

# NEWSLETTER

2012/22

## Editorial



Photo Juanita Schläpfer

Over the last fourteen years, the PSC has developed a reputation for its high quality seminars and symposiums for specialist scientific audiences. This tradition will continue this October with the PSC

Symposium Trends and Advances in Plant Biology, and in November, the PSC PhD students have organized an illustrious list of speakers for their symposium “Plants Replacing Fossil Fuels?”

With the launch of the Plant Science Expeditions Program funded by the SNSF, the PSC is reaching out to new audiences. I am very pleased to have been appointed coordinator of the program, which aims to communicate plant breeding for the future, and global changes in the Swiss Alps, to families with children aged 10–16. This is a challenging target group, but I am confident that with my background in museum pedagogy and informal science learning, we will be able to engage them in dialogue about the exciting research being done by PSC members. I am currently collecting input from research teams and would like to hear from you if you are interested in joining us in the challenge of inspiring the next generation and awakening their interest in plant science.

Juanita Schläpfer

[juanita.schlaepfer@usys.ethz.ch](mailto:juanita.schlaepfer@usys.ethz.ch)

## Awards

Yann Hautier, Institute of Environmental Sciences, University of Zurich, received a Marie Curie International Outgoing Fellowship for Career Development (IOF) for the project “GLOBEPURE – Global drivers of loss of biodiversity with eutrophication and their potential use for restoration ecology”. (Andy Hector group)

Sebastian Wolf received a Marie Curie Fellowship for the project „ECOWAX – Evaluating the variability of ecosystem water vapour fluxes and spatiotemporal effects of extreme events”. (Nina Buchman group)



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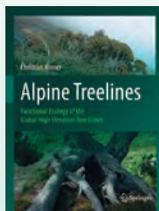
## Upcoming events

**Challenges in Plant Sciences – PSC Colloquium, 26 September & 6 November 2012, ETH Zurich**

**Trends and Advances in Plant Biology – PSC Symposium, 19 October 2012, ETH Zurich, Semper Aula**

**Plants Replacing Fossil Fuels? – PSC PhD Symposium, 8 November 2012, ETH Zurich, Auditorium Maximum**

## Books



**Alpine Treelines – Functional Ecology of the Global High Elevation Tree Limits**

C Körner 2012. Springer Basel. ISBN 978-3-0348-0395-3. 220 p, CHF 93.50

Alpine treelines mark the low-temperature limit of tree growth and occur in mountains world-wide. Presenting a companion to his book *Alpine Plant Life*, Christian Körner provides a global synthesis of the treeline phenomenon from sub-arctic to equatorial latitudes and a functional explanation based on the biology of trees.

## PLANT FELLOWS, second call

**International Post doc Fellowship Programme in Plant Sciences**

The second call will be open from 1 November 2012 until 31 January 2013.

Application templates and guidelines can be found on [www.plantfellows.ch](http://www.plantfellows.ch).

# RESEARCH

## Syngenta projects

This section presents results from a project that investigated the diversity of plant carbohydrates storage and was funded by the PSC–Syngenta research fellowship program. It was a postdoc project of Sylvain Bischof, with Prof. Samuel Zeeman and Prof. Wilhelm Gruissem, both at the Institute of Agricultural Sciences, ETH Zurich.

### Metabolic reprogramming of carbohydrate storage from starch to glycogen in *Cecropia peltata* revealed by RNA-seq and quantitative proteomics

Glycogen and starch are the most widespread storage carbohydrates in living organisms. The archaea, bacteria, and many eukaryotes (including yeast, fungi, and animals) accumulate glycogen, while plants make starch. However, there are a few exceptions to this rule, including the fast-growing pioneer tree native to the subtropical regions, *Cecropia peltata*. *C. peltata* is known for its invasive nature, the medicinal properties of its leaf extracts, and for its myrmecophytic lifestyle, sharing a symbiotic relationship with stinging ants. The ants feed on Müllerian bodies – specialized multicellular egg-like structures produced on pads of tissue at the petiole-stem interface called trichilia. Müllerian bodies accumulate large amounts of a soluble, glycogen-like polysaccharide in spherical plastids, while the chloroplasts in leaves synthesise starch. The ability of plants to synthesise starch evolved from an ancestral capacity to make glycogen, and the biosynthetic enzymes are a mosaic derived from the host and cyanobacterial endosymbiont genomes. Both storage carbohydrates are composed of glucose polymers, but differences in their specific structure determine their physicochemical properties. Starch has rather long glucan chains that are organized in semi-crystalline granules. Glycogen exhibits shorter chains and a higher frequency of branch points, and is soluble. A set of synthases, branching and debranching enzymes, elongate, branch and debranch glucans, thus controlling starch and glycogen biosynthesis. However, it remains unclear how the specialized isoforms of these enzymes work together to determine carbohydrate architecture and, therefore, the capacity to synthesise starch rather than glycogen. *C. peltata* provides a unique natural system that offers an understanding of how the biosynthetic machinery can be qualitatively and quantitatively re-configured to make different amounts of either polymer.

In this project, we combined microscopy, biochemistry and high-throughput profiling technologies to investigate how *C. peltata* configures its biosynthetic machinery in Müllerian bodies and leaves. Electron micrographs, sugar and glucan measurements showed that soluble sugars and phyto-glycogen accumulated to very high levels in Müllerian bodies, but not in leaves. Structural characterization of extracted soluble and insoluble carbohydrates confirmed that the glycogen has greater numbers of short oligosaccharide branches than the leaf starch. To reveal changes in the key biosynthetic enzymes (starch synthases, branching enzymes and debranching enzymes), we undertook integrated RNA-seq and quantitative shotgun proteomics approaches in Müllerian bodies and leaves. First, we de-novo assembled a transcriptional map based on long 454 reads and obtained quantitative information on transcripts by Illumina sequencing. Next, we applied label-free quantitative proteomics to obtain insight into the metabolic networks of Müllerian bodies and leaves. We observed major differences in the expression of specific isoforms of starch synthases, branching enzymes and debranching enzymes, both at transcript and protein level. These results allow us to understand how the plant determines its storage carbohydrate structure. The newly-achieved balance of enzymes constitutes a natural archetype for future biotechnological reprogramming of storage carbohydrate synthesis in crops. Our data also provide a valuable resource for the study of *C. peltata*, which is both a troublesome invasive species and a potential biomedical crop.

Sylvain Bischof, Wilhelm Gruissem & Samuel Zeeman, *Institute of Agricultural Sciences, ETH Zurich*

#### Relevant Publications

Zeeman SC, Kossmann J, Smith AM. Starch: its metabolism, evolution, and biotechnological modification in plants. *Annu Rev Plant Biol.* 2010; 61: 209–34.

Rickson, FR. Glycogen Plastids in Mullerian Body Cells of *Cecropia peltata* – A Higher Green Plant. *Science* 1971; 173: 344–7.

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# EDUCATION

## PSC PhD-courses, fall term 2012

- Introductory Course to R, 17–19 Sep 2012
- Scientific Writing Practice 1, 21 Sep & 12 Oct 2012
- Plant Science & Policy: Stakeholder Engagement, 25 Sep & 26 Oct 2012
- Colloquium – Challenges in Plant Sciences, 26 Sep & 6 Nov 2012
- Radioisotopes in Plant Nutrition, 5/12/19/26 Oct, 9/16 Nov, 7/14 Dec 2012
- Sustainable Plant Systems (Online Course/Seminar), 8 Oct & 10 Dec 2012
- Practical Application of Chlorophyll Fluorescence Analysis, 15 & 16 Oct 2012
- Training Course in Meta-Analysis, 22–24 Oct 2012
- Genetic Diversity: Techniques, 1 & 22 Nov 2012
- Statistical Methods in Molecular Biology, 8 & 9 Nov 2012
- Writing a Post-doctoral Grant, 27 & 28 Nov 2012
- Computational Biology, 5–7 Dec 2012
- Genetic Diversity: Techniques and Analysis, 14–18 Jan 2013

## PhD fellows are bridging sciences and policy

At the beginning of the 21st century, we are experiencing social, environmental and technological change at an unprecedented pace. These realities make it imperative to go further in encouraging fresh ideas and new ways of thinking, particularly in the areas of research, innovation and higher education. We need a forward-looking and proactive approach towards the challenges we face. It still holds true

that the best way of approaching future challenges is to get involved in confronting them actively and shaping them continuously. The ability of people to do this increasingly depends on their having received science-based training or education.

This is why the PSC and the Mercator Foundation Switzerland launched the transdisciplinary PSC–Mercator fellowship program. Our aim is to add value to both higher education and research efforts by stimulating initiatives that benefit the public at large, by helping to implement topical or structural innovation, and by contributing to the creation of a research-friendly society. We believe that it makes sense to engage in collaborative actions with universities, research organisations, governments and enterprises.

The Mercator Foundation Switzerland is proud to support the PSC in its main objective of promoting excellence in transdisciplinary research and teaching, and after meeting the four PhD fellows Tobias Bühlmann, John Garcia-Ulloa, Erin Gleeson and Sonja Hassold on the occasion of the PhD Symposium of Plant Science & Policy Fellowships in May 2012, I am excited by the prospect of learning more about their research in landscape management, biodiversity and environmental protection and of hearing, hopefully, about their fruitful collaboration with policy organizations.

*Beno Baumberger, Mercator Foundation Switzerland*

**Contact PSC Plant Science & Policy PhD Program:**  
Andrea Pfisterer, [andrea.pfisterer@ipw.biol.ethz.ch](mailto:andrea.pfisterer@ipw.biol.ethz.ch)



Group picture, PhD Symposium of Plant Science & Policy Fellowships. May 9, 2012

# SCIENCE HIGHLIGHTS

**Nature 483:341–344 (2012)**

## **A *petunia* ABC protein controls strigolactone-dependent symbiotic signalling and branching**

*Kretschmar T, Kohlen W, Sasse J, Borghi L, Schlegel M, Bachelier JB, Reinhard D, Bours R, Bouwmeester HJ, Martinoia E*

Strigolactones were originally identified as stimulators of the germination of root-parasitic weeds that pose a serious threat to resource-limited agriculture. They are mostly exuded from roots and function as signalling compounds in the initiation of arbuscular mycorrhizae, which are plant–fungus symbionts with a global effect on carbon and phosphate cycling. Recently, it was established that strigolactones are phytohormones that regulate plant shoot architecture by inhibiting the outgrowth of axillary buds. Despite their importance, it is not known how strigolactones are transported. ATP-binding cassette (ABC) transporters, however, are known to have functions in phytohormone translocation. Here, we show that the *Petunia hybrida* ABC transporter PDR1 has a key role in regulating the development of arbuscular mycorrhizae and axillary branches, by functioning as a cellular strigolactone exporter. *P. hybrida* pdr1 mutants are defective in strigolactone exudation from their roots, resulting in reduced symbiotic interactions. Above ground, pdr1 mutants have an enhanced branching phenotype, which is indicative of impaired strigolactone allocation. Overexpression of *Petunia axillaris* PDR1 in *Arabidopsis thaliana* results in increased tolerance of high concentrations of a synthetic strigolactone, consistent with increased export of strigolactones from the roots. PDR1 is the first known component in strigolactone transport, providing new opportunities for investigating and manipulating strigolactone-dependent processes.

**Science 335:1344–1347 (2012)**

## **Climatic Niche Shifts Are Rare Among Terrestrial Plant Invaders**

*Petitpierre B, Kueffer C, Broennimann O, Randin C, Daehler C, Guisan A*

The assumption that climatic niche requirements of invasive species are conserved between their native and invaded ranges is key to predicting the risk of invasion. However, this assumption has been challenged recently by evidence of niche shifts in some species. Here, we report the first large-scale test of niche conservatism for 50 terrestrial plant invaders between Eurasia, North America, and Australia.

We show that when analog climates are compared between regions, fewer than 15% of species have more than 10% of their invaded distribution outside their native climatic niche. These findings reveal that substantial niche shifts are rare in terrestrial plant invaders, providing support for an appropriate use of ecological niche models for the prediction of both biological invasions and responses to climate change.

**PLoS Biology 10(4): APR 2012**

## **Rapid De Novo Evolution of X Chromosome Dosage Compensation in *Silene latifolia*, a Plant with Young Sex Chromosomes**

*Muyle A, Zemp N, Deschamps C, Mousset S, Widmer A, Marais GAB*

**Current Biology 22(13) (2012)**

## **AtABCG29 Is a Monolignol Transporter Involved in Lignin Biosynthesis**

*Alejandro S, Lee Y, Tohge T, Sudre D, Osorio S, Park J, Bovet L, Lee Y, Geldner N, Fernie AR, Martinoia E*



**PSC website**  
[www.plantsciences.ch](http://www.plantsciences.ch)

# PSC MEMBER

## Professor Jonathan Levine: new PSC member



Photo Susi Lindig

Research in our plant ecology group examines leading questions at the interface of plant population and community ecology. Though I am primarily an empirical ecologist, the approaches we take often have population

models at their core, allowing rigorous links between theoretical concepts and the dynamics of plants in their natural environment. Over the last ten years, our research has focused on two primary themes: (1) the maintenance of species diversity and (2) the controls over the spread and impact of biological invasions.

Our research into the maintenance of species diversity generally combines experiments and models to explore the role of niche differences in regulating species coexistence. Our recent work examines how differences between species in their functional traits and patterns of relatedness determine the outcome of competition. These projects have taken advantage of annual plant communities in California, where population models can reasonably describe community dynamics, but we are now shifting focus to communities of annual weeds in Switzerland. Projects just underway are exploring the role of variation within species, natural selection, and climate driven phenological shifts in determining species-level coexistence.

In the area of biological invasions, our projects have explored all stages of the invasion process, from introduction through impact. Current work examines how habitat fragmentation influences the spread of invasive plants across landscapes and the persistence of native populations in invaded systems. This work combines mathematical theory with empirical approaches involving *Arabidopsis*, an experimental system in which we can quantify the ecological and evolutionary controls over invader spread. In other work, we are examining how genetic diversity influences the adaptive potential of invader populations, and how invader phenology regulates their establishment and impact.

## Curriculum vitae

Jonathan Levine studied biology at Brown University, in the United States. From 1996-2001, he was a doctoral student at the University of California, Berkeley, investigating the influence of native species diversity in regulating the success of biological invasions. He conducted postdoctoral work at Imperial College, Silwood Park, and began a faculty position at the University of California, Los Angeles in 2002. From 2003-2011, he was an Assistant, Associate, and Full Professor at the University of California, Santa Barbara, and in 2011, he moved to ETH Zurich as a Full Professor of Plant Ecology.

## Prof. Dr. Jonathan Levine

Plant Ecology

Institute of Integrative Biology, ETH Zurich

[jlevine@ethz.ch](mailto:jlevine@ethz.ch)

<http://www.plantecology.ibz.ethz.ch/publications>



Photo J. Levine

Annual plant community on serpentine soils



Photo J. Levine

Manipulating early rainfall



## Trends and Advances in Plant Biology – PSC Symposium

19 October 2012, ETH Zurich, Semper Aula

[http://www.plantsciences.ch/psc\\_events/Symposia/Symposium2012](http://www.plantsciences.ch/psc_events/Symposia/Symposium2012)

- 09:00 Opening remarks, Samuel Zeeman, PSC President, Switzerland
- 09:15 Ethylene action and interaction in *Arabidopsis* seedling growth, Dominique Van Der Straeten, Ghent University, Belgium
- 09:50 Systems and trans systems level analysis of iron deficiency responses, Sabeeha Merchant, UC Los Angeles, USA
- 10:25 Reprogramming root cells for AM symbiosis, Maria Harrison, Boyce Thompson Institute for Plant Research, USA
- 11:00 **Break**
- 11:15 Exploiting *Arabidopsis* natural variation, Maarten Koornneef, Max Planck Institute for Plant Breeding Research, Germany
- 11:50 The role of microtubules in stomatal function in *Arabidopsis*, Winslow Briggs, Carnegie Institution for Science, Stanford, USA
- 12.25 Guard Cell CO<sub>2</sub> and Abscisic Acid Signal Transduction Network, Julian Schroeder, UC San Diego, USA
- 13.00 **Lunch Break**
- 14.30 Crops FACE the future, Donald Ort, University of Illinois, USA
- 15.05 Next generation nutritionally enhanced staple crops, Paul Christou, University of Lleida, Spain
- 15.40 **Break**
- 16.00 Understanding subspecific reproductive isolation in rice, Qifa Zhang, Huazhong Agricultural University, China
- 16.35 Integrating biochemical genomics and quantitative genetics to balance the nutritional content of plants, Dean DellaPenna, Michigan State University, USA
- 17.10 Rice MtN<sub>3</sub>/saliva family: an important player in rice-Xanthomonas oryzae interaction, Shiping Wang, Huazhong Agricultural University, China
- 17.45 Concluding remarks by Wilhelm Gruissem, ETH Zurich, Switzerland

## Plants replacing fossil fuels? – PSC PhD Symposium

8 November 2012, ETH Zurich Auditorium Maximum

<http://plantsreplacingfossilfuels2012.info>

- 8:30 Registration
- 9:00 Welcome, Samuel Zeeman (PSC President)
- Plant-based products – Overview, Chair: Michal Kulak**
- 09:15 The bioenergy, food and environment trilemma, David Tilman (U Minnesota) | 09:45 Plant fuels vs. fossil fuels – the environmental benchmark today and tomorrow, Rainer Zah (EMPA) | 10:15 Economics of biofuels and commercialization of early-stage biofuel technologies, Gunter Festel (ETH Zurich)
- 10:45 **Break**
- Plants in practice, Chair: Seraina Beeler**
- 11:15 Role of enzymes in fuel ethanol production from either grain (1st generation) or biomass (2nd generation), Oliver Nussli (Novozymes) | 11:45 Algal bioenergy – prospects and challenges, Alison Smith (U Cambridge) | 12:15 Wood degradation as oxidative stress, Florian Seebeck (U Basel)
- 12:45 **Lunch Break**
- Broader considerations, Chair: Erin Gleeson**
- 14:15 Biofuels: Ethical issues, Alena Buyx (U Muenster) | 14:45 Sustainability Bioenergy – biodiversity, food security, GHG reduction and rural development, Uwe Fritsche (IINAS) | 15:15 Biofuels – State and Policy in Switzerland, Christoph Rotzetter (BAFU)
- 15:45 **Break**
- 16:15 Round table discussion, The role of plant-based energy substitutes in Switzerland, Chair: Michelle Grant (WFSC ETH Zurich)
- 17:30 Feedback, wrap-up and farewell

**Contact Newsletter**  
 sylvia.martinez@unibas.ch  
 Phone: +41 (0)61 267 35 03  
 Institute of Botany, University of Basel,  
 Schönbeinstrasse 6, 4056 Basel, Switzerland

**Production**  
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 Penelope Barnett, Wasterkingen ZH  
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**Editors**  
 Sylvia Martínez, Manuela Dahinden

**Text Contributions**  
 Beno Baumberger, Sylvain Bischof, Jonathan Levine, Juanita Schlaepfer