The International Symposium on Plant Photobiology 2019: a bright and colourful experience

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Abstract

Light is a key resource for plants as it fuels photosynthesis. It also provides essential information about their habitat. Thus, light tracking is of great importance to plants throughout their life cycle. To gain information about their light environment, plants possess light receptors that cover the perception of the complete light spectrum, including light invisible to the human eye (far-red and ultra-violet light). The information sensed by these photoreceptors is utilized for optimal growth during day–night cycles and in sub-optimal light conditions, such as shaded areas and high-light sun flecks. Plant photobiology research focuses on the perception of light by plants, their developmental adaptations to a changing light environment and the mechanistic and genetic basis of these adaptations. The International Symposium on Plant Photobiology (ISPP) is a biannual meeting where the world's leaders, as well as upcoming talents in the field, gather to share their latest results and discuss future directions. The past edition was held between June 3 and 8 of 2019 in the beautiful PRBB research park building on the seafront of the city of Barcelona (Spain). The ISPP2019 was organized by a gender-balanced committee formed by two junior (Lot Gommers and Jordi Moreno-Romero) and two senior researchers (Jamie F. Martínez-Garcia and Elena Monte).

A very brief ISPP history

ISPP meetings began 30 years ago and are organized without the auspices of a specific scientific society. Instead, the organization relies on volunteer and enthusiastic plant photobiology laboratories and rotates among the Americas, Asia and Europe. Among the first organizers was Winslow Briggs (1928–2019), a reference and inspiring photobiologist, as well as a conservationist, who sadly passed away in February 2019 and to whom ISPP2019 paid tribute.

The goals and achievements of the ISPP2019 edition

As the lively research community of plant photobiologists keeps growing, the meeting offered the possibility for participants to meet each other and to promote networking and new collaborations in a setting that favoured non-gender-biased interactions. With this goal in mind, an important challenge for the organizers was to promote the attendance of early career researchers and young talent, keep a gender-balanced participation and to create a positive ambience. In addition, we also aimed to lower the carbon footprint of the event. As part of this ‘green deal’, participants contributed to plant a forest, with one tree per participant covered by the inscription (additional contributions were voluntary, https://tree-nation.com/profile/ispp-2019), recycling was promoted, and use of non-recyclable material was minimized.

These actions aimed to express our commitment to reduce the negative impact that scientific events have on a planet's health. We hope that these actions, however small, are maintained or improved in future ISPP editions, such as the next one to be held in New York in spring 2021. We also opened a twitter account, @ISPPhotobiology, that is now being used to spread the next ISPP edition by the current organizers.

ISPP2019 also hosted the Light, Plants, Action! outreach activity with the collaboration of CENTRE FOR RESEARCH IN AGRICULTURAL GENOMICS (CRAG) and BAU Design college of Barcelona. During the meeting, artists and scientists shared the open space where poster sessions and coffee breaks took place and where an artistic installation grew, using drawings and paintings to approach plant photobiology from a different perspective, and capturing plant shapes with the light-sensitive cyanotype technique. One of the pieces is our cover art for this ISPP2019 special issue (?). The installation was also used as the set to film a series of short interviews by local high-school and older students who came to meet some of the ISPP2019 scientists and asked them questions about plant photobiology and the scientific career (https://www.cragenomica.es/crag-news/photobiology-meets-art-light-plants-action). We would like to thank all the ISPP2019 attendees who participated in this event.

The meeting brought together 140 international scientists (64 women, 76 men) from 23 countries in four continents (50% of the attendees being from laboratories in Germany, Spain, United Kingdom or China) and a strong participation of early career scientists (Fig. 1). The meeting had 11 topics ranging from the function and structure of photoreceptors to signalling factors; the integration of light with hormones, temperature, metabolism and/or the circadian clock; eco-photobiology; and evolutionary and spatial aspects of light signalling. Sessions had a mix of presentations on different topics, which we believed better reflects the interconnection among all of them. The meeting had 24 invited speakers, 23 selected speakers from abstracts and 23 selected flash talks organized in 12 sessions. The list of speakers was gender-balanced, and presentations by early career researchers were actively promoted in the selected presentations and flash talks. The daily poster sessions and coffee and lunch breaks offered plenty of time in a relaxed setting to meet, talk science and facilitate collaborations to push forward novel and sound research in the field.

The lively research community of plant photobiologists keeps very active, and this has resulted in breakthrough discoveries during the last years, some of which were presented and discussed during the meeting. Thanks to the generosity of Physiologia Plantarum in supporting the ISPP2019, we have edited this special issue, in which both young and established researchers, mostly ISPP12019 attendees, have contributed. Here, we would like to thank the enthusiastic participation of all special issue contributors, as well as the generous help of the anonymous reviewers. At the end of this note, an illustration and four popular science summaries are offered for the ‘non-expert’ reader interested in plant photobiology.


The ISPP2019 group photo at the PRBB in Barcelona, courtesy of Andras Viczian.

A glimpse of the special issue content

Hypocotyl elongation is one of the most commonly studied light-regulated processes, likely because of its simplicity (only cell length is involved in the elongation of this organ of embryonic origin) and the great effect that light conditions have on its elongation. Indeed, classical work using the hypocotyl as a study model has helped to define a role for the photoreceptors for ULTRAVIOLET-B (UV-B) (UVR8), blue light (cryptochromes) and red and far-red light (phytochromes) in regulating this process, identifying several components (e.g. CONSTITUTIVE PHOTOMORPHOGENIC/SUPPRESSOR OF PHYA-105 (COP/SPA), PHYTOCHROME INTERACTING FACTORs (PIFs), ELONGATED HYPOCOTYL 5 (HY5)) and revealing the molecular mechanisms involved. These studies have been mostly performed using the model system Arabidopsis thaliana during the transition from etiolated to de-etiolated development. In this special issue, the study of hypocotyl elongation is also central in the different topics analysed.

Work on light signalling components is reviewed and expanded in several contributions. The molecular mechanisms suppressing COP1/SPA E3 ubiquitin ligase activity in blue light are reviewed by Jathish Ponnu (Ponnu 2020). In an accompanying research paper by Enamul Huq and colleagues, including Ute Hoecker, a genomic approach is taken to understand the genomic basis for the constitutive photomorphogenic phenotype of spaQ in the dark (Pham et al. 2020). The importance by which PIFs control environmentally regulated responses such as light and temperature is reviewed by Martin Balcerowitcz (Balcerowicz 2020), whereas the molecular mechanisms regulating PIF activity are covered by David Favero (Favero 2020). During seedling growth under photoperiodic conditions, hypocotyl elongation is rhythmic, and PIFs have been shown to play a critical role as promoters of growth at dawn. Under alternating day–night cycles (photoperiods), hypocotyl elongation is promoted during the long nights of short days, whereas growth is reduced in long days. Two research papers from the group of Elena Monte expand what is known about the role of PIFs in the photoperiod growth of the hypocotyl. In the first one, PIF7 is the focus, in collaboration with the laboratories of Pablo Leivar and Peter H. Quail (Leivar et al. 2020). In the second one, the PIF target CDF5 is shown to be post-transcriptionally regulated during this process in the promotion of positive cell elongation regulators, in collaboration with the group of Rossana Henriques (Martín et al. 2020).

Other photo-regulated processes that have received much attention in recent years are the ones in response to the proximity of other plants, known as the shade avoidance syndrome. From them, the most frequently analysed is the shade-induced hypocotyl elongation. The review from the team of Ronal Pierik summarizes recent work into the complex structure of the basic HELIX-LOOP-HELIX (bHLH) network and how it regulates elongation growth, thus focusing on the transcriptional control (Buti et al. 2020). In a second review, the current knowledge on how the seedling shade responses are regulated at the epigenetic level has been covered by the group of Jaime Martínez-García (Martínez-García and Moreno-Romero 2020).

In addition to hypocotyl elongation, many other very important plant responses, such as stem phototropism or flowering, are also affected by light. In a first paper, the current knowledge about hypocotyl and inflorescence stem growth reorientation towards blue or UV-B, with a focus on the molecular mechanisms, is reviewed by Martina Legris and Alessandra Boccaccini (Legris and Boccaccini 2020). In a second review, the group of Eirini Kaiserli (Perrella et al. 2020) discusses the major players that regulate light and temperature signalling, and the cross-talk between them, in reference to a crucial developmental decision faced by plants: when is the right time to flower.

Two papers deal with aspects related to the circadian clock, which allow organisms to anticipate environmental changes associated with the photoperiod. Because circadian rhythms are cell autonomous, multicellular organisms contain multiple clocks, and environmental light can reset and differently affect the various clock outputs. The first paper from the laboratories of Hugh Nimmo and Dimitri Nusinow (Nimmo et al. 2020) aimed to understand how the root clock responds to light quality, but little is known about the circadian clock in photosynthetic eukaryotes outside the green lineage. In the second manuscript, Eva Farre (Farre 2020) summarizes the phenotypic characterization of circadian rhythms and current efforts to determine the mechanisms of this ‘brown clock’ in stramenopiles (which include diatoms and brown algae), a diverse group of secondary endosymbionts whose plastids originated from a red alga.

Within each cell, chloroplast biogenesis requires carefully coordinated communication between the nucleus and the chloroplast to integrate light signalling and information about the state of the plastid through retrograde signals. The manuscript from Åsa Strand and collaborators (Hernández-Verdeja et al. 2020) reviews the genetic components and molecular mechanisms involved in how etioplasts are converted into chloroplast in response to light, as well as the implication of PIFs.

Other manuscripts also cover photobiology research in species other than Arabidopsis thaliana. An evolutionary view is provided by the team of Andreas Hiltbrunner about the role of PIFs in controlling gene expression in the moss Physcomitrella patens (Xu et al. 2020). A comparative analysis on the role of COP1 and HY5 between Arabidopsis and maize by Rongcheng Lin and collaborators highlights the degree of conservation of mechanisms controlling photoresponses between monocots and dicots (Huai et al. 2020).

Finally, a review paper from Paolo Facella's laboratory covers how understanding photoresponses plays a role in the development of new crops to adapt to current demands (Fantini and Facella 2020).

We hope that this collection of reviews and original articles will stimulate further research on all aspects of plant photobiology research and foster its further application for achieving the Sustainable Development Goals proposed by the United Nations for 2030 (see www.un.org/sustainabledevelopment).