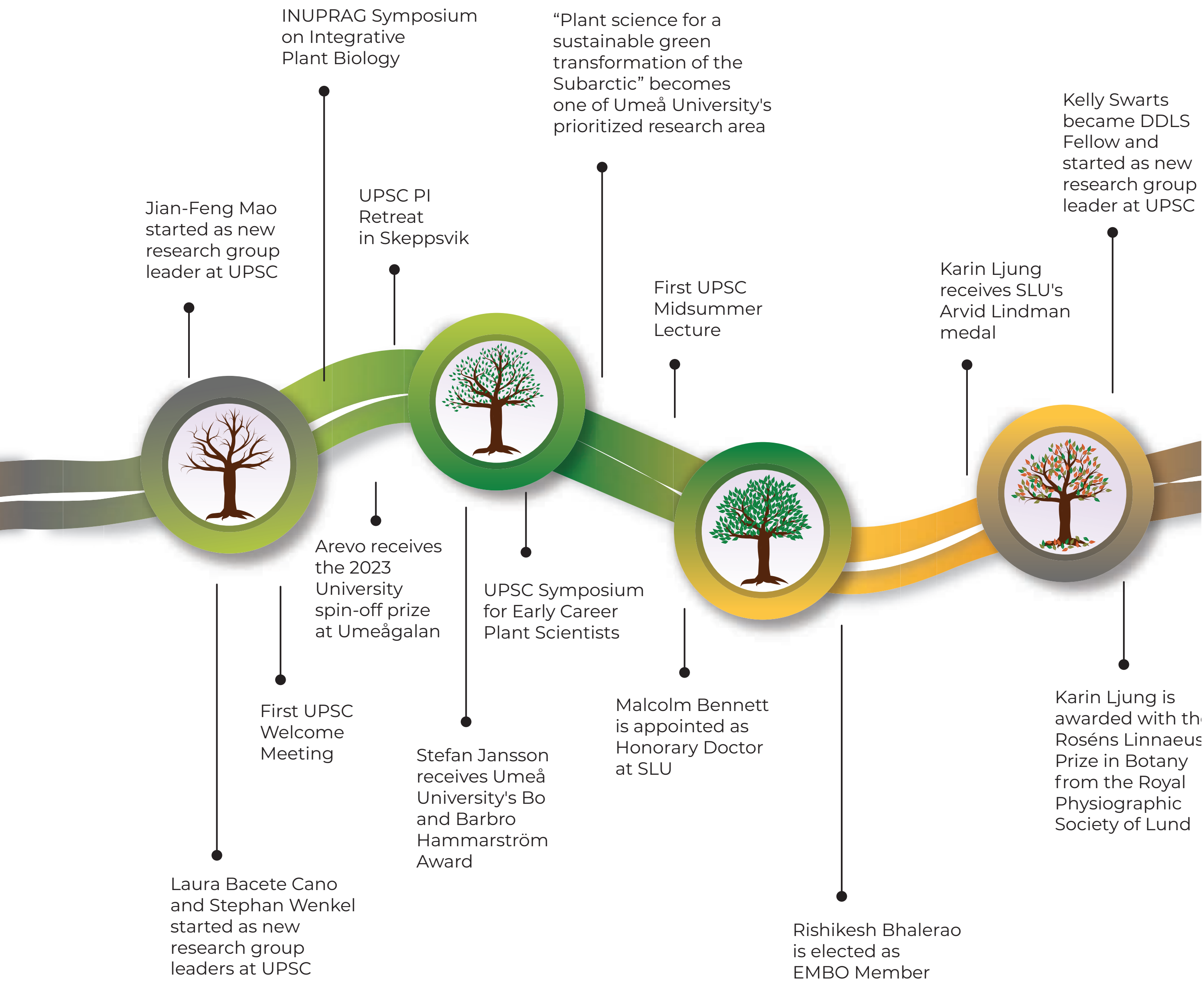
4. Highlights from 2022-2023

Centre Highlights 2022



Highlights from 2022-2023

Centre Highlights 2023



Tree images by Marcin from Pixabay

Highlights from 2022-2023

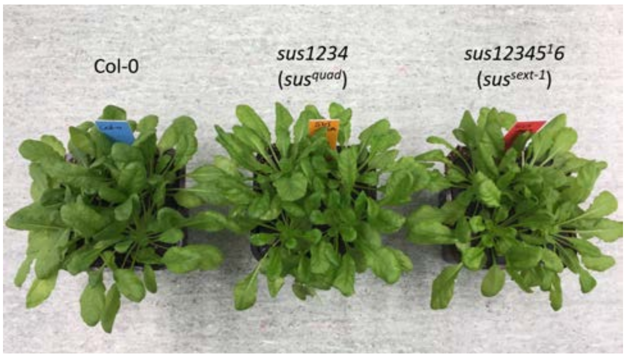
Research Highlights

The Chinese pine giga-genome provides new insights into conifer evolution

Conifers dominate the world's forest ecosystems and are the most widely planted tree species. Their giant and complex genomes present great challenges for assembling a complete reference genome for evolutionary and genomic studies. A research team from UPSC and Beijing's BAICTBMD led by UPSC PI Harry Wu completed a 25-Gb chromosome-level assembly of *Pinus tabuliformis* and reveal that its genome size is mostly attributable to huge intergenic regions and long introns with high transposable element content. The results were published in Cell.

Niu et al. (2022) The Chinese pine genome and methylome unveil key features of conifer evolution. Cell, 185:204-217

Chinese pine *Pinus tabuliformis* (photo: Harry Wu)



Arabidopsis mutant analysis shows that sucrose synthase makes no significant contribution to transitory starch synthesis in Arabidopsis leaves (left: wild-type plant, middle quadruple and right sextuple sucrose synthase mutant; photo: Wei Wang)

Researchers resolve a long-standing controversy about the starch synthesis pathway

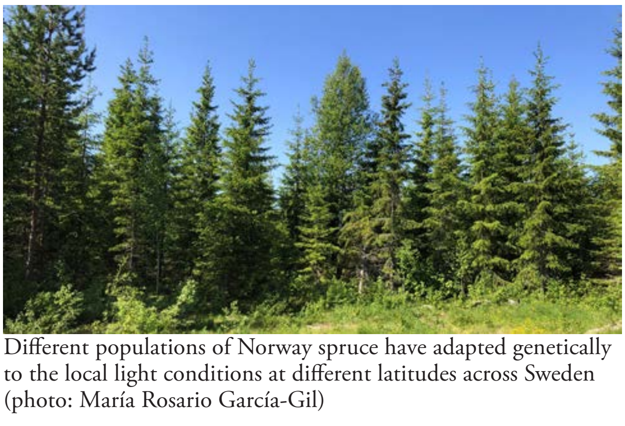
Many plants build up starch reserves in their leaves during the day that are used as carbon and energy source during the night and to buffer against fluctuating light conditions during the day. The enzyme sucrose synthase was long discussed as one of the key players in the synthesis of this transitory starch. Researchers from Sweden, Germany and UK have shown now that this is not the case, resolving a 20-year old controversy about one of the most important pathways of photosynthetic metabolism. The work was published in the journal Nature Plants.

Fünfgeld et al. (2022) Sucrose synthases are not involved in starch synthesis in Arabidopsis leaves. Nature Plants, 8, 574–582

Norway spruce has adapted genetically to the different light conditions across Sweden

Why can Norway spruce from Northern Sweden tolerate shade better than Norway spruce from Southern Sweden? Sonali Ranade and María Rosario García-Gil from UPSC compared the DNA sequence of Norway spruce trees from different latitudes across Sweden and found variations in the genes of light-sensing photoreceptors. These variations could be aligned with the light conditions at the different latitudes. Their results were published in the journal Plant, Cell and Environment.

Ranade & García-Gil (2023) Clinal variation in PHY (PAS domain) and CRY (CCT domain) - Signs of local adaptation to light quality in Norway spruce. Plant, Cell & Environment, 46, 2391–2400



Different populations of Norway spruce have adapted genetically to the local light conditions at different latitudes across Sweden (photo: María Rosario García-Gil)

Research Highlights

Aspens are passive savers in times of plenty

Aspen trees are not relying on their starch reserves when grown under benign conditions. This is shown in a new study with modified aspen defective in starch synthesis. The starch-lacking trees were also absorbing less carbon dioxide compared to non-modified trees, but their growth and performance was not affected. The study done by Totte Niittylä's group from Umeå Plant Science Centre and SLU was published today in Current Biology.

Wang et al. (2022) Aspen growth is not limited by starch reserves. Current Biology, Volume 32, Issue 16, 3619-3627.e4

Young aspen trees lacking starch reserves (middle and right) grow as well as trees with starch (left). The starchless pgm mutant trees were created using the gene editing tool CRISPR-Cas9 which works as a pair of high-precision genetic scissors (pgm: PHOSPHOGLUCOMUTASE gene; photo: Wei Wang)

Conifer needles consume oxygen in early spring even during the day (photo: Stefan Jansson)

Conifer needles consume oxygen when times are hard

Plants give us oxygen through photosynthesis - this is commonly taught in school. An international research team have now shown that particularly in early spring when low temperatures coincide with high light, conifer needles consume – not produce – oxygen by using an ancient mechanism. The results were published in Nature Communications.

Bag et al. (2023) Flavodiiron-mediated O2 photoreduction at photosystem I acceptor-side provides photoprotection to conifer thylakoids in early spring. Nature Communications 14, 3210

Fertilisation reshapes the tree-fungi relationship in boreal forests

How do nutritional changes affect the interaction between trees and soil microorganisms? This has long remained a black box but a new study has shed light onto this cryptic association. It shows that increased soil nutrition changes the communication between trees and their associated fungi, restructuring the root-associated fungal community with major implications for carbon cycling in the forest. The study was published in Proceedings of the National Academy of Sciences as collaboration between UPSC and SciLifeLab.

Law et al. (2022) Metatranscriptomics captures dynamic shifts in mycorrhizal coordination in boreal forests. Proceedings of the National Academy of Sciences (PNAS), 119 (26) e2118852119

Fertilisation promotes plant growth but changes the plant's interaction with their mycorrhizal fungal partners (photo by Dalibor Perina on Unsplash)

Highlights from 2022-2023

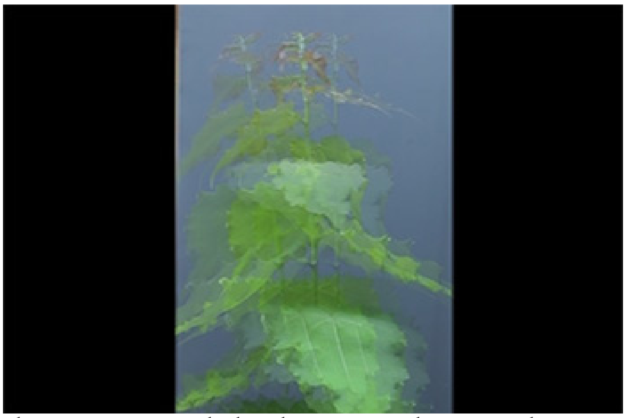
Research Highlights

Initiation of sencescence is regulated differently in aspen than in annual plants

Aspen varieties from different latitudes become senescent at different times even when growing at the same place. An international research team led by Stefan Jansson from UPSC used this fact to study which internal and external factors determine the onset of senescence. They performed an extensive study but the only common factor they found was a connection to salicylic acid, a plant hormone involved in stress signalling. Instead of advancing senescence like in annual plants, it represses it in aspen. The study was published in the journal Nature Communications.

Lihavainen et al. (2023) Salicylic acid metabolism and signalling coordinate senescence initiation in aspen in nature. Nature Communications 14, 4288

Differently coloured aspen leaves (photo: Lars Björkén)



Flexing stress was applied to the aspen trees by moving them on a conveyor belt. When the belt abruptly accelerated or brought to a halt, the trees were shaking (photo: Félix Barbut)

Aspen trees exposed to repetitive flexing grew faster

The sight of trees swaying in the wind has captivated the imagination of artists and nature enthusiasts. However, for the trees themselves, this continuous mechanical stimulation can be a source of stress. A research team led by Ewa Mellerowicz from UPSC and SLU set out to study the effect of such repetitive flexing on aspen trees and found that the trees grew faster. The study was published in the journal New Phytologist.

Urbancsok et al. (2023), Flexure wood formation via growth reprogramming in hybrid aspen involves jasmonates and polyamines and transcriptional changes resembling tension wood development. New Phytologist 240(6) 2312-2334;

Novel analysis method enables higher subcellular resolution

Research teams from Sweden and the Czech Republic have developed a novel method that allows to analyse low concentrated substances on the subcellular level. Using this method, the researchers demonstrated that plant growth substances are distributed unevenly in the different compartments of a plant cell. Although the method was initially established on plant cells, its potential extends to numerous research applications beyond plant science. The study was published in The Plant Journal Technical Advance.

Skalický et al. (2023). Fluorescence-activated multi-organelle mapping of subcellular plant hormone distribution. The Plant Journal 116(6)1825-1841

Vladimír Skalický and Ioanna Antoniadi are working at the cell sorting instrument which allows separating differently labelled cell compartments (photo: Asal Atakhani)

Highlights from 2022-2023

Research Highlights

MicroRNA keeps young aspen trees longer green than older trees

In a forest, even trees have their generational conflicts. Young trees often find themselves under the canopy of the older trees. Their survival strategy is to kick off their growth earlier in spring and stay longer green in autumn. A research team from Umeå Plant Science Centre, SLU, and Huazhong Agricultural University in China has revealed that a small RNA molecule acts as a master regulator in aspen, modulating the length of the growing season in an age dependent manner. The study was published in the journal Proceedings of the National Academy of Sciences (PNAS).

Liao et al. (2023) Age-dependent seasonal growth cessation in Populus. Proceedings of the National Academy of Sciences (PNAS) 120(48) e2311226120

At the field site in Wuhan, China: Young aspen trees (in front) keep their leaves longer than older trees (in the back). Photo taken on November 23, 2023 by Kejing Wang

Merchantia growing on petri dishes (photo: Mattias Pettersson)

Highlights from Education

Teaching activities UPSC

The **Department of Forest Genetics and Plant Physiology** at SLU is involved in four undergraduate courses in the Bachelor programme in Forestry at SLU Umeå. The courses have around 20-40 students and deal with topics from wood biology and chemistry to genetics and tree breeding. In addition, the department is involved in a Master course in Plant Molecular Biology together with SLU Alnarp, SLU Uppsala, and Umeå University. This course collects around 25 students from several campuses in a hybrid format.

Our proximity and deep collaboration with the department of Plant Physiology at Umeå University enable us to be involved in courses run by them as well. The department also offers thesis courses for students during their undergraduate studies. Furthermore, we have a strong international presence of European students in the Erasmus+ programme and other exchange students. These students are important for our goal of training the next generation of researchers and the students function as an important gateway to attracting future PhD students to the department.

Students in the lab at Umeå Univeristy (photo: Malin Grönborg)

The **Department of Plant Physiology** at Umeå University organises and administers the Master's Programme in Plant and Forest Biotechnology. Plant biotechnology has been established as an increasingly important tool for solving global problems of food, feed, fuel and ecosystem management in an environmentally sound and sustainable manner. Aim of our Master's programme is to provide students with specialized expertise and skills to recognize, understand and find solutions to these challenges. To this end, courses within the programme are designed such to provide students with a strong, up-to-date theoretical background and practical skills in plant physiology, molecular biology, biotechnology and molecular breeding. Special sections are dedicated to raise awareness and understanding of the ethical, ecological and legal aspects of plant biotechnology. Majority of the programme courses contain a variety of laboratory exercises providing the students with hands-on experience and training in how to design, perform, interpret and report scientific experiments. The programme, that encompasses two-years of full-time studies worth of 120 ECTS results in a Master's Degree in molecular biology with specialization in plant and forest biotechnology..

PhD Education

Both UPSC departments educate PhD students and have a similar number of PhD students, rather constantly around 20 PhD students each. On average there are three to four PhD defences per year per department.

Although Umeå University and SLU have different formal procedures and requirements concerning PhD education, our ambition is that the UPSC PhD education should be as homogenous and aligned as possible. For example, they all present their progress in the weekly UPSC Monday seminar series and in 2023, the first UPSC halftime seminar day was organized with four PhD students presenting the progress of their PhD projects. These half-time seminar days are planned to be organized approximately 2-3 times a year and involve an evaluation by invited external evaluators.

In 2022, a new postgraduate course was established entitled Advanced microscopy course in plant science. This five-day course built on the existing course "Light microscopy and sample preparation in plant sciences" and aimed on developing practical skills and theoretical understanding of confocal and other advanced microscopy methods as well as quantitative image analysis.

(Illustration: Inhousebyrån at Umeå Univeristy)

Highlights from 2022-2023

PhD Graduates

Conifers use special mechanisms to keep their needles evergreen

What allows conifer trees to stay green during winter when temperatures are low but solar radiation is high? Pushan Bag, PhD student in Stefan Jansson's group at Umeå Plant Science Centre, showed that conifers have evolved special mechanisms that prevent damage to their photosynthetic machinery. He defended his PhD thesis at the Department of Plant Physiology, Umeå University, on the 20th of May 2022.

Title of the thesis: **How could Christmas trees remain ever green? Photosynthetic acclimation of Scots pine and Norway spruce needles during winter**

PhD student Pushan Bag at Nydalasjön in Umeå (photo: Jenna Lihavainen)

PhD student David Castro at one of his field sites close to Sollefteå.

Seedling performance is modulated by soil properties and soil microorganisms

How do soil properties and microorganisms in the soil influence seedling growth? David Castro, PhD student in Vaughan Hurry's group at UPSC and SLU showed in his PhD thesis that understanding this complex relationship between the three partners can help to optimize biodiversity-friendly forest management and to get a better picture about the ecology of endemic species. David Castro defended his PhD thesis at the Department of Forest Genetics and Plant Physiology, SLU, on the 24th of May 2022.

Title of the thesis: **Who comes first? Implications of the plant-microbiome-soil continuum feedback on plant performance**

Studying soil fungal dynamics using sequencing methods

How do forest management strategies that aim on improving plant growth influence the fungal community? Andreas Schneider, PhD student in Nathaniel Street´s group at Umeå Plant Science Centre, has contributed to the development of new sequence analysis methods that make it easier to study fungal communities. Andreas Schneider defended his PhD thesis on the 1st of June 2022 at the Department of Plant Physiology, Umeå University.

Title of the thesis: **Perturbance and stimulation - using nitrogen addition and high throughput sequencing to study fungal communities in boreal forests**

PhD student Andreas Schneider (photo: Laura Hinojosa)

PhD Graduates

Her results fill knowledge gaps on carbon allocation in trees

Trees are key players for carbon removal from the atmosphere. But what is happening with the carbon once it enters the trees? Sonja Viljamaa, PhD student in Totte Niittylä's group at UPSC and SLU, headed off to track carbon in aspen trees, focusing especially on carbon allocation to wood formation. Together with bioinformaticians, she identified new gene regulatory networks in developing wood and showed that aspen trees save carbon passively under optimal conditions. Sonja Viljamaa defended her PhD thesis at the Department of Forest Genetics and Plant Physiology, SLU, on the 21st of November 2022.

Title of the thesis: **Carbon allocation in aspen trees**

PhD student Sonja Viljamaa (photo: Sonali Ranade)

PhD student Isabella Hallberg-Sramek has studied the expectations that are put on the Swedish forests and how they can be addressed by forest management (photo: Olle Melkerhed)

Combining local and scientific knowledge benefits forest management

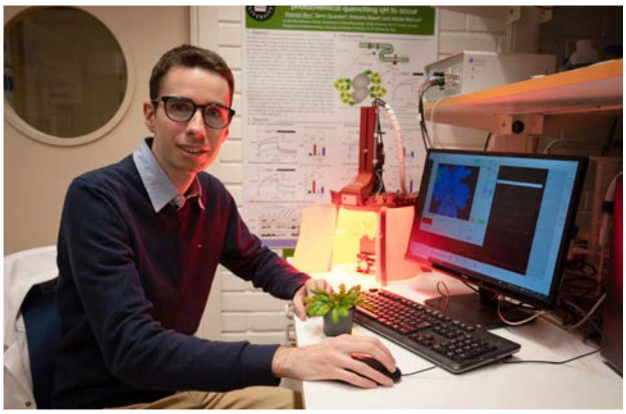
How, why and for whom should forests be managed? PhD student Isabella Hallberg-Sramek identified these as key questions underlying forest conflicts and expectations on forests in Sweden. Together with local stakeholders and by using different transdisciplinary scientific approaches she worked on identifying practical solutions to adjust forest management strategies to current and future needs. Isabella Hallberg-Sramek defended her PhD thesis at the Department of Forest Genetics and Plant Physiology, SLU, on the 24th of May 2023.

Title: **Tailoring forest management to local socio-ecological contexts - Addressing climate change and local stakeholders' expectations of forests**

A sun protection mechanism helps plants to survive strong sunlight

Just like people can get sunburned, plants can also suffer from too much sunlight. To stay healthy, they use an internal "sun protection mechanism". Pierrick Bru, PhD student working with Alizée Malnoë, has been studying a special component of this plant "sun protection mechanism" called qH and found it is quite adaptable. He defended his PhD thesis on the 8th of December 2023 at the Department of Plant Physiology, Umeå University.

Title: **Investigating the molecular mechanism of photoprotection qH, in *Arabidopis thaliana***



PhD student Pierrick Bru is measuring how much light energy is converted into heat in Arabidopsis thaliana plants (photo: Alexis Brun).

Research Collaborations

UPSC is committed to international and national networking and has collaborative links with outstanding research environments around the world. The nature of these collaborations and partnerships can vary from collaborations between research groups to formal partnerships like the trilateral INUPRAG cooperation between the National Research Institute for Agriculture, Food and Environment (INRAE) in France (BAP and ECODIV divisions) and the Center for Research in Agricultural Genomics (CRAG) in Barcelona, Spain.

In recent years, UPSC researchers have also been successful in attracting funding for larger projects, for example from the Swedish Foundation for Strategic Research (SSF) and the Knut and Alice Wallenberg Foundation. These projects are collaborative in nature, involving research groups not only from UPSC, but also from other departments at Umeå University and SLU, as well as other universities in Sweden and abroad. Below we present some of the collaborative highlights for 2022 and 2023.

INUPRAG Symposium on Integrative Plant Biology 2023 in Umeå

IIn February 2023, the third INUPRAG Symposium took place at Hotel Mimer in Umeå. Researchers from the three INUPRAG partners - from the French INRAE, from UPSC and from the Spanish research centre CRAG - presented their recent work, exchanged ideas and planted seeds for new research collaborations. All three institutes are strong plant science research environments and the cooperation, which started in 2015, aims to promote the training of young scientists, for example through lab exchanges, and to transfer knowledge and tools that are developed on model species such as Arabidopsis and poplar to crops and trees through joint research projects.

About 140 participants attended the two-and-a-half-day symposium, more than initially expected. Thirty-five high quality talks by group leaders and 36 posters, mainly from PhD students and postdocs, were presented. In addition to the multidisciplinary presentations, two round table discussions were organised on the European Horizon Europe programme and on ways to further enhance networking within the INUPRAG cooperation.

Catherine Bellini concluding the INUPRAG Symposium on Integrative Plant Biology 2023 (photo: Anne Honsel)

Participants from the INUPRAG symposium visited the phenotyping facility at UPSC (photo: Anne Honsel).

Connection to SciLifeLab and the Data-Driven Life Science Programme

An important collaboration partner since several years is the Science for Life Laboratory (SciLifeLab). The Swedish Metabolomics Facility, a SciLifeLab infrastructure, is located at UPSC. Researchers at UPSC regularly use SciLifeLab infrastructures in Umeå and elsewhere in Sweden and have many research collaborations, such as the genome sequencing projects for Norway spruce and Scots pine that is funded by the Knut and Alice Wallenberg Foundation.

The link to SciLifeLab was strengthened in 2022 and 2023 with the nomination of Nathaniel Street as a SciLifeLab Group Leader and the recruitment of Kelly Swarts as a Fellow in the SciLifeLab and Wallenberg National Data-Driven Life Science (DDLS) programme, a 12-year initiative focused on strengthening the competence in data-driven research. Nathaniel Street has also been appointed Scientific Co-Lead for SciLifeLab's Planetary Biology capability, one of three themes into which SciLifeLab organises its infrastructure technology and expertise.

Highlights from 2022-2023

Research Collaborations

UPSC Symposium for Early Career Plant Scientists

National and international networking and collaboration are important not only for sharing knowledge and expertise, but also to recruit excellent researchers at all career stages. In 2023, UPSC took up again an initiative targeted at young researchers, to make them aware of the possibilities at UPSC and to motivate them to join UPSC as a postdoc: the UPSC Symposium for Early Career Plant Scientists. Postdoctoral candidates could apply to the symposium and the best candidates were invited to visit UPSC for two days in early June.

Almost 50 applications from young scientists were received and six of them, from Canada, France, Germany and India, were short-listed after an evaluation and selection process. All of them were at the end of or had recently completed their PhD and were selected because they had a high chance of success in applying for competitive European postdoctoral fellowships. The invited young scientists presented their research, met and discussed possible projects with UPSC group leaders, visited UPSC's facilities and had the opportunity to expand their network. The feedback from the participants was very positive and one of them has already started to work as a postdoc at UPSC.

Speed dating under the time control of Laura Bacete (right front) at the symposium in June 2023 - postdoctoral candidates and UPSC group leaders interacted with each other in different formats to identify common interests (photo: Stéphanie Robert)

Industrial Collaborations

For more than 20 years, UPSC has hosted several successive competence centres and industrial graduate research schools in forest biotechnology and forest genetics, jointly run between SLU, Umeå University and a number of selected industrial partners. The aim has been to conduct excellent basic research in plant science and to translate it into innovations with commercial potential as well as to train a new generation of highly qualified personnel with research competence for the forestry and agricultural industries. The spin-off companies SweTree Technologies and Arevo both originated from research conducted in the core departments of UPSC and now act as important bridges between academic research at UPSC and industrial stakeholders.

Field visit with the competence centre board to a birch trial site outside the research station Ekebo, Skogforsk in 2022 (photo: Maria Israelsson Nordström)

The most recent competence centre, the UPSC Centre for Forest Biotechnology, was active between the years 2017 to 2022. This centre was funded by the Swedish innovation agency Vinnova, SLU, Umeå University and the industry partners Holmen Skog, Sveaskog, Stora Enso, SweTree Technologies, Arevo and the Forestry Research Centre of Sweden - Skogforsk.

At the heart of the centre was a research graduate school where industrial PhD students, employed or closely associated with industrial partners, helped to create strong links between academia and industry. Most of them have continued to work in industry, and contribute to increase their employers' competence and capacity to obtain new research data. In addition, several proof-of-concept projects, collaborative projects and field trips to the industrial partners – such as the field trip to Skogforsk in Ekebo in 2023 - have created a strong and active network between academia and the Swedish forest industry.

Now, between the years 2024-2030, this legacy will be continued in a new Research School in Future Silviculture at SLU, thanks to an initiative from the Knut and Alice Wallenberg Foundation.

Highlights from 2022-2023

UPSC Outreach Activities

Part of UPSC's mission is to inform the society about its activities and different efforts are made to fulfil this mission. Here, we highlight some of the activities of 2022 and 2023.

UPSC on social media

In November 2021, UPSC launched a channel on Twitter - now X - with the aim of reaching out mainly, but not exclusively, to other researchers. The main content sent out is research news, job advertisements and new publications. Almost a year later, in October 2022, the follower group had grown to 1000 followers and has now reached more than 2000.

In parallel with the Twitter/X channel, the pre-existing but inactive LinkedIN page was reactivated in October 2023 and has continued to grow since then. Like the Twitter/X channel, it is aimed at researchers, but also at stakeholders and UPSC Alumni. The content sent out is almost identical to that published on Twitter/X, except that new publications are only mentioned when the article is highlighted in a popular science context. Starting with a comfortable number of 756 followers, the UPSC LinkedIN channel has now reached around 2000 followers.

Testing the plants' mechanical strength: Asal Atakhani explains the concept of elasticity and shows the tools she uses to test the plant's elasticity at the Fascination of Plants in 2022 (photo: Malin Grönborg)

Fascination of Plants Day 2022

On May 21, 2022, UPSC organised a popular science event at Curiosum, Umeå University's science centre, to celebrate the sixth international Fascination of Plants Day 2022. Visitors, mainly families with children, were able to test and increase their knowledge about plants and plant science at eighteen different stations. The number of visitors was with about 150 participants lower than in previous years, probably due to the high number of other activities taking place in Umeå at the same time. However,

Maximiliano Estravis Barcala performed at the Researchers Stand-Up at Curiosum in 2023 (photo: Barbora Pařízková)

most of the visitors who came stayed for a long time and gave very positive feedback. The event even made the front page of the local newspaper Västerbottens-Kuriren.

Other outreach activities

UPSC regularly welcomes school classes and other visitors for facility tours to inform them about the research carried out at UPSC. These activities were stopped in previous years due to the Covid-19 pandemic, but become very popular again in 2022 and 2023. UPSC researchers also participated in several public outreach events organised in Umeå, like for example the local "Pint of Science" festival that was organised by the Umeå Postdoc Society. With hands-on activities, they participated in ForskarFredag, the Swedish version of the European Researchers' Night, and SLU-dagen 2023, an open house event at SLU in Umeå. Another initiative involving UPSC researchers and organised in conjunction with ForskarFredag is "Låna en forskare". School classes could borrow a scientist to visit them at school and talk to them about their research. In 2023, there were even brave souls who took part in the Researchers Stand-Up at Curiosum as a comedian scientist and in the Researchers' Grand Prix in Umeå, a science slam event.

Sonali Ranade (right) presented together with and Madhusree Mitra (not shown) the "Touch me not"plant at *ForskarFredag 2023* (photo: Gabrielle Beans, Curiosum, ForskarFredag 2023)

Highlights from 2022-2023

Working at UPSC

Collaboration and exchange between different groups at UPSC is facilitated by shared labs, equipment and offices, and by joint seminars, meetings and other activities. Our goal is to create an open and stimulating work environment where people can feel well and perform excellent research. Since 2021, UPSC is conducting an annual work environment survey to identify areas for improvement.

UPSC benefits a lot from an active, dynamic and dedicated community that regularly organises social events such as Thursday pubs, movie nights, pizza and ping-pong evenings. Newcomers to UPSC can join several different groups like for example a climbing, cycling or innebandy group. During the summer, the "UPSCgardeners" grow vegetables in outside UPSC, and more recently the "UPSCrafters" were formed by a group of people who like to craft things.

During the two years of restrictions due to the Covid-19 pandemic, the sense of community at UPSC suffered, and it was especially hard for newcomers to integrate. Two events originally planned for 2020 had to be postponed twice before they could finally take place in 2022: the UPSC Days in Saxnäs and the UPSC PhD and Postdoc Retreat in Skeppsvik. Both were highly appreciated and helped to strengthen the community.

UPSC Days 2022 in Saxnäs

In August 2022, UPSC organised the UPSC Days 2022 in Saxnäs. More than 80 people working at UPSC spent three days in the beautiful surroundings of South Lapland discussing in different constellations UPSC's strengths and weaknesses as well as opportunities and threats for UPSC. The goal was to bring people together, strengthen the community at UPSC and identify ways to improve the research environment at UPSC. The engagement of the participants was great, and the feedback collected during these discussions was enormous.

Based on this feedback, several measures have been taken following the UPSC Days. For example, newcomers are now introduced to UPSC in a welcome meeting that is held four times a year. Twice a year, UPSC Christmas and Midsummer lectures are held by UPSC group leaders, followed by a joint fika or barbecue, respectively. Postdocs and PhD students are invited once a year in November to an information meeting about Swedish academia and possible career paths, and UPSC started to provide financial and advisory support to the Umeå Postdoc Society, which was funded in 2020 but had a difficult start due to the Covid-19 pandemic.

Group picture at the end of the UPSC Days 2022 in Saxnäs (photo: Anne Honsel)

Team building activities like doing together a jigsaw puzzle under limited time were an important part in the programme of the UPSC PhD and Postdoc Retreat in Skeppsvik (photo: Anne Honsel)

3rd UPSC PhD and Postdoc Retreat 2022 in Skeppsvik

At the end of September 2022, about 40 PhD students and postdocs from UPSC spent two days at Skeppsvik Herrgård, around thirty kilometres outside of Umeå. After two years of distancing, the interest was high to join the UPSC PhD and Postdoc Retreat, which was organised by the PhD students and postdocs themselves. The programme included team building activities, a session with UPSC alumni who are now working either in academia or outside of academia, a part on grant writing. The two days were rounded off with an afternoon session to deepen the discussions that started at the UPSC DAYS 2022 in Saxnäs and to plan future activities.

The general feedback from the participants was very positive and several new initiatives were started after the retreat. The PhD students and postdocs started for example a Buddy initiative to help new arriving postdocs and PhD students find their way around UPSC and integrate into the community. Laura Tünnermann and Tinkara Bizjak, two PhD students who attended the retreat, started to revive the seminar series "Outside of Academia" with the aim to show different career options that are waiting for scientists outside of academia. Scientists who have left academia are invited to explain why they left academia, what their current job is like and how they got there.

At UPSC in summer (photo: Anne Honsel

5. Institutional Insights

Institutional Insights

UPSC in Numbers

Total numbers

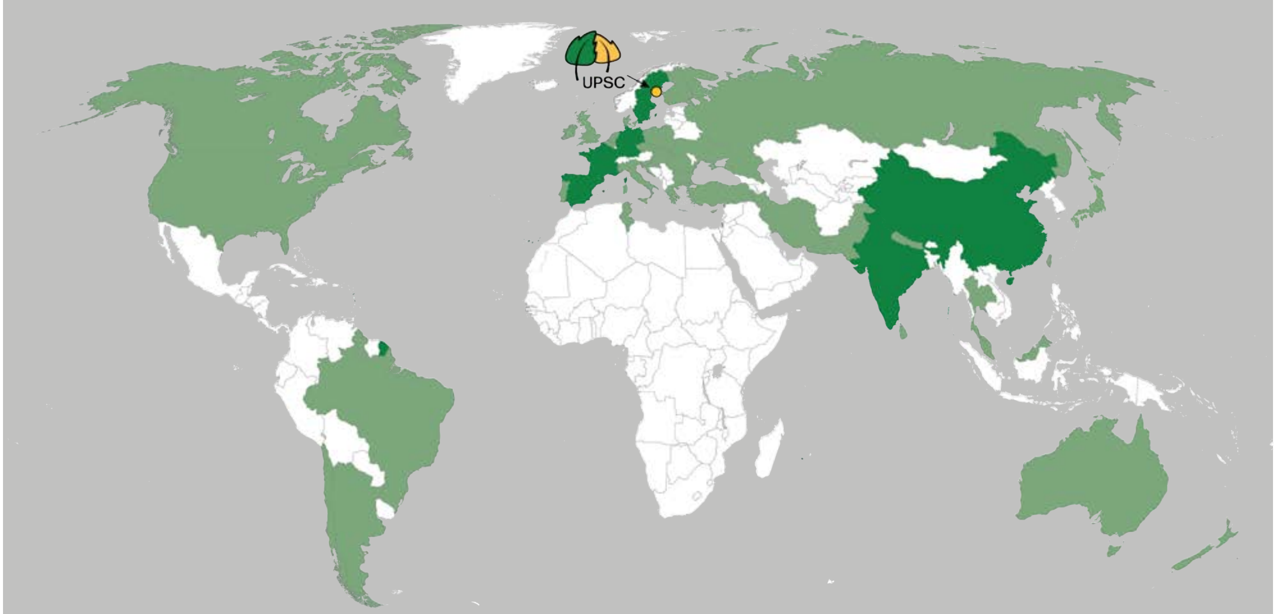
31	188	45	54%
Research Groups	Total	Nationalities	Female

Distribution among staff categories

31	33	51	35	29	9
Group leaders	Staff Scientists	Postdocs*	PhD Students	Technical Staff	Admin Staff**

Data taken from December 2023 for both departments together
*Postdocs on stipend and contract
** Administrative Staff includes staff for Human Resources, Economy and Communication

Nationalities represented at UPSC



Nationalities ("nation" is defined by the existence of a national soccer team) represented at UPSC in December 2023. For persons with dual citizenships, the one that was not represented already is counted. Dark green: 10 or more people present with this nationality; light green: less than 10 people present with this nationality.

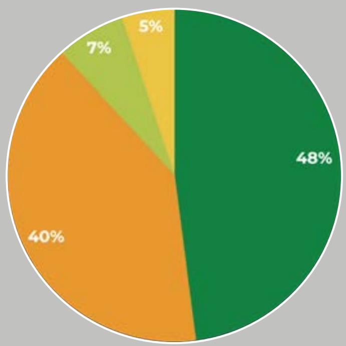
Institutional Insights

Funding

The total funding of Umeå Plant Science Centre for the years 2022-2023 is shown as combined income (figure 1) and costs (figure 2) from the Department of Forest Genetics and Plant Physiology, SLU and the Department of Plant Physiology, Umeå University. The four largest contributers are the Knut and Alice Wallenberg Foundation, the Swedish Research Council, the Swedish Foundation for Strategic Research and Kempestiftelserna.

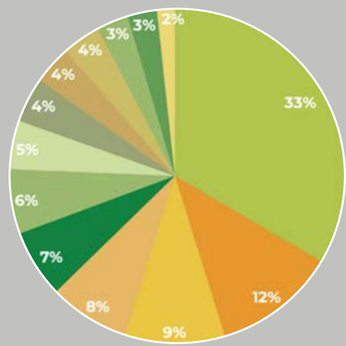
Figure 1: Income of UPSC under 2022 and 2023

a) Total Income: 462,6 MSEK



- External Grants
- Core Funding from Umeå University & SLU
- Other Income
- Services (e.g. user fees for facilities)

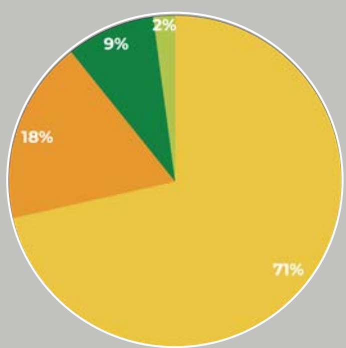
b) Income from External Funders: 221,8 MSEK



- Knut and Alice Wallenberg Foundation (33%)
- Swedish Research Council (12%)
- Swedish Foundatin for Strategic Research (9%)
- Kempestiftelserna (8%)
- Bio4Energy (7%)
- Vinnova (6%)
- Formas (5%)
- EU Grants (4%)
- SciLifeLab (4%)
- Other (each less than 1%) (4%)*
- Trees for the Future (T4F) (3%)
- Novo Nordisk Foundation (3%)
- Carl Trygger Foundation (2%)

** Other funders specified:*
Foundations affiliated/associated with SLU/UMU, The Royal Swedish Academy of Agriculture and Forestry, The Royal Swedish Academy of Sciences, Norwegian University of Life Sciences, StoraEnso, Center for Business and Policy Studies, The Nordic Joint Committee for Agricultural and Food Research, Scandinavian Plant Physiology Society (SPPS), The Swedish Foundation for International Cooperaation in Research and Higher Education, King Saudi University, Saudi Arabia, The Swedish International Development Cooperation Agency, Magnus Bergvalls Stiftelse, Föreningen Skogsträdsförädling, Stiftelsen Skogssällskapet, Stiftelsen, Nils och Dorthi Troëdssons forskningsfond, Olle Engkvists Stiftelse, Sven och Ebba-Christina Hagbergs Stiftelse, ÅForsk, Sven och Lilly Lawskis fond för naturvetenskaplig forskning

Figure 2: Spending under 2022 and 2023



- Research
- Support & Leadership
- Premises
- Education

Publications

Articles and reviews including at least one of the following affiliations: Umeå Plant Science Centre; Department of Forest Genetics and Plant Physiology, the Swedish University of Agricultural Sciences; Department of Plant Physiology, Umeå University.

Aghbolaghi MA, Dedicova B, Sharifzadeh F, Omidi M, Egertsdotter U. *Stipagrostis pennata (Trin.) De Winter Artificial Seed Production and Seedlings Multiplication in Temporary Immersion Bioreactors*. **Plants**. (2022); **11**. doi 10.3390/plants11223122

Ailizati A, Nagahage ISP, Miyagi A, Ishikawa T, Kawai-Yamada M, Demura T, Yamaguchi M. *VND-INTERACTING2 effectively inhibits transcriptional activities of VASCULAR-RELATED NAC-DOMAIN7 through a conserved sequence*. **Plant Biotechnology**. (2022); **39**: 147-53. doi 10.5511/plantbiotechnology.22.0122a

Akhter S, Westrin KJ, Zivi N, Nordal V, Kretzschmar WW, Delhomme N, Street NR, Nilsson O, Emanuelsson O, Sundström JF. *Cone-setting in spruce is regulated by conserved elements of the age-dependent flowering pathway*. **New Phytologist**. (2022); **236**: 1951-63. doi 10.1111/nph.18449

Amanda D, Frey FP, Neumann U, Przybyl M, Šimura J, Zhang Y, Chen Z, Gallavotti A, Fernie AR, Ljung K, Acosta IF. *Auxin boosts energy generation pathways to fuel pollen maturation in barley*. **Current biology**. (2022); **32**: 1798-811. doi 10.1016/j.cub.2022.02.073

André D, Marcon A, Lee KC, Goretti D, Zhang B, Delhomme N, Schmid M, Nilsson O. *FLOWERING LOCUS T paralogs control the annual growth cycle in Populus trees*. **Current Biology**. (2022); **32**: 2988-96.e4. doi 10.1016/j.cub.2022.05.023

Andre D, Zambrano JA, Zhang B, Lee KC, Ruhl M, Marcon A, Nilsson O. *Populus SVL Acts in Leaves to Modulate the Timing of Growth Cessation and Bud Set*. **Frontiers in Plant Science**. (2022). doi 10.3389/fpls.2022.823019

Antoniadi I, Mateo-Bonmatí E, Pernisová M, Brunoni F, Antoniadi M, Villalonga MGA, Ament A, Karády M, Turnbull C, Doležal K, Pěnčík A, Ljung K, Novák O. *IPT9, a cis-zeatin cytokinin biosynthesis gene, promotes root growth*. **Frontiers in Plant Science**. (2022); **13**. doi 10.3389/fpls.2022.932008

Antoniadi I, Skalický V, Sun G, Ma W, Galbraith DW, Novák O, Ljung K. *Fluorescence activated cell sorting—A selective tool for plant cell isolation and analysis*. **Cytometry Part A**. (2022); **101**: 725-36. doi 10.1002/cyto.a.24461

Aoki W, Bergius N, Kozlan S, Fukuzawa F, Okuda H, Murata H, Ishida TA, Vaario LM, Kobayashi H, Kalmiş E, Fukiharu T, Gisusi S, Matsushima KI, Terashima Y, Narimatsu M, Matsushita N, Ka KH, Yu F, Yamanaka T, Fukuda M, Yamada A. *New findings on the fungal species Tricholoma matsutake from Ukraine, and revision of its taxonomy and biogeography based on multilocus phylogenetic analyses*. **Mycoscience**. (2022); **63**: 197-214. doi 10.47371/mycosci.2022.07.004

Armada-Moreira A, Dar AM, Zhao Z, Cea C, Gelinas J, Berggren M, Costa A, Khodagholy D, Stavrinidou E. *Plant electrophysiology with conformable organic electronics: Deciphering the propagation of Venus flytrap action potentials*. **Science Advances**. (2023); **9**. doi 10.1126/sciadv.adh4443

Armada-Moreira A, Diacci C, Dar AM, Berggren M, Simon DT, Stavrinidou E. *Benchmarking organic electrochemical transistors for plant electrophysiology*. **Frontiers in Plant Science**. (2022); **13**. doi 10.3389/fpls.2022.916120

Arshad R, Saccon F, Bag P, Biswas A, Calvaruso C, Bhatti AF, Grebe S, Mascoli V, Mahbub M, Muzzopappa F, Polyzois A, Schiphorst C, Sorrentino M, Streckaité S, van Amerongen H, Aro EM, Bassi R, Boekema EJ, Croce R, Dekker J, van Grondelle R, Jansson S, Kirilovsky D, Kouřil R, Michel S, Mullineaux CW, Panzarová K, Robert B, Ruban AV, van Stokkum I, Wientjes E, Büchel C. *A kaleidoscope of photosynthetic antenna proteins and their emerging roles*. **Plant Physiology**. (2022); **189**: 1204-19. doi 10.1093/plphys/kiac175

Atakhani A, Bogdziewiez L, Verger S. *Characterising the mechanics of cell–cell adhesion in plants*. **Quantitative Plant Biology**. (2022). doi 10.1017/qpb.2021.16

Aubry E, Hoffmann B, Vilaine F, Gilard F, Klemens PAW, Guérard F, Gakière B, Neuhaus HE, Bellini C, Dinant S, Le Hir R. *A vacuolar hexose transport is required for xylem development in the inflorescence stem*. **Plant Physiology**. (2022); **188**: 1229-47. doi 10.1093/plphys/kiab551

Baba AI, Mir MY, Riyazuddin R, Cséplő Á, Rigó G, Fehér A. *Plants in Microgravity: Molecular and Technological Perspectives*. **International Journal of Molecular Sciences**. (2022); **23**. doi 10.3390/ijms231810548

Baez LA, Bacete L. *Cell wall dynamics: novel tools and research questions*. **Journal of Experimental Botany**. (2023); **74**: 6448-67. doi 10.1093/jxb/erad310

Bag P, Shutova T, Shevela D, Lihavainen J, Nanda S, Ivanov AG, Messinger J, Jansson S. *Flavodiiron-mediated O2 photoreduction at photosystem I acceptor-side provides photoprotection to conifer thylakoids in early spring*. **Nature Communications**. (2023); **14**. doi 10.1038/s41467-023-38938-z

Bai B, Schiffthaler B, van der Horst S, Willems L, Vergara A, Karlström J, Mähler N, Delhomme N, Bentsink L, Hanson J. *SeedTransNet: a directional translational network revealing regulatory patterns during seed maturation and germination*. **Journal of Experimental Botany**. (2023); **74**: 2416-32. doi 10.1093/jxb/erac394

Baş Y, Berglund L, Niittylä T, Zattarin E, Aili D, Sotra Z, Rinklake I, Junker J, Rakar J, Oksman K. *Preparation and Characterization of Softwood and Hardwood Nanofibril Hydrogels: Toward Wound Dressing Applications*. **Biomacromolecules**. (2023); **24**: 5605-19. doi 10.1021/acs.biomac.3c00596

Bernacka-Wojcik I, Talide L, Abdel Aziz I, Simura J, Oikonomou VK, Rossi S, Mohammadi M, Dar AM, Seitanidou M, Berggren M, Simon DT, Tybrandt K, Jonsson MP, Ljung K, Niittylä T, Stavrinidou E. *Flexible Organic Electronic Ion Pump for Flow-Free Phytohormone Delivery into Vasculature of Intact Plants*. **Advanced Science**. (2023); **10**. doi 10.1002/advs.202206409

Bernacki MJ, Mielecki J, Antczak A, Drożdżek M, Witoń D, Dąbrowska-Bronk J, Gawroński P, Burdiak P, Marchwicka M, Rusaczonek A, Dąbkowska-Susfał K, Strobel WR, Mellerowicz EJ, Zawadzki J, Szechyńska-Hebda M, Karpiński S. *Biotechnological Potential of the Stress Response and Plant Cell Death Regulators Proteins in the Biofuel Industry*. **Cells**. (2023); **12**. doi 10.3390/cells12162018

Biniaz Y, Tahmasebi A, Tahmasebi A, Albrectsen BR, Poczai P, Afsharifar A. *Transcriptome Meta-Analysis Identifies Candidate Hub Genes and Pathways of Pathogen Stress Responses in Arabidopsis thaliana*. **Biology**. (2022); **11**. doi 10.3390/biology11081155

Bizjak T, Sellstedt A, Gratz R, Nordin A. *Presence and activity of nitrogen-fixing bacteria in Scots pine needles in a boreal forest: a nitrogen-addition experiment*. **Tree Physiology**. (2023); **43**: 1354-64. doi 10.1093/treephys/tpad048

Blaschek L, Murozuka E, Serk H, Ménard D, Pesquet E. *Different combinations of laccase paralogs nonredundantly control the amount and composition of lignin in specific cell types and cell wall layers in Arabidopsis*. **Plant Cell**. (2023); **35**: 889-909. doi 10.1093/plcell/koac34

Blaško R, Forsmark B, Gundale MJ, Lim H, Lundmark T, Nordin A. *The carbon sequestration response of aboveground biomass and soils to nutrient enrichment in boreal forests depends on baseline site productivity*. **Science of the Total Environment**. (2022); **838**. doi 10.1016/j.scitotenv.2022.156327

Borthakur D, Busov V, Cao XH, D, Q, Gailing O, Isik F, Ko JH, Li C., Li Q., Niu S, Qu Q, Vu THG, Wang XR, Wei Z, Zhang L, We, H. 2022. *Current status and trends of forest genomics*. **Forestry Research.** (2022); **2**: 11. doi: 10.48130/FR-2022-0011

Borysiuk K, Ostaszewska-Bugajska M, Kryzheuskaya K, Gardeström P, Szal B. *Glyoxalase I activity affects Arabidopsis sensitivity to ammonium nutrition*. **Plant Cell Reports**. (2022); **41**: 2393-413. doi 10.1007/s00299-022-02931-5

Bourdon M, Lyczakowski JJ, Cresswell R, Amsbury S, Vilaplana F, Le Guen MJ, Follain N, Wightman R, Su C, Alatorre-Cobos F, Ritter M, Liszka A, Terrett OM, Yadav SR, Vatén A, Nieminen K, Eswaran G, Alonso-Serra J, Müller KH, Iuga D, Miskolczi PC, Kalmbach L, Otero S, Mähönen AP, Bhalerao R, Bulone V, Mansfield SD, Hill S, Burgert I, Beaugrand J, Benitez-Alfonso Y, Dupree R, Dupree P, Helariutta Y. *Ectopic callose deposition into woody biomass modulates the nano-architecture of macrofibrils*. **Nature Plants**. (2023); **9**: 1530-46. doi 10.1038/s41477-023-01459-0

Boussardon C, Bag P, Juvany M, Šimura J, Ljung K, Jansson S, Keech O. *The RPN12a proteasome subunit is essential for the multiple hormonal homeostasis controlling the progression of leaf senescence*. **Communications Biology**. (2022); **5**. doi 10.1038/s42003-022-03998-2

Boussardon C, Carrie C, Keech O. *Comparison of plastid proteomes points towards a higher plastidial redox turnover in vascular tissues than in mesophyll cells*. **Journal of Experimental Botany**. (2023); **74**: 4110-24. doi 10.1093/jxb/erad133

Boussardon C, Keech O. *Tissue-Specific Isolation of Tagged Arabidopsis Plastids*. **Current Protocols**. (2023); **3**. doi 10.1002/cpz1.673

Bru P, Steen CJ, Park S, Amstutz CL, Sylak-Glassman EJ, Lam L, Fekete A, Mueller MJ, Longoni F, Fleming GR, Niyogi KK, Malnoë A. *The major trimeric antenna complexes serve as a site for qH-energy dissipation in plants*. **Journal of Biological Chemistry**. (2022); **298**. doi 10.1016/j.jbc.2022.102519

Brunoni F, Pencik A, Zukauskaite A, Ament A, Kopecna M, Collani S, Kopecny D, Novak O. *Amino acid conjugation of oxIAA is a secondary metabolic regulation involved in auxin homeostasis*. **New Phytologist** (2023); **238**: 2264-70. doi 10.1111/nph.18887

Burko Y, Willige BC, Seluzicki A, Novák O, Ljung K, Chory J. *PIF7 is a master regulator of thermomorphogenesis in shade*. **Nature Communications**. (2022); **13**. doi 10.1038/s41467-022-32585-6

Calderon RH, Dalton J, Zhang Y, Quail PH. *Shade triggers posttranscriptional PHYTOCHROME-INTERACTING FACTOR-dependent increases in H3K4 trimethylation*. **Plant Physiology**. (2022); **190**: 1915-26. doi 10.1093/plphys/kiac282

Calderon RH, de Vitry C, Wollman FA, Niyogi KK. *Rubredoxin 1 promotes the proper folding of D1 and is not required for heme b559 assembly in Chlamydomonas photosystem II*. **Journal of Biological Chemistry**. (2023); **299**. doi 10.1016/j.jbc.2023.102968

Capovilla G, Castro KG, Collani S, Kearney SM, Kehoe DM, Chisholm SW. *Chitin degradation by Synechococcus WH7803*. **Scientific Reports**. (2023); **13**. doi 10.1038/s41598-023-47332-0

Casanova-Sáez R, Mateo-Bonmatí E, Šimura J, Pěnčík A, Novák O, Staswick P, Ljung K. *Inactivation of the entire Arabidopsis group II GH3s confers tolerance to salinity and water deficit*. **New Phytologist**. (2022); **235**: 263-75. doi 10.1111/nph.18114

Castro D, Concha C, Jamett F, Ibáñez C, Hurry V. *Soil Microbiome Influences on Seedling Establishment and Growth of Prosopis chilensis and Prosopis tamarugo from Northern Chile*. **Plants**. (2022); **11**. doi 10.3390/plants11202717

Chandra A, Tünnermann L, Löfstedt T, Gratz R. *Transformer-based deep learning for predicting protein properties in the life sciences*. **eLife**. (2023); **12**. doi 10.7554/eLife.82819

Chardon F, De Marco F, Marmagne A, Le Hir R, Vilaine F, Bellini C, Dinant S. *Natural variation in the long-distance transport of nutrients and photoassimilates in response to N availability*. **Journal of Plant Physiology**. (2022); **273**. doi 10.1016/j.jplph.2022.153707

Chen JJ, Wang W, Qin WQ, Men SZ, Li HL, Mitsuda N, Ohme-Takagi M, Wu AM. *Transcription factors KNAT3 and KNAT4 are essential for integument and ovule formation in Arabidopsis*. **Plant Physiology**. (2023); **191**: 463-78. doi 10.1093/plphys/kiac513

Chen P, Song Y, Liu X, Xiao L, Bu C, Liu P, Zhao L, Ingvarsson PK, Wu HX, El-Kassaby YA, Zhang D. *LncRNA PMAT–PtoMYB46 module represses PtoMATE and PtoARF2 promoting Pb2+ uptake and plant growth in poplar*. **Journal of Hazardous Materials**. (2022); **433**. doi 10.1016/j.jhazmat.2022.128769

Chen ZQ, Klingberg A, Hallingbäck HR, Wu HX. *Preselection of QTL markers enhances accuracy of genomic selection in Norway spruce*. **BMC Genomics**. (2023); **24**. doi 10.1186/s12864-023-09250-3

Chen ZQ, Zan Y, Zhou L, Karlsson B, Tuominen H, García-Gil MR, Wu HX. *Genetic architecture behind developmental and seasonal control of tree growth and wood properties in Norway spruce*. **Frontiers in Plant Science**. (2022); **13**. doi 10.3389/fpls.2022.927673

Chowdhury J, Ferdous J, Lihavainen J, Albrectsen BR, Lundberg-Felten J. *Fluorogenic properties of 4-dimethylaminocinnamaldehyde (DMACA) enable high resolution imaging of cell-wall-bound proanthocyanidins in plant root tissues*. **Frontiers in Plant Science**. (2023); **13**. doi 10.3389/fpls.2022.1060804

Chowdhury J, Kemppainen M, Delhomme N, Shutava I, Zhou J, Takahashi J, Pardo AG, Lundberg-Felten J. *Laccaria bicolor pectin methylesterases are involved in ectomycorrhiza development with Populus tremula × Populus tremuloides*. **New Phytologist**. (2022); **236**: 639-55. doi 10.1111/nph.18358

Colesie C, Pan Y, Cary SC, Gemal E, Brabyn L, Kim J-H, Green TGA, Lee CK. *The Longest Baseline Record of Vegetation Dynamics in Antarctica Reveals Acute Sensitivity to Water Availability*. **Earth's Future**. (2022). doi 10.1029/2022EF002823

Crepin A, Belgio E, Šedivá B, Trsková EK, Cunill-Semanat E, Kaňa R. *Size and Fluorescence Properties of Algal Photosynthetic Antenna Proteins Estimated by Microscopy*. **International Journal of Molecular Sciences**. (2022); **23**. doi 10.3390/ijms23020778

Curci PL, Zhang J, Mähler N, Seyfferth C, Mannapperuma C, Diels T, Van Hautegem T, Jonsen D, Street N, Hvidsten TR, Hertzberg M, Nilsson O, Inzé D, Nelissen H, Vandepoele K. *Identification of growth regulators using cross-species network analysis in plants*. **Plant Physiology**. (2022); **190**: 2350-65. doi 10.1093/plphys/kiac374

Dash L, Swaminathan S, Šimura J, Gonzales CLP, Montes C, Solanki N, Mejia L, Ljung K, Zabotina OA, Kelley DR. *Changes in cell wall composition due to a pectin biosynthesis enzyme GAUT10 impact root growth*. **Plant Physiology**. (2023); **193**: 2480-97. doi 10.1093/plphys/kiad465

Davis GV, de Souza Moraes T, Khanapurkar S, Dromiack H, Ahmad Z, Bayer EM, Bhalerao RP, Walker SI, Bassel GW. *Toward uncovering an operating system in plant organs*. **Trends in Plant Science**. (2023). doi 10.1016/j.tplants.2023.11.006

Decker D, Aubert J, Wilczynska M, Kleczkowski LA. *Exploring Redox Modulation of Plant UDP-Glucose Pyrophosphorylase*. **International Journal of Molecular Sciences**. (2023); **24**. doi 10.3390/ijms24108914

Demes E, Verger S. *High-throughput characterization of cortical microtubule arrays response to anisotropic tensile stress*. **BMC Biology**. (2023); **21**. doi 10.1186/s12915-023-01654-7

Derba-Maceluch M, Mitra M, Hedenström M, Liu X, Gandla ML, Barbut FR, Abreu IN, Donev EN, Urbancsok J, Moritz T, Jönsson LJ, Tsang A, Powlowski J, Master ER, Mellerowicz EJ. *Xylan glucuronic acid side chains fix suberin-like aliphatic compounds to wood cell walls.*

New Phytologist. (2023); **238**: 297-312. doi 10.1111/nph.18712

Derba-Maceluch M, Sivan P, Donev EN, Gandla ML, Yassin Z, Vaasan R, Heinonen E, Andersson S, Amini F, Scheepers G, Johansson U, Vilaplana FJ, Albrectsen BR, Hertzberg M, Jönsson LJ, Mellerowicz EJ. *Impact of xylan on field productivity and wood saccharification properties in aspen*. **Frontiers in Plant Science**. (2023); **14**. doi 10.3389/fpls.2023.1218302

Diamanti R, Srinivas V, Johansson AI, Nordström A, Griese JJ, Lebrette H, Högbom M. *Comparative structural analysis provides new insights into the function of R2-like ligand-binding oxidase*. **FEBS Letters**. (2022); **596**: 1600-10. doi 10.1002/1873-3468.14319

Ding X, Diao S, Luan Q, Wu HX, Zhang Y, Jiang J. *A transcriptome-based association study of growth, wood quality, and oleoresin traits in a slash pine breeding population*. **PLoS Genetics**. (2022); **18**. doi 10.1371/journal.pgen.1010017

Domevscik M, Häggström B, Lim H, Öhlund J, Nordin A. *Large-scale assessment of artificially coated seeds for forest regeneration across Sweden*. **New Forests**. (2023); **54**: 255-67. doi 10.1007/s11056-022-09920-2

Dominguez PG, Niittylä T. *Mobile forms of carbon in trees: Metabolism and transport*. **Tree Physiology**. (2022); **42**: 458-87. doi 10.1093/treephys/tpab123

Donev EN, Derba-Maceluch M, Yassin Z, Gandla ML, Pramod S, Heinonen E, Kumar V, Scheepers G, Vilaplana F, Johansson U, Hertzberg M, Sundberg B, Winestrand S, Hörnberg A, Alriksson B, Jönsson LJ, Mellerowicz EJ. *Field testing of transgenic aspen from large greenhouse screening identifies unexpected winners*. **Plant Biotechnology Journal**. (2023); **21**: 1005-21. doi 10.1111/pbi.14012

Dube F, Hinas A, Delhomme N, Åbrink M, Svärd S, Tydén E. *Transcriptomics of ivermectin response in Caenorhabditis elegans: Integrating abamectin quantitative trait loci and comparison to the Ivermectin-exposed DA1316 strain*. **PLoS ONE**. (2023); **18**. doi 10.1371/journal.pone.0285262

Dufil G, Bernacka-Wojcik I, Armada-Moreira A, Stavrinidou E. *Plant Bioelectronics and Biohybrids: The Growing Contribution of Organic Electronic and Carbon-Based Materials*. **Chemical Reviews**. (2022); **122**: 4847-83. doi 10.1021/acs.chemrev.1c00525

Ellerstrand SJ, Choudhury S, Svensson K, Andersson MN, Kirkeby C, Powell D, Schlyter F, Jönsson AM, Brydegaard M, Hansson B, Runemark A. *Weak population genetic structure in Eurasian spruce bark beetle over large regional scales in Sweden*. **Ecology and Evolution**. (2022); **12**. doi 10.1002/ece3.9078

Eriksson ANM, Rigaud C, Rokka A, Skaugen M, Lihavainen JH, Vehniäinen ER. *Changes in cardiac proteome and metabolome following exposure to the PAHs retene and fluoranthene and their mixture in developing rainbow trout alevins*. **Science of the Total Environment**. (2022); **830**. doi 10.1016/j.scitotenv.2022.154846

Escamez S, Robinson KM, Luomaranta M, Gandla ML, Mähler N, Yassin Z, Grahn T, Scheepers G, Stener LG, Jansson S, Jönsson LJ, Street NR, Tuominen H. *Genetic markers and tree properties predicting wood biorefining potential in aspen (Populus tremula) bioenergy feedstock*. **Biotechnology for Biofuels and Bioproducts**. (2023); **16**. doi 10.1186/s13068-023-02315-1

Estravis Barcala M, van der Valk T, Chen Z, Funda T, Chaudhary R, Klingberg A, Fundova I, Suontama M, Hallingbäck H, Bernhardsson C, Nystedt B, Ingvarsson PK, Sherwood E, Street N, Gyllensten U, Nilsson O, Wu HX. *Whole-genome resequencing facilitates the development of a 50K single nucleotide polymorphism genotyping array for Scots pine (Pinus sylvestris L.) and its transferability to other pine species*. **Plant Journal**. (2023). doi 10.1111/tpj.16535

Farag SI, Francis MK, Gurung JM, Wai SN, Stenlund H, Francis MS, Nadeem A. *Macrophage innate immune responses delineate between defective translocon assemblies produced by Yersinia pseudotuberculosis YopD mutants*. **Virulence**. (2023); **14**. doi 10.1080/21505594.2023.2249790

Fataftah N, Edlund E, Lihavainen J, Bag P, Björkén L, Näsholm T, Jansson S. *Nitrate fertilization may delay autumn leaf senescence, while amino acid treatments do not*. **Physiologia Plantarum**. (2022); **174**. doi 10.1111/ppl.13690

Fünfgeld MMFF, Wang W, Ishihara H, Arrivault S, Feil R, Smith AM, Stitt M, Lunn JE, Niittylä T. *Sucrose synthases are not involved in starch synthesis in Arabidopsis leaves*. **Nature Plants**. (2022); **8**: 574-82. doi 10.1038/s41477-022-01140-y

Gaur RK, de Abreu IN, Albrectsen BR. *Compensatory phenolic induction dynamics in aspen after aphid infestation*. **Scientific Reports**. (2022); **12**. doi 10.1038/s41598-022-13225-x

Giaume F, Bono GA, Martignago D, Miao Y, Vicentini G, Toriba T, Wang R, Kong D, Cerise M, Chirivì D, Biancucci M, Khahani B, Morandini P, Tameling W, Martinotti M, Goretti D, Coupland G, Kater M, Brambilla V, Miki D, Kyozuka J, Fornara F. *Two florigens and a florigen-like protein form a triple regulatory module at the shoot apical meristem to promote reproductive transitions in rice*. **Nature Plants**. (2023); **9**: 525-34. doi 10.1038/s41477-023-01383-3

Gil-Muñoz F, Bernhardsson C, Ranade SS, Scofield DG, Pulkkinen PO, Ingvarsson PK, García-Gil MR. *QTL mapping of the narrow-branch "Pendula" phenotype in Norway spruce (Picea abies L. Karst.)*. **Tree Genetics and Genomes**. (2023); **19**. doi 10.1007/s11295-023-01599-6

Gong X, Shen T, Li X, Lin H, Chen C, Li H, Wu Z, Liu Q, Xu M, Zhang B, Zhong Y. *Genome-Wide Characterization and Analysis of bHLH Transcription Factors Related to Anthocyanin Biosynthesis in Cinnamomum camphora ('Gantong 1')*. **International Journal of Molecular Sciences**. (2023); **24**. doi 10.3390/ijms24043498

Govindjee G, Peterson LF, Satoh K, Herbert S, de Kouchkovsky Y, Schreiber U, Murata N, Öquist G, Larkum AWD, Hiyama T, Berry JA. *David (Dave) Charles Fork (1929–2020): a gentle human being, a great experimenter, and a passionate researcher*. **Photosynthesis Research**. (2023); **155**: 107-25. doi 10.1007/s11120-022-00964-1

Green AC, Marttila P, Kiweler N, Chalkiadaki C, Wiita E, Cookson V, Lesur A, Eiden K, Bernardin F, Vallin KSA, Borhade S, Long M, Ghahe EK, Jiménez-Alonso JJ, Jemth AS, Loseva O, Mortusewicz O, Meyers M, Viry E, Johansson AI, Hodek O, Homan E, Bonagas N, Ramos L, Sandberg L, Frödin M, Moussay E, Slipicevic A, Letellier E, Paggetti J, Sørensen CS, Helleday T, Henriksson M, Meiser J. *Formate overflow drives toxic folate trapping in MTHFD1 inhibited cancer cells*. **Nature Metabolism**. (2023); **5**: 642-59. doi 10.1038/s42255-023-00771-5

Grenzi M, Buratti S, Parmagnani AS, Abdel Aziz I, Bernacka-Wojcik I, Resentini F, Šimura J, Doccula FG, Alfieri A, Luoni L, Ljung K, Bonza MC, Stavrinidou E, Costa A. *Long-distance turgor pressure changes induce local activation of plant glutamate receptor-like channels*. **Current Biology**. (2023); **33**: 1019-35.e8. doi 10.1016/j.cub.2023.01.042

Guo JF, Wang B, Liu ZL, Mao JF, Wang XR, Zhao W. *Low genetic diversity and population connectivity fuel vulnerability to climate change for the Tertiary relict pine Pinus bungeana*. **Journal of Systematics and Evolution**. (2023); **61**: 143-56. doi 10.1111/jse.12821

Guo JF, Zhao W, Andersson B, Mao JF, Wang XR. *Genomic clines across the species boundary between a hybrid pine and its progenitor in the eastern Tibetan Plateau*. **Plant Communications**. (2023); **4**. doi 10.1016/j.xplc.2023.100574

Häggström B, Gundale MJ, Nordin A. *Environmental controls on seedling establishment in a boreal forest: implications for Scots pine regeneration in continuous cover forestry*. **European Journal of Forest Research**. (2023). doi 10.1007/s10342-023-01609-1

Häggström B, Lutter R, Lundmark T, Sjödin F, Nordin A. *Effect of arginine-phosphate addition on early survival and growth of Scots pine, Norway spruce and silver birch*. **Silva Fennica**. (2023); **57**. doi 10.14214/sf.22013

Hall D, Zhao W, Heuchel A, Gao J, Wennström U, Wang XR. *The effect of gene flow on frost tolerance in Scots pine – Latitudinal translocation of genetic material.* **Forest Ecology and Management**. (2023); **544**. doi 10.1016/j.foreco.2023.121215

Hallberg-Sramek I, Nordström EM, Priebe J, Reimerson E, Mårald E, Nordin A. *Combining scientific and local knowledge improves evaluating future scenarios of forest ecosystem services*. **Ecosystem Services**. (2023); **60**. doi 10.1016/j.ecoser.2023.101512

Hallberg-Sramek I, Reimerson E, Priebe J, Nordstroem E-M, Marald E, Sandstroem C, Nordin A. *Bringing Climate-Smart Forestry Down to the Local Level-Identifying Barriers, Pathways and Indicators for Its Implementation in Practice*. **Forests**. (2022). doi 10.3390/f13010098

Hamon-Josse M, Villaécija-Aguilar JA, Ljung K, Leyser O, Gutjahr C, Bennett T. *KAI2 regulates seedling development by mediating light-induced remodelling of auxin transport*. **New Phytologist**. (2022); **235**: 126-40. doi 10.1111/nph.18110

Hao J, Malnoë A. *A Simple Sonication Method to Isolate the Chloroplast Lumen in Arabidopsis thaliana*. **Bio-protocol**. (2023); **13**. doi 10.21769/BioProtoc.4756

Hasegawa Y, Huarancca Reyes T, Uemura T, Baral A, Fujimaki A, Luo Y, Morita Y, Saeki Y, Maekawa S, Yasuda S, Mukuta K, Fukao Y, Tanaka K, Nakano A, Takagi J, Bhalerao RP, Yamaguchi J, Sato T. *The TGN/EE SNARE protein SYP61 and the ubiquitin ligase ATL31 cooperatively regulate plant responses to carbon/nitrogen conditions in Arabidopsis*. **Plant Cell**. (2022); **34**: 1354-74. doi 10.1093/plcell/koac014

He L, Guo FY, Cai XJ, Chen HP, Lian CL, Wang Y, Shang C, Zhang Y, Wagner ND, Zhang ZX, Hörandl E, Wang XR. *Evolutionary origin and establishment of a dioecious diploid-tetraploid complex*. **Molecular Ecology**. (2023); **32**: 2732-49. doi 10.1111/mec.16902

Hernández-Verdeja T, Vuorijoki L, Jin X, Vergara A, Dubreuil C, Strand Å. *GENOMES UNCOUPLED1 plays a key role during the de-etiolation process in Arabidopsis*. **New Phytologist**. (2022); **235**: 188-203. doi 10.1111/nph.18115

Heuchel A, Hall D, Zhao W, Gao J, Wennström U, Wang XR. *Genetic diversity and background pollen contamination in Norway spruce and Scots pine seed orchard crops*. **Forestry Research.** (2022); **2**: 8. doi: 10.48130/FR-2022-0008

Hodek O, Argemi-Muntadas L, Khan A, Moritz T. *Mixed-mode chromatography-mass spectrometry enables targeted and untargeted screening of carboxylic acids in biological samples*. **Analytical Methods**. (2022). doi 10.1039/d1ay02143e

Hodek O, Henderson J, Argemi-Muntadas L, Khan A, Moritz T. *Structural elucidation of 3-nitrophenylhydrazine derivatives of tricarboxylic acid cycle acids and optimization of their fragmentation to boost sensitivity in liquid chromatography-mass spectrometry*. **Journal of Chromatography B: Analytical Technologies in the Biomedical and Life Sciences**. (2023); **1222**. doi 10.1016/j.jchromb.2023.123719

Hoffmann G, López-González S, Mahboubi A, Hanson J, Hafren, A. *Cauliflower mosaic virus protein P6 is a multivalent node for RNA granule proteins and interferes with stress granule responses during plant infection*. **Plant Cell**. (2023); **35**: 3363-82. doi 10.1093/plcell/koad101

Hoffmann G, Mahboubi A, Bente H, Garcia D, Hanson J, Hafrén A. *Arabidopsis RNA processing body components LSM1 and DCP5 aid in the evasion of translational repression during Cauliflower mosaic virus infection*. **Plant Cell**. (2022); **34**: 3128-47. doi 10.1093/plcell/koac132

Hussain Q, Zheng M, Hanninen H, Bhalerao RP, Riaz MW, Sajjad M, Zhang R, Wu J. *Effect of the photoperiod on bud dormancy in Liriodendron chinense*. **Journal of Plant Physiology**. (2022). doi 10.1016/j.jplph.2022.153835

Igamberdiev AU, Kleczkowski LA. *Toward understanding the emergence of life: A dual function of the system of nucleotides in the metabolically closed autopoietic organization*. **BioSystems**. (2023); **224**. doi 10.1016/j.biosystems.2023.104837

Islam MM, Deepo DM, Nasif SO, Siddique AB, Hassan O, Siddique AB, Paul NC. *Cytogenetics and consequences of polyploidization on different biotic-abiotic stress tolerance and the potential mechanisms involved*. **Plants**. (2022); **11**. doi 10.3390/plants11202684

Israeli A, Schubert R, Man N, Teboul N, Yarce JCS, Rosowski EE, Wu MF, Levy M, Efroni I, Ljung K, Hause B, Reed JW, Ori N. *Modulating auxin response stabilizes tomato fruit set*. **Plant Physiology**. (2023); **192**: 2336-55. doi 10.1093/plphys/kiad205

Ivanov AG, Krol M, Savitch LV, Szyszka-Mroz B, Roche J, Sprott DP, Selstam E, Wilson KW, Gardiner R, Öquist G, Hurry VM, Hüner NPA. *The decreased PG content of pgp1 inhibits PSI photochemistry and limits reaction center and light-harvesting polypeptide accumulation in response to cold acclimation*. **Planta**. (2022); **255**. doi 10.1007/s00425-022-03819-0

Jin M, Liu H, Liu X, Guo T, Guo J, Yin Y, Ji Y, Li Z, Zhang J, Wang X, Qiao F, Xiao Y, Zan Y, Yan J. *Complex genetic architecture underlying the plasticity of maize agronomic traits*. **Plant Communications**. (2023); **4**. doi 10.1016/j.xplc.2022.100473

Jobert F, Soriano A, Brottier L, Casset C, Divol F, Safran J, Lefebvre V, Pelloux J, Robert S, Péret B. *Auxin triggers pectin modification during rootlet emergence in white lupin*. **Plant Journal**. (2022); **112**: 1127-40. doi 10.1111/tpj.15993

Jobert F, Yadav S, Robert S. *Auxin as an architect of the pectin matrix*. **Journal of Experimental Botany**. (2023); **74**: 6933-49. doi 10.1093/jxb/erad174

Jonasson S, Bünder A, Berglund L, Niittylä T, Oksman K. *Characteristics of Cellulose Nanofibrils from Transgenic Trees with Reduced Expression of Cellulose Synthase Interacting 1*. **Nanomaterials**. (2022); **12**. doi 10.3390/nano12193448

Jonsson K, Hamant O, Bhalerao RP. *Plant cell walls as mechanical signaling hubs for morphogenesis*. **Current Biology**. (2022); **32**: R334-R40. doi 10.1016/j.cub.2022.02.036

Jonsson K, Ma Y, Routier-Kierzkowska AL, Bhalerao RP. *Multiple mechanisms behind plant bending*. **Nature Plants**. (2023); **9**: 13-21. doi 10.1038/s41477-022-01310-y

Jourquin J, Fernandez AI, Wang Q, Xu K, Chen J, Šimura J, Ljung K, Vanneste S, Beeckman T. *GOLVEN peptides regulate lateral root spacing as part of a negative feedback loop on the establishment of auxin maxima*. **Journal of Experimental Botany**. (2023); **74**: 4031-49. doi 10.1093/jxb/erad123

Jurca M, Sjölander J, Ibáñez C, Matrosova A, Johansson M, Kozarewa I, Takata N, Bakó L, Webb AAR, Israelsson-Nordström M, Eriksson ME. *ZEITLUPE Promotes ABA-Induced Stomatal Closure in Arabidopsis and Populus*. **Frontiers in Plant Science**. (2022); **13**. doi 10.3389/fpls.2022.829121

Kauppi PE, Stål G, Arnesson-Ceder L, Hallberg Sramek I, Hoen HF, Svensson A, Wernick IK, Högberg P, Lundmark T, Nordin A. *Managing existing forests can mitigate climate change*. **Forest Ecology and Management**. (2022); **513**. doi 10.1016/j.foreco.2022.120186

Kidwai M, Mishra P, Bellini C. *Species-specific transcriptional reprogramming during adventitious root initiation*. **Trends in Plant Science** (2023); **28**: 128-30. doi 10.1016/j.tplants.2022.11.003

Kleczkowski LA, Decker D. *Effects of Magnesium, Pyrophosphate and Phosphonates on Pyrophosphorolytic Reaction of UDP-Glucose Pyrophosphorylase*. **Plants**. (2022); **11**. doi 10.3390/plants11121611

Kleczkowski LA, Igamberdiev AU. *Magnesium and cell energetics: At the junction of metabolism of adenylate and non-adenylate nucleotides*. **Journal of Plant Physiology**. (2023); **280**: 153901. doi 10.1016/j.jplph.2022.153901

Kokla A, Leso M, Zhang X, Simura J, Serivichyaswat PT, Cui S, Ljung K, Yoshida S, Melnyk CW. *Nitrogen represses haustoria formation through abscisic acid in the parasitic plant Phtheirospermum japonicum*. **Nature Communications**. (2022); **13**. doi 10.1038/s41467-022-30550-x

Kolbeck A, Marhavy P, De Bellis D, Li B, Kamiya T, Fujiwara T, Kalmbach L, Geldner N. *CASP microdomain formation requires cross cell wall stabilization of domains and non-cell autonomous action of LOTR1*. **eLife**. (2022). doi 10.7554/eLife.69602.sa2

Law SR, Serrano AR, Daguerre Y, Sundh J, Schneider AN, Stangl ZR, Castro D, Grabherr M, Näsholm T, Street NR, Hurry V. *Metatranscriptomics captures dynamic shifts in* *mycorrhizal coordination in boreal forests*. **Proceedings of the National Academy of Sciences of the United States of America**. (2022); **119**. doi 10.1073/pnas.2118852119

Le KC, Johnson S, Aidun CK, Egertsdotter U. *In Vitro Propagation of the Blueberry 'Blue Suede™' (Vaccinium hybrid) in Semi-Solid Medium and Temporary Immersion Bioreactors*. **Plants**. (2023); **12**. doi 10.3390/plants12152752

Le Provost G, Lalanne C, Lesur I, Louvet JM, Delzon S, Kremer A, Labadie K, Aury JM, Da Silva C, Moritz T, Plomion C. *Oak stands along an elevation gradient have different molecular strategies for regulating bud phenology*. **BMC Plant Biology**. (2023); **23**. doi 10.1186/s12870-023-04069-2

Lecoy J, Ranade SS, García-Gil MR. *Analysis of the ASR and LP3 homologous gene families reveal positive selection acting on LP3-3 gene*. **Gene**. (2023); **850**. doi 10.1016/j.gene.2022.146935

Lee KC, Kim YC, Kim JK, Lee H, Lee JH. *Regulation of Flowering Time and Other Developmental Plasticities by 3' Splicing Factor-Mediated Alternative Splicing in Arabidopsis thaliana*. **Plants**. (2023); **12**. doi 10.3390/plants12193508

Li J, Han F, Yuan T, Li W, Li Y, Wu HX, Wei H, Niu S. *The methylation landscape of giga-genome and the epigenetic timer of age in Chinese pine*. **Nature Communications**. (2023); **14**. doi 10.1038/s41467-023-37684-6

Li L, Milesi P, Tiret M, Chen J, Sendrowski J, Baison J, Chen ZQ, Zhou L, Karlsson B, Berlin M, Westin J, Garcia-Gil MR, Wu HX, Lascoux M. *Teasing apart the joint effect of demography and natural selection in the birth of a contact zone*. **New Phytologist**. (2022); **236**: 1976-87. doi 10.1111/nph.18480

Li Z, Lathe RS, Li J, He H, Bhalerao RP. *Towards understanding the biological foundations of perenniality*. **Trends in Plant Science**. (2022); **27**: 56-68. doi 10.1016/j.tplants.2021.08.007

Liao X, Su Y, Klintenäs M, Li Y, Sane S, Wu Z, Chen Q, Zhang B, Nilsson O, Ding J. *Age-dependent seasonal growth cessation in Populus*. **Proceedings of the National Academy of Sciences of the United States of America**. (2023); **120**. doi 10.1073/pnas.2311226120

Liebsch D, Juvany M, Li Z, Wang HL, Ziolkowska A, Chrobok D, Boussardon C, Wen X, Law SR, Janečková H, Brouwer B, Lindén P, Delhomme N, Stenlund H, Moritz T, Gardeström P, Guo H, Keech O. *Metabolic control of arginine and ornithine levels paces the progression of leaf senescence*. **Plant Physiology**. (2022); **189**: 1943-60. doi 10.1093/plphys/kiac244

Lihavainen J, Šimura J, Bag P, Fataftah N, Robinson KM, Delhomme N, Novák O, Ljung K, Jansson S. *Salicylic acid metabolism and signalling coordinate senescence initiation in aspen in nature*. **Nature Communications**. (2023); **14**. doi 10.1038/s41467-023-39564-5

Lim H, Jämtgård S, Oren R, Gruffman L, Kunz S, Näsholm T. *Organic nitrogen enhances nitrogen nutrition and early growth of Pinus sylvestris seedlings*. **Tree Physiology**. (2022) **42**: 513-522. doi 10.1093/treephys/tpab127

Lindberg A, Niemi C, Takahashi J, Sellstedt A, Gentili FG. *Cold stress stimulates algae to produce value-added compounds*. **Bioresource Technology Reports**. (2022); **19**. doi 10.1016/j.biteb.2022.101145

Lindén E, te Beest M, Abreu IN, Moritz T, Sundqvist MK, Barrio IC, Boike J, Bryant JP, Bråthen KA, Buchwal A, Bueno CG, Cuerrier A, Egelkraut DD, Forbes BC, Hallinger M, Heijmans M, Hermanutz L, Hik DS, Hofgaard A, Holmgren M, Huebner DC, Høye TT, Jónsdóttir IS, Kaarlejärvi E, Kissler E, Kumpula T, Limpens J, Myers-Smith IH, Normand S, Post E, Rocha AV, Schmidt NM, Skarin A, Soininen EM, Sokolov A, Sokolova N, Speed JDM, Street L, Tananaev N, Tremblay JP, Urbanowicz C, Watts DA, Zimmermann H, Olofsson J. *Circum-Arctic distribution of chemical anti-herbivore compounds suggests biome-wide trade-off in defence strategies in Arctic shrubs*. **Ecography**. (2022); **2022**. doi 10.1111/ecog.06166

Liu C, Mentzelopoulou A, Hatzianestis IH, Tzagkarakis E, Skaltsogiannis V, Ma X, Michalopoulou VA, Romero–Campero FJ, Romero–Campero AB, Sarris PF, Marhavy P, Bölter B, Kanterakis A, Gutierrez–Beltran E, Moschou PN. *A proxitome-RNA-capture approach reveals that processing bodies repress co-regulated hub genes*. **Plant Cell**. (2023): koad288. doi 10.1093/plcell/koad288

Liu H, Zhao W, Zhang RG, Mao JF, Wang XR. *Repetitive Elements, Sequence Turnover and Cyto-Nuclear Gene Transfer in Gymnosperm Mitogenomes*. **Frontiers in Genetics**. (2022); **13**. doi 10.3389/fgene.2022.867736

Liu L, Qin L, Safdar LB, Zhao C, Cheng X, Xie M, Zhang Y, Gao F, Bai Z, Huang J, Bhalerao RP, Liu S, Wei Y. *The plant trans-Golgi network component ECHIDNA regulates defense, cell death, and endoplasmic reticulum stress*. **Plant Physiology**. (2023); **191**: 558-74. doi 10.1093/plphys/kiac400

Liu S, Zhang L, Sang Y, Lai Q, Zhang X, Jia C, Long Z, Wu J, Ma T, Mao K, Street NR, Ingvarsson PK, Liu J, Wang J. *Demographic History and Natural Selection Shape Patterns of Deleterious Mutation Load and Barriers to Introgression across Populus Genome*. **Molecular Biology and Evolution**. (2022); **39**. doi 10.1093/molbev/msac008

Long M, Sanchez-Martinez A, Longo M, Suomi F, Stenlund H, Johansson AI, Ehsan H, Salo VT, Montava-Garriga L, Naddafi S, Ikonen E, Ganley IG, Whitworth AJ, McWilliams TG. *DGAT1 activity synchronises with mitophagy to protect cells from metabolic rewiring by iron depletion*. **EMBO Journal**. (2022); **41**. doi 10.15252/embj.2021109390

López-López A, Keech O, Rouhier N. *Maturation and*

Assembly of Iron-Sulfur Cluster-Containing Subunits in the Mitochondrial Complex I From Plants. **Frontiers in Plant Science**. (2022); **13**. doi 10.3389/fpls.2022.916948

Lstibůrek M, García-Gil MR, Steffenrem A. *Rolling front landscape breeding*. **Annals of Forest Science**. (2023); **80**. doi 10.1186/s13595-023-01203-w

Ma Y, Jonsson K, Aryal B, De Veylder L, Hamant O, Bhalerao RP. *Endoreplication mediates cell size control via mechanochemical signaling from cell wall*. **Science Advances**. (2022); **8**. doi 10.1126/sciadv.abq2047

Malnoë A. *In vivo oxidation by thioredoxin regulates chloroplast enzymes activity*. **Proceedings of the National Academy of Sciences of the United States of America**. (2022); **119**. doi 10.1073/pnas.2121408119

Manoharan L, Roth B, Bang C, Stenlund H, Ohlsson B. *An Okinawan-Based Nordic Diet Leads to Profound Effects on Gut Microbiota and Plasma Metabolites Linked to Glucose and Lipid Metabolism*. **Nutrients**. (2023); **15**. doi 10.3390/nu15143273

Maqdasy S, Lecoutre S, Renzi G, Frendo-Cumbo S, Rizo-Roca D, Moritz T, Juvany M, Hodek O, Gao H, Couchet M, Witting M, Kerr A, Bergo MO, Choudhury RP, Aouadi M, Zierath JR, Krook A, Mejhert N, Ryden M. *Impaired phosphocreatine metabolism in white adipocytes promotes inflammation*. **Nature Metabolism**. (2022). doi 10.1038/s42255-022-00525-9

Marabita F, James T, Karhu A, Virtanen H, Kettunen K, Stenlund H, Boulund F, Hellström C, Neiman M, Mills R, Perheentupa T, Laivuori H, Helkkula P, Byrne M, Jokinen I, Honko H, Kallonen A, Ermes M, Similä H, Lindholm M, Widén E, Ripatti S, Perälä-Heape M, Engstrand L, Nilsson P, Moritz T, Miettinen T, Sallinen R, Kallioniemi O. *Multiomics and digital monitoring during lifestyle changes reveal independent dimensions of human biology and health*. **Cell Systems**. (2022); **13**: 241-55.e7. doi 10.1016/j.cels.2021.11.001

Marhava P. *Recent developments in the understanding of PIN polarity*. **New Phytologist**. (2022); **233**: 624-30. doi 10.1111/nph.17867

Martínez-Hidalgo P, Humm EA, Still DW, Shi B, Pellegrini M, de la Roca G, Veliz E, Maymon M, Bru P, Huntemann M, Clum A, Palaniappan K, Varghese N, Mukherjee S, Reddy TBK, Daum C, Ivanova NN, Kyrpides NC, Shapiro N, Eloe-Fadrosh EA, Hirsch AM. *Medicago root nodule microbiomes: insights into a complex ecosystem with potential candidates for plant growth promotion*. **Plant and Soil**. (2022); **471**: 507-26. doi 10.1007/s11104-021-05247-7

Mateos JL, Sanchez SE, Legris M, Esteve-Bruna D, Torchio JC, Petrillo E, Goretti D, Blanco-Touriñán N, Seymour DK, Schmid M, Weigel D, Alabadí D, Yanovsky MJ. *PICLN modulates alternative splicing and light/temperature responses in plants*. **Plant Physiology**. (2023); **191**: 1036-51. doi 10.1093/plphys/kiac527

Mehra P, Pandey BK, Melebari D, Banda J, Leftley N, Couvreur V, Rowe J, Anfang M, De Gernier H, Morris E, Sturrock CJ, Mooney SJ, Swarup R, Faulkner C, Beeckman T, Bhalerao RP, Shani E, Jones AM, Dodd IC, Sharp RE, Sadanandom A, Draye X, Bennett MJ. *Hydraulic flux–responsive hormone redistribution determines root branching*. **Science**. (2022); **378**: 762-8. doi 10.1126/science.add3771

Miao R, Siao W, Zhang N, Lei Z, Lin D, Bhalerao RP, Lu C, Xu W. *Katanin-Dependent Microtubule Ordering in Association with ABA Is Important for Root Hydrotropism*. **International Journal of Molecular Sciences**. (2022); **23**. doi 10.3390/ijms23073846

Nagahage ISP, Matsuda K, Miyashita K, Fujiwara S, Mannapperuma C, Yamada T, Sakamoto S, Ishikawa T, Nagano M, Ohtani M, Kato K, Uchimiya H, Mitsuda N, Kawai-Yamada M, Demura T, Yamaguchi M. *NAC domain transcription factors VNI2 and ATAF2 form protein complexes and regulate leaf senescence*. **Plant Direct**. (2023); **7**. doi 10.1002/pld3.529

Nakano Y, Endo H, Gerber L, Hori C, Ihara A, Sekimoto M, Matsumoto T, Kikuchi J, Ohtani M, Demura T. *Enhancement of Secondary Cell Wall Formation in Poplar Xylem Using a Self-Reinforced System of Secondary Cell Wall-Related Transcription Factors*. **Frontiers in Plant Science**. (2022); **13**. doi 10.3389/fpls.2022.819360

Nasif SO, Siddique AB, Siddique AB, Islam MM, Hassan O, Deepo DM, Hossain A. *Prospects of endophytic fungi as a natural resource for the sustainability of crop production in the modern era of changing climate*. **Symbiosis**. (2023); **89**: 1-25. doi 10.1007/s13199-022-00879-4

Navarro-Quiles C, Mateo-Bonmatí E, Candela H, Robles P, Martínez-Laborda A, Fernández Y, Šimura J, Ljung K, Rubio V, Ponce MR, Micol JL. *The Arabidopsis ATP-Binding Cassette E protein ABCE2 is a conserved component of the translation machinery*. **Frontiers in Plant Science**. (2022); **13**. doi 10.3389/fpls.2022.1009895

Nguyen HTH, Chen ZQ, Fries A, Berlin M, Hallingbäck HR, Wu HX. *Effect of additive, dominant and epistatic variances on breeding and deployment strategy in Norway spruce*. **Forestry**. (2022); **95**: 416-27. doi 10.1093/forestry/cpab052

Nibbering P, Castilleux R, Wingsle G, Niittylä T. *CAGEs are Golgi-localized GT31 enzymes involved in cellulose biosynthesis in Arabidopsis*. **Plant Journal**. (2022); **110**: 1271-85. doi 10.1111/tpj.15734

Nickolov K, Gauthier A, Hashimoto K, Laitinen T, Väisänen E, Paasela T, Soliymani R, Kurusu T, Himanen K, Blokhina O, Fagerstedt KV, Jokipii-Lukkari S, Tuominen H, Häggman H, Wingsle G, Teeri TH, Kuchitsu K, Kärkönen A. *Regulation of PaRBOH1-mediated ROS production in Norway spruce by Ca2+ binding and phosphorylation*.

Frontiers in Plant Science. (2022); **13**. doi 10.3389/fpls.2022.978586

Nie S, Tian XC, Kong L, Zhao SW, Chen ZY, Jiao SQ, El-Kassaby YA, Porth I, Yang FS, Zhao W, Mao JF. *Potential allopolyploid origin of Ericales revealed with gene-tree reconciliation*. **Frontiers in Plant Science**. (2022); **13**. doi 10.3389/fpls.2022.1006904

Nie S, Zhao SW, Shi TL, Zhao W, Zhang RG, Tian XC, Guo JF, Yan XM, Bao YT, Li ZC, Kong L, Ma HY, Chen ZY, Liu H, El-Kassaby YA, Porth I, Yang FS, Mao JF. *Gapless genome assembly of azalea and multi-omics investigation into divergence between two species with distinct flower color*. **Horticulture Research**. (2023); **10**. doi 10.1093/hr/uhac241

Nie YM, Han FX, Ma JJ, Chen X, Song YT, Niu SH, Wu HX. *Genome-wide TCP transcription factors analysis provides insight into their new functions in seasonal and diurnal growth rhythm in Pinus tabuliformis*. **BMC Plant Biology**. (2022); **22**. doi 10.1186/s12870-022-03554-4

Nielsen UB, Hansen CB, Hansen U, Johansen VK, Egertsdotter U. *Accumulated effects of factors determining plant development from somatic embryos of Abies nordmanniana and Abies bornmuelleriana*. **Frontiers in Plant Science**. (2022); **13**. doi 10.3389/fpls.2022.989484

Nilsson O. *Winter dormancy in trees*. **Current Biology**. (2022); **32**: R630-R4. doi 10.1016/j.cub.2022.04.011

Niu S, Li J, Bo W, Yang W, Zuccolo A, Giacomello S, Chen X, Han F, Yang J, Song Y, Nie Y, Zhou B, Wang P, Zuo Q, Zhang H, Ma J, Wang J, Wang L, Zhu Q, Zhao H, Liu Z, Zhang X, Liu T, Pei S, Li Z, Hu Y, Yang Y, Li W, Zan Y, Zhou L, Lin J, Yuan T, Li W, Li Y, Wei H, Wu HX. *The Chinese pine genome and methylome unveil key features of conifer evolution*. **Cell**. (2022); **185**: 204-17.e14. doi 10.1016/j.cell.2021.12.006

Nookaraju A, Pandey SK, Ahlawat YK, Joshi CP. *Understanding the Modus Operandi of Class II KNOX Transcription Factors in Secondary Cell Wall Biosynthesis*. **Plants**. (2022); **11**. doi 10.3390/plants11040493

Norén Lindbäck L, Ji Y, Cervela-Cardona L, Jin X, Pedmale UV, Strand Å. *An interplay between bZIP16, bZIP68, and GBF1 regulates nuclear photosynthetic genes during photomorphogenesis in Arabidopsis*. **New Phytologist**. (2023); **240**: 1082-96. doi 10.1111/nph.19219

Ntefidou M, Eklund DM, Le Bail A, Schulmeister S, Scherbel F, Brandl L, Dörfler W, Eichstädt C, Bannmüller A, Ljung K, Kost B. *Physcomitrium patens PpRIC, an ancestral CRIB-domain ROP effector, inhibits auxin-induced differentiation of apical initial cells*. **Cell Reports**. (2023); **42**. doi 10.1016/j.celrep.2023.112130

Öhlund P, Delhomme N, Hayer J, Hesson JC, Blomström AL. *Transcriptome Analysis of an Aedes albopictus Cell Line Single-and Dual-Infected with Lammi Virus and WNV*. **International Journal of Molecular Sciences**. (2022); **23**. doi 10.3390/ijms23020875

Oikonomou VK, Dreier T, Sandéhn A, Mohammadi M, Christensen JL, Tybrandt K, Dahl AB, Dahl VA, Bech M, Stavrinidou E. *Elucidating the Bulk Morphology of Cellulose-Based Conducting Aerogels with X-Ray Microtomography*. **Advanced Materials Technologies**. (2023); **8**. doi 10.1002/admt.202300550

Ortiz R, Reslow F, Vetukuri R, García-Gil MR, Pérez-Rodríguez P, Crossa J. *Inbreeding Effects on the Performance and Genomic Prediction for Polysomic Tetraploid Potato Offspring Grown at High Nordic Latitudes*. **Genes**. (2023); **14**. doi 10.3390/genes14061302

Ortiz-García P, Pérez-Alonso MM, González Ortega-Villaizán A, Sánchez-Parra B, Ludwig-Müller J, Wilkinson MD, Pollmann S. *The Indole-3-Acetamide-Induced Arabidopsis Transcription Factor MYB74 Decreases Plant Growth and Contributes to the Control of Osmotic Stress Responses*. **Frontiers in Plant Science**. (2022); **13**. doi 10.3389/fpls.2022.928386

Pařízková B, Antoniadi I, Poxson DJ, Karady M, Simon DT, Zatloukal M, Strnad M, Doležal K, Novák O, Ljung K. *iP & OEIP – Cytokinin Micro Application Modulates Root Development with High Spatial Resolution*. **Advanced Materials Technologies**. (2022); **7**. doi 10.1002/admt.202101664

Pateras IS, Williams C, Gianniou DD, Margetis AT, Avgeris M, Rousakis P, Legaki AI, Mirtschink P, Zhang W, Panoutsopoulou K, Delis AD, Pagakis SN, Tang W, Ambs S, Warpman Berglund U, Helleday T, Varvarigou A, Chatzigeorgiou A, Nordström A, Tsitsilonis OE, Trougakos IP, Gilthorpe JD, Frisan T. *Short term starvation potentiates the efficacy of chemotherapy in triple negative breast cancer via metabolic reprogramming*. **Journal of Translational Medicine**. (2023); **21**. doi 10.1186/s12967-023-03935-9

Pérez-Alonso MM, Guerrero-Galán C, González Ortega-Villaizán A, Ortiz-García P, Scholz SS, Ramos P, Sakakibara H, Kiba T, Ludwig-Müller J, Krapp A, Oelmüller R, Vicente-Carbajosa J, Pollmann S. *The calcium sensor CBL7 is required for Serendipita indica-induced growth stimulation in Arabidopsis thaliana, controlling defense against the endophyte and K+ homoeostasis in the symbiosis*. **Plant Cell and Environment**. (2022); **45**: 3367-82. doi 10.1111/pce.14420

Pérez-García F, Brito LF, Irla M, Jorge JMP, Sgobba E. *Editorial: Promising and sustainable microbial feedstocks for biotechnological processes*. **Frontiers in Microbiology**. (2022); **13**. doi 10.3389/fmicb.2022.973723 EDITORIAL

Pervaiz T, Amjid MW, El-Kereamy A, Niu SH, Wu HX. *Microrna and cdna-microarray as potential targets against abiotic stress response in plants: Advances and prospects*. **Agronomy**. (2022); **12**. doi 10.3390/agronomy12010011

Peters A, Rabe P, Liebing A-D, Krumbholz P, Nordstrom A, Jager E, Kraft R, Staeubert C. *Hydroxycarboxylic acid receptor 3 and GPR84-Two metabolite-sensing G protein-coupled receptors with opposing functions in innate immune cells *. **Pharmacological Research**. (2022). doi 10.1016/j.phrs.2021.106047

Pitsili E, Rodriguez-Trevino R, Ruiz-Solani N, Demir F, Kastanaki E, Dambire C, de Pedro-Jové R, Vercammen D, Salguero-Linares J, Hall H, Mantz M, Schuler M, Tuominen H, Van Breusegem F, Valls M, Munné-Bosch S, Holdsworth MJ, Huesgen PF, Rodriguez-Villalon A, Coll NS. *A phloem-localized Arabidopsis metacaspase (AtMC3) improves drought tolerance*. **New Phytologist**. (2023); **239**: 1281-99. doi 10.1111/nph.19022

Pramod S, Anju M, Rajesh H, Thulaseedharan A, Rao KS. *Effect of Exogenously Applied 24-Epibrassinolide and Brassinazole on Xylogenesis and Microdistribution of Cell Wall Polymers in Leucaena leucocephala (Lam) De Wit*. **Journal of Plant Growth Regulation**. (2022); **41**: 404-16. doi 10.1007/s00344-021-10313-6

Priebe J, Hallberg-Sramek I, Reimerson E, Mårald E. *The spectrum of knowledge: integrating knowledge dimensions in the context of forests and climate change*. **Sustainability Science**. (2023); **18**: 1329-41. doi 10.1007/s11625-023-01309-0

Priebe J, Reimerson E, Hallberg-Sramek I, Sténs A, Sandström C, Mårald E. *Transformative change in context : stakeholders' understandings of leverage at the forest–climate nexus*. **Sustainability Science**. (2022); **17**: 1921-38. doi 10.1007/s11625-022-01090-6

Przybyla-Toscano J, Maclean AE, Franceschetti M, Liebsch D, Vignols F, Keech O, Rouhier N, Balk J. *Protein lipoylation in mitochondria requires Fe–S cluster assembly factors NFU4 and NFU5*. **Plant Physiology**. (2022); **188**: 997-1013. doi 10.1093/plphys/kiab501

Rabe P, Gehmlich M, Peters A, Krumbholz P, Nordstrom A, Staeubert C. *Combining metabolic phenotype determination with metabolomics and transcriptional analyses to reveal pathways regulated by hydroxycarboxylic acid receptor 2*. **Hormones and Cancer**. (2022). doi 10.1007/s12672-022-00503-3

Raizada R, Gaur RK, Albrectsen BR. *Recursive partitioning to prioritize morphometric traits that separate Aspen specialist Chaitophorus aphid by species and stage*. **International Journal of Tropical Insect Science**. (2022); **42**: 941-6. doi 10.1007/s42690-021-00620-6

Ranade SS, García-Gil MR. *Clinal variation in PHY (PAS domain) and CRY (CCT domain)—Signs of local adaptation to light quality in Norway spruce*. **Plant Cell and Environment**. (2023); **46**: 2391-400. doi 10.1111/pce.14638

Ranade SS, Seipel G, Gorzsás A, García-Gil MR. *Adaptive strategies of Scots pine under shade : Increase in lignin synthesis and ecotypic variation in defense-related gene expression*. **Physiologia Plantarum**. (2022); **174**. doi 10.1111/ppl.13792

Ranade SS, Seipel G, Gorzsás A, García-Gil MR. *Enhanced lignin synthesis and ecotypic variation in defense-related gene expression in response to shade in Norway spruce*. **Plant, Cell and Environment**. (2022); **45**: 2671-81. doi 10.1111/pce.14387

Ranjan A, Perrone I, Alallaq S, Singh R, Rigal A, Brunoni F, Chitarra W, Guinet F, Kohler A, Martin F, Street NR, Bhalerao R, Legué V, Bellini C. *Molecular basis of differential adventitious rooting competence in poplar genotypes*. **Journal of Experimental Botany**. (2022); **73**: 4046-64. doi 10.1093/jxb/erac126

Rodríguez BD, Kloth KJ, Albrectsen BR. *Effects of condensed tannins on behavior and performance of a specialist aphid on aspen*. **Ecology and Evolution**. (2022); **12**. doi 10.1002/ece3.9229

Röhricht H, Przybyla-Toscano J, Forner J, Boussardon C, Keech O, Rouhier N, Meyer EH. *Mitochondrial ferredoxin-like is essential for forming complex I-containing supercomplexes in Arabidopsis*. **Plant Physiology**. (2023); **191**: 2170-84. doi 10.1093/plphys/kiad040

Routier C, Vallan L, Daguerre Y, Juvany M, Istif E, Mantione D, Brochon C, Hadziioannou G, Strand I, Näsholm T, Cloutet E, Pavlopoulou E, Stavrinidou E. *Chitosan-Modified Polyethyleneimine Nanoparticles for Enhancing the Carboxylation Reaction and Plants' CO2 Uptake*. **ACS Nano**. (2023); **17**: 3430-41. doi 10.1021/acsnano.2c09255

Sági-Kazár M, Sárvári É, Cseh B, Illés L, May Z, Hegedűs C, Barócsi A, Lenk S, Solymosi K, Solti Á. *Iron uptake of etioplasts is independent from photosynthesis but applies the reduction-based strategy*. **Frontiers in Plant Science**. (2023); **14**. doi 10.3389/fpls.2023.1227811

Sasaki T, Saito K, Inoue D, Serk H, Sugiyama Y, Pesquet E, Shimamoto Y, Oda Y. *Confined-microtubule assembly shapes three-dimensional cell wall structures in xylem vessels*. **Nature Communications**. (2023); **14**. doi 10.1038/s41467-023-42487-w

Schiffthaler B, van Zalen E, Serrano AR, Street NR, Delhomme N. *Seiðr: Efficient calculation of robust ensemble gene networks*. **Heliyon**. (2023); **9**. doi 10.1016/j.heliyon.2023.e16811

Sharma M, Marhava P. *Regulation of PIN polarity in response to abiotic stress*. **Current Opinion in Plant Biology**. (2023); **76**. doi 10.1016/j.pbi.2023.102445

Shi TL, Ma HY, Wang X, Liu H, Yan XM, Tian XC, Li ZC, Bao YT, Chen ZY, Zhao SW, Xiang Q, Jia KH, Nie S, Guan W, Mao JF. *Differential gene expression and potential regulatory network of fatty acid biosynthesis during fruit and leaf development in yellowhorn (Xanthoceras sorbifolium), an oil-producing tree with significant deployment values*. **Frontiers in Plant Science**. (2023); **14**: 1297817. doi 10.3389/fpls.2023.1297817

Shukla P, Kidwai M, Narayan S, Shirke PA, Pandey KD, Misra P, Chakrabarty D. *Phytoremediation potential of Solanum viarum Dunal and functional aspects of their capitate glandular trichomes in lead, cadmium, and zinc detoxification*. **Environmental Science and Pollution Research**. (2023); **30**: 41878-99. doi 10.1007/s11356-023-25174-7

Siddique AB, Albrectsen BR, Ilbi H, Siddique AB. *Optimization of Protocol for Construction of Fungal ITS Amplicon Library for High-Throughput Illumina Sequencing to Study the Mycobiome of Aspen Leaves*. **Applied Sciences (Switzerland)**. (2022); **12**. doi 10.3390/app12031136

Siddique AB, Menke L, Dinedurga M, Albrectsen BR. *Molecular studies of rust on European aspen suggest an autochthonous relationship shaped by genotype*. **Frontiers in Plant Science**. (2023); **14**. doi 10.3389/fpls.2023.1111001

Singh RK, Bhalerao RP, Maurya JP. *When to branch: seasonal control of shoot architecture in trees*. **FEBS Journal**. (2022); **289**: 8062-70. doi 10.1111/febs.16227

Sipari N, Lihavainen J, Keinänen M. *Metabolite Profiling of Paraquat Tolerant Arabidopsis thaliana Radical-induced Cell Death1 (rcd1)—A Mediator of Antioxidant Defence Mechanisms*. **Antioxidants**. (2022); **11**. doi 10.3390/antiox11102034

Sivan P, Heinonen E, Latha Gandla M, Jiménez-Quero A, Özeren HD, Jönsson LJ, Mellerowicz EJ, Vilaplana F. *Sequential extraction of hemicelluloses by subcritical water improves saccharification of hybrid aspen wood grown in greenhouse and field conditions*. **Green Chemistry**. (2023); **25**: 5634-46. doi 10.1039/d3gc01020a

Skalický V, Antoniadi I, Pěnčík A, Chamrád I, Lenobel R, Kubeš MF, Zatloukal M, Žukauskaitė A, Strnad M, Ljung K, Novák O. *Fluorescence-activated multi-organelle mapping of subcellular plant hormone distribution*. **Plant Journal**. (2023); **116**: 1825-41. doi 10.1111/tpj.16456

Small L, Ehrlich A, Iversen J, Ashcroft SP, Trost K, Moritz T, Hartmann B, Holst JJ, Treebak JT, Zierath JR, Barres R. *Comparative analysis of oral and intraperitoneal glucose tolerance tests in mice*. **Molecular Metabolism**. (2022). doi 10.1016/j.molmet.2022.101440

Sollis E, den Hoed J, Quevedo M, Estruch SB, Vino A, Dekkers DHW, Demmers JAA, Poot R, Deriziotis P, Fisher SE. *Characterization of the TBR1 interactome: variants associated with neurodevelopmental disorders disrupt novel protein interactions*. **Human Molecular Genetics**. (2023); **32**: 1497-510. doi 10.1093/hmg/ddac311

Soni N, Bacete L. *The interplay between cell wall integrity and cell cycle progression in plants*. **Plant Molecular Biology**. (2023); **113**: 367-82. doi 10.1007/s11103-023-01394-w

Stavrinidou E, Dufil G, Bernacka-Wojcik I, Armada-Moreira A. *Plant Bioelectronics and Biohybrids: The Growing Contribution of Organic Electronic and Carbon-Based Materials*. **Chemical Reviews**. (2022). doi 10.1021/acs.chemrev.1c00525

Su C, Kokosza A, Xie X, Pěnčík A, Zhang Y, Raumonen P, Shi X, Muranen S, Topcu MK, Immanen J, Hagqvist R, Safronov O, Alonso-Serra J, Eswaran G, Venegas MP, Ljung K, Ward S, Mähönen AP, Himanen K, Salojärvi J, Fernie AR, Novák O, Leyser O, Pałubicki W, Helariutta Y, Nieminen K. *Tree architecture: A strigolactone-deficient mutant reveals a connection between branching order and auxin gradient along the tree stem*. **Proceedings of the National Academy of Sciences of the United States of America**. (2023); **120**. doi 10.1073/pnas.2308587120

Sun Y, Wang B, Ren J, Zhou Y, Han Y, Niu S, Zhang Y, Shi Y, Zhou J, Yang C, Ma X, Liu X, Luo Y, Jin C, Luo J. *OsbZIP18, a Positive Regulator of Serotonin Biosynthesis, Negatively Controls the UV-B Tolerance in Rice*. **International Journal of Molecular Sciences**. (2022); **23**. doi 10.3390/ijms23063215

Svennerstam H, Jämtgård S. *Timing is everything – obtaining accurate measures of plant uptake of amino acids*. **New Phytologist**. (2022); **234**: 311-8. doi 10.1111/nph.17964

Svensson C, Bader MKF, Forsmark B, Nilsson U, Lundmark T, Nordin A, Bergh J. *Early and repeated nutrient additions support far greater stemwood production in Norway spruce than traditional late-rotation fertilisation*. **Forest Ecology and Management**. (2023); **549**. doi 10.1016/j.foreco.2023.121425

Tan B, Ingvarsson PK. *Integrating genome-wide association mapping of additive and dominance genetic effects to improve genomic prediction accuracy in Eucalyptus*. **Plant Genome**. (2022); **15**. doi 10.1002/tpg2.20208

Templalexis D, Tsitsekian D, Liu C, Daras G, Simura J, Moschou P, Ljung K, Hatzopoulos P, Rigas S. *Potassium transporter TRH1/KUP4 contributes to distinct auxin-mediated root system architecture responses*. **Plant Physiology**. (2022); **188**: 1043-60. doi 10.1093/plphys/kiab472

Tian XC, Guo JF, Yan XM, Shi TL, Nie S, Zhao SW, Bao YT, Li ZC, Kong L, Su GJ, Mao JF, Lin J. *Unique gene duplications and conserved microsynteny potentially associated with resistance to wood decay in the Lauraceae*. **Frontiers in Plant Science**. (2023); **14**. doi 10.3389/fpls.2023.1122549

Tiret M, Olsson L, Grahn T, Karlsson B, Milesi P, Lascoux M, Lundqvist SO, García-Gil MR. *Divergent selection predating the Last Glacial Maximum mainly acted on macro-phenotypes in Norway spruce*. **Evolutionary Applications**. (2023); **16**: 163-72. doi 10.1111/eva.13519

Tünnermann L, Colou J, Näsholm T, Gratz R. *To have or not to have: expression of amino acid transporters during pathogen infection*. **Plant Molecular Biology**. (2022); **109**: 413-25. doi 10.1007/s11103-022-01244-1

Urbancsok J, Donev EN, Sivan P, van Zalen E, Barbut FR, Derba-Maceluch M, Šimura J, Yassin Z, Gandla ML, Karady M, Ljung K, Winestrand S, Jönsson LJ, Scheepers G, Delhomme N, Street NR, Mellerowicz EJ. *Flexure wood formation via growth reprogramming in hybrid aspen involves jasmonates and polyamines and transcriptional changes resembling tension wood development*. **New Phytologist**. (2023); **240**: 2312-34. doi 10.1111/nph.19307

van Dijk LJA, Regazzoni EDE, Albrectsen BR, Ehrlén J, Abdelfattah A, Stenlund H, Pawlowski K, Tack AJM. *Single, but not dual, attack by a biotrophic pathogen and a sap-sucking insect affects the oak leaf metabolome*. **Frontiers in Plant Science**. (2022); **13**. doi 10.3389/fpls.2022.897186

Vélëz H, Gauchan DP, García-Gil MDR. *Taxol and ß-tubulins from endophytic fungi isolated from the Himalayan Yew, Taxus wallichiana Zucc*. **Frontiers in Microbiology**. (2022); **13**. doi 10.3389/fmicb.2022.956855

Vergara A, Haas JC, Aro T, Stachula P, Street N, Hurry V. *Norway spruce deploys tissue-specific responses during acclimation to cold*. **Plant, Cell and Environment**. (2022); **45**: 427-45. doi 10.1111/pce.14241

Vukašinović N, Serif M, Bacete L. *Cracking the green wall code: insights into cell wall integrity across organisms*. **Frontiers in Plant Physiology**. (2023); **1**. doi 10.3389/fphgy.2023.1323899

Walker CH, Ware A, Simura J, Ljung K, Wilson Z, Bennett T. *Cytokinin signaling regulates two-stage inflorescence arrest in Arabidopsis*. **Plant Physiology**. (2023); **191**: 479-95. doi 10.1093/plphys/kiac514

Wang L, Li LL, Chen L, Zhang RG, Zhao SW, Yan H, Gao J, Chen X, Si YJ, Chen Z, Liu H, Xie XM, Zhao W, Han B, Qin X, Jia KH. *Telomere-to-telomere and haplotype-resolved genome assembly of the Chinese cork oak (Quercus variabilis)*. **Frontiers in Plant Science**. (2023); **14**. doi 10.3389/fpls.2023.1290913

Wang W, Talide L, Viljamaa S, Niittylä T. *Aspen growth is not limited by starch reserves*. **Current Biology**. (2022); **32**: 3619-27.e4. doi 10.1016/j.cub.2022.06.056

Wang W, Viljamaa S, Hodek O, Moritz T, Niittylä T. *Sucrose synthase activity is not required for cellulose biosynthesis in Arabidopsis*. **Plant Journal**. (2022); **110**: 1493-7. doi 10.1111/tpj.15752

Wang WB, He XF, Yan XM, Ma B, Lu CF, Wu J, Zheng Y, Wang WH, Xue WB, Tian XC, Guo JF, El-Kassaby YA, Porth I, Leng PS, Hu ZH, Mao JF. *Chromosome-scale genome assembly and insights into the metabolome and gene regulation of leaf color transition in an important oak species, Quercus dentata*. **New Phytologist**. (2023); **238**: 2016-32. doi 10.1111/nph.18814

Wang X, Ingvarsson PK. *Quantifying adaptive evolution and the effects of natural selection across the Norway spruce genome*. **Molecular Ecology**. (2023); **32**: 5288-304. doi 10.1111/mec.17106

Wieloch T, Augusti A, Schleucher J. *A model of photosynthetic CO2 assimilation in C3 leaves accounting for respiration and energy recycling by the plastidial oxidative pentose phosphate pathway*. **New Phytologist**. (2023); **239**: 518-32. doi 10.1111/nph.18965

Witzell J, Decker VHG, Agostinelli M, Romeralo C, Cleary M, Albrectsen BR. *Aspen Leaves as a "Chemical Landscape" for Fungal Endophyte Diversity—Effects of Nitrogen Addition*. **Frontiers in Microbiology**. (2022); **13**. doi 10.3389/fmicb.2022.846208

Wu H, Nilsson O. *Threatened forests: As the Northern forests suffer from the effects of climate change, genomics has great potential to help them adapt: As the Northern forests suffer from the effects of climate change, genomics has great potential to help them adapt*. **EMBO Reports**. (2023); **24**: e57106. doi 10.15252/embr.202357106

Xiao L, Fang Y, Zhang H, Quan M, Zhou J, Li P, Wang D, Ji L, Ingvarsson PK, Wu HX, El-Kassaby YA, Du Q, Zhang D. *Natural variation in the prolyl 4-hydroxylase gene PtoP4H9 contributes to perennial stem growth in Populus*. **Plant Cell**. (2023); **35**: 4046-65. doi 10.1093/plcell/koad212

Xu J, Luo H, Zhou S-S, Jiao S-Q, Jia K-H, Nie S, Liu H, Zhao W, Wang X-R, El-Kassaby YA, Porth I, Mao J-F. *UV-B and UV-C radiation trigger both common and distinctive signal perceptions and transmissions in Pinus tabuliformis Carr*. **Tree Physiology**. (2022); **42**: 1587-600. doi 10.1093/treephys/tpac021

Yan XM, Zhou SS, Liu H, Zhao SW, Tian XC, Shi TL, Bao YT, Li ZC, Jia KH, Nie S, Guo JF, Kong L, Porth IM, Mao JF. *Unraveling the evolutionary dynamics of the TPS gene family in land plants*. **Frontiers in Plant Science**. (2023); **14**. doi 10.3389/fpls.2023.1273648

Yang T, Zhang R, Tian X, Yao G, Shen Y, Wang S, Mao J, Li G, Liu A, Sun W, Ma Y. *The chromosome-level genome assembly and genes involved in biosynthesis of nervonic acid of Malania oleifera*. **Scientific Data**. (2023); **10**: 298. doi 10.1038/s41597-023-02218-8

Yu G, Hao J, Pan X, Shi L, Zhang Y, Wang J, Fan H, Xiao Y, Yang F, Lou J, Chang W, Malnoë A, Li M. *Structure of Arabidopsis SOQ1 lumenal region unveils C-terminal domain essential for negative regulation of photoprotective qH*. **Nature Plants**. (2022); **8**: 840-55. doi 10.1038/s41477-022-01177-z

Zacharaki V, Meena SK, Kindgren P. *The non-coding RNA*

SVALKA locus produces a cis-natural antisense transcript that negatively regulates the expression of CBF1 and biomass production at normal temperatures. **Plant Communications**. (2023); **4**. doi 10.1016/j.xplc.2023.100551

Zacharaki V, Ponnu J, Crepin N, Langenecker T, Hagmann J, Skorzinski N, Musialak-Lange M, Wahl V, Rolland F, Schmid M. *Impaired KIN10 function restores developmental defects in the Arabidopsis trehalose 6-phosphate synthase1 (tps1) mutant*. **New Phytologist**. (2022); **235**: 220-33. doi 10.1111/nph.18104

Zeng Y, Verstraeten I, Trinh HK, Lardon R, Schotte S, Olatunji D, Heugebaert T, Stevens C, Quareshy M, Napier R, Nastasi SP, Costa A, De Rybel B, Bellini C, Beeckman T, Vanneste S, Geelen D. *Chemical induction of hypocotyl rooting reveals extensive conservation of auxin signalling controlling lateral and adventitious root formation*. **New Phytologist**. (2023); **240**: 1883-99. doi 10.1111/nph.19292

Zhao B, Bian L, Feng Q, Wu J, Zhang X, Zheng R, Zheng X, Yang Z, Chen Z, Wu HX, Shi J. *Development of an Advanced-Generation Multi-Objective Breeding Population for the 4th Cycle of Chinese Fir (Cunninghamia lanceolata (Lamb.) Hook.)*. **Forests**. (2023); **14**. doi 10.3390/f14081658

Zhao SW, Guo JF, Kong L, Nie S, Yan XM, Shi TL, Tian XC, Ma HY, Bao YT, Li ZC, Chen ZY, Zhang RG, Ma YP, El-Kassaby YA, Porth I, Zhao W, Mao JF. *Haplotype-resolved genome assembly of Coriaria nepalensis a non-legume nitrogen-fixing shrub*. **Scientific Data**. (2023); **10**: 259. doi 10.1038/s41597-023-02171-6

Zhou Y, Zhang Z, Bao Z, Li H, Lyu Y, Zan Y, Wu Y, Cheng L, Fang Y, Wu K, Zhang J, Lyu H, Lin T, Gao Q, Saha S, Mueller L, Fei Z, Städler T, Xu S, Zhang Z, Speed D, Huang S. *Graph pangenome captures missing heritability and empowers tomato breeding*. **Nature**. (2022); **606**: 527-34. doi 10.1038/s41586-022-04808-9

Zuch DT, Doyle SM, Majda M, Smith RS, Robert S, Torii KU. *Cell biology of the leaf epidermis: Fate specification, morphogenesis, and coordination*. **Plant Cell**. (2022); **34**: 209-27. doi 10.1093/plcell/koab250

Žukauskaitė A, Saiz-Fernández I, Bieleszová K, Iškauskienė M, Zhang C, Smýkalová I, Dzedulionytė K, Kubeš MF, Sedlářová M, Pařízková B, Pavlović I, Vain T, Petřík I, Malinauskienė V, Šačkus A, Strnad M, Robert S, Napier R, Novák O, Doležal K. *New PEO-IAA-Inspired Anti-Auxins: Synthesis, Biological Activity, and Possible Application in Hemp (Cannabis Sativa L.) Micropropagation*. **Journal of Plant Growth Regulation**. (2023); **42**: 7547-63. doi 10.1007/s00344-023-11031-x

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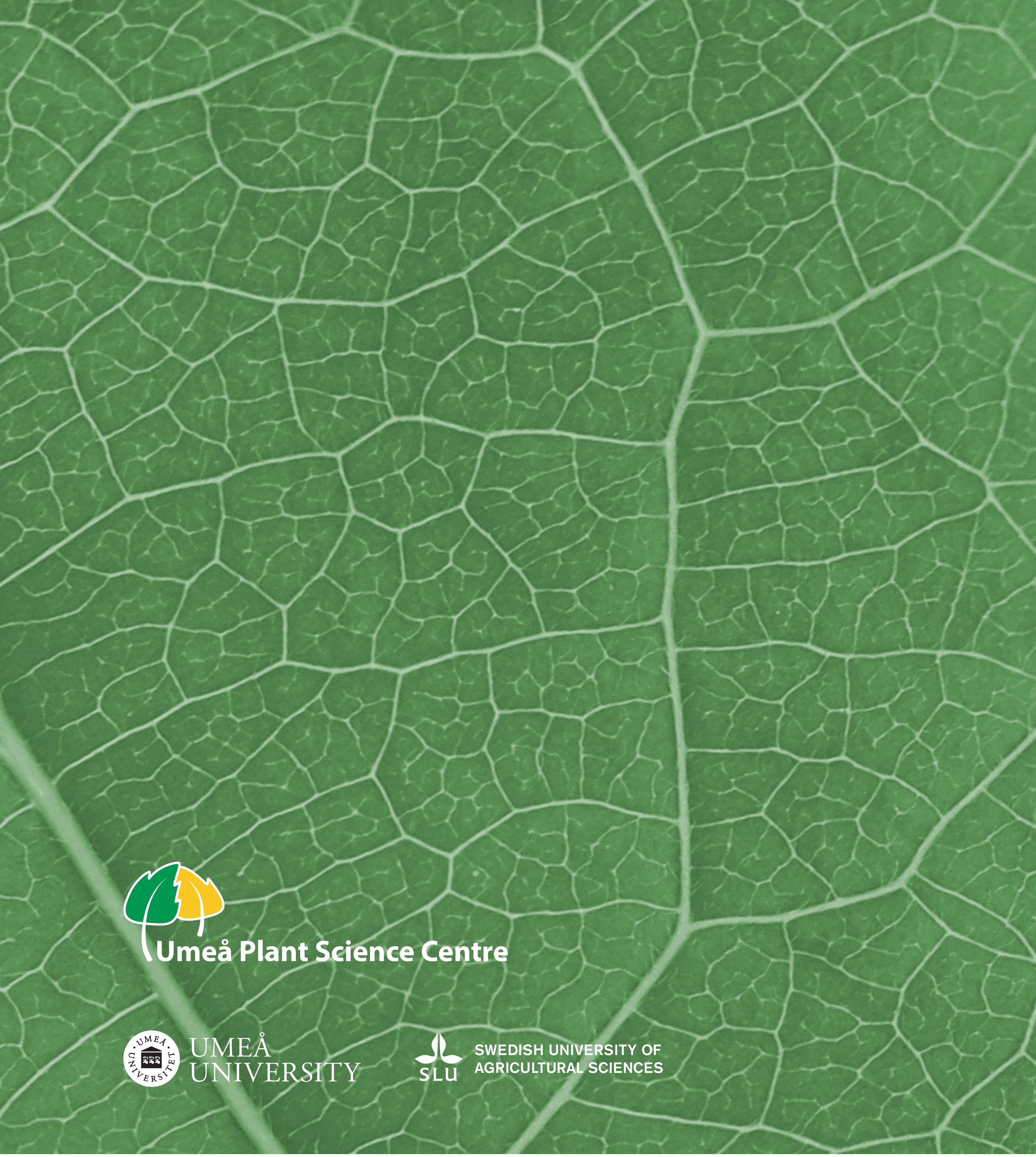

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