UV4growth

COST-Action FA0906
WG4 mini-conference

Girona, Spain, 25-26 April 2012

Plant responses to UV radiation:
from
individuals to ecosystems

Abstracts

Universitat de Girona

Published by the Environmental Sciences Department / Mediterranean Woody Plant Ecohysiology Research Group (GRTC 0083) of the University of Girona, Maria Aurèlia Campany nº 69, Girona (Catalonia), Spain.
Title: Abstracts of the WG4 mini-conference of COST Action FA0906 UV4growth "Plant responses to UV radiation: from individuals to ecosystems", Girona (Catalonia), Spain, 25-26 April 2012.
Edited by: Verdaguer D. & Llorens L.
ISBN 978-84-8458-389-9

ESF provides the COST Office through an EC contract

COST is supported by the EU RTD Framework programme

Contents

About COST

COST- the acronym for European Cooperation in Science and Technology- is the oldest and widest European intergovernmental network for cooperation in research. Established by the Ministerial Conference in November 1971, COST is presently used by the scientific communities of 35 European countries to cooperate in common research projects supported by national funds.

The funds provided by COST - less than 1% of the total value of the projects - support the COST cooperation networks (COST Actions) through which, with EUR 30 million per year, more than 30 000 European scientists are involved in research having a total value which exceeds EUR 2 billion per year. This is the financial worth of the European added value which COST achieves.

A "bottom up approach" (the initiative of launching a COST Action comes from the European scientists themselves), "à la carte participation" (only countries interested in the Action participate), "equality of access" (participation is open also to the scientific communities of countries not belonging to the European Union) and "flexible structure" (easy implementation and light management of the research initiatives) are the main characteristics of COST.

As precursor of advanced multidisciplinary research COST has a very important role for the realisation of the European Research Area (ERA) anticipating and complementing the activities of the Framework Programmes, constituting a "bridge" towards the scientific communities of emerging countries, increasing the mobility of researchers across Europe and fostering the establishment of "Networks of Excellence" in many key scientific domains such as: Biomedicine and Molecular Biosciences; Food and Agriculture; Forests, their Products and Services; Materials, Physical and Nanosciences; Chemistry and Molecular Sciences and Technologies; Earth System Science and Environmental Management; Information and Communication Technologies; Transport and Urban Development; Individuals, Societies, Cultures and Health. It covers basic and more applied research and also addresses issues of pre-normative nature or of societal importance.

Introduction – Organizers

Dear colleagues,

As organizing committee we have the pleasure of welcoming you to the University of Girona (Catalonia), Spain, to attend the UV4growth WG4 mini-conference on "Plant responses to UV radiation: from individuals to ecosystems".

UV4Growth is a COST-funded network of researchers with interests in the effects of UV-B radiation on plants (http://www.ucc.ie/en/uv4growth/). Within the UV4Growth network, workgroup 4 aims to investigate the interaction between UV-B regulated processes and the effects of climate change, linking organism responses with those at the community and ecosystem level. It also explores the importance of these interactions for agronomic practice, plant breeding, (protected)-crop management as well as habitat conservation and management.

The mini-conference "Plant responses to UV radiation: from individuals to ecosystems" has, therefore, a strong focus on UV effects on plant and ecosystem functioning in the context of climate change. It also aims to explore challenges and opportunities for ongoing UV-B research by addressing questions such as:

- How the interaction between future changes in UV and other abiotic factors, such as water availability or temperature, will affect plant growth and metabolism?
- How UV changes can affect plant-animal interactions in the near future? Will we be able to apply this knowledge to the agronomic practice?
- Which will be the main impacts of UV changes on ecosystem processes? Can we generate enough knowledge to recommend management strategies for habitat conservation?
- Will UV changes have important effects on cryptogams?
- What are the relevant questions that our future research needs to address?

Consequently, the mini-conference will be organized into four key themes:

- UV interactions with other abiotic factors: Effects on plant growth and metabolism
- UV effects on plant-animal interactions
- Changes at the ecosystem level in response to UV
- Cryptogams and UV: Impacts and interactions

The financial support of COST (EU RTD Framework programme) for organising this mini-conference is gratefully acknowledged.

Members of the Organizing Committee wish you a very successful conference and a pleasant stay in Girona:

Marcel Jansen, Chair UV4Growth
Dylan Gwyn-Jones, WG4 leader
Laura Llorens, local organiser
Dolors Verdaguer, local organiser.

Conference Program

Girona, 25 April 2012

09.30–10.00 h Registration

10.00–10.15 h Introduction and welcome

10.15–10.55 h Inaugural conference:

Jelte Rozema. *Department of Ecological Science, Faculty of Earth and Life Sciences, VU University, The Netherlands.*

Ozone depletion and enhanced UV: did it negatively affect plant growth in ecosystems and can we track past UV?

----------11.00–11.30h COFFEE BREAK----------

1 st SESSION

Topic A: UV interactions with other abiotic factors: Effects on plant growth and metabolism

Chair – Alan Jones

11.30-12.10h Keynote lecture 1:

T Matthew Robson, Saara Hartikainen, Pedro J Aphalo. *Department of Biosciences, Plant Biology, University of Helsinki, Finland.*

Solar ultraviolet-B radiation ameliorates some effects of drought

12.10-12.30h Short talk 1:

Karel Klem, Petr Holub, Jiří Kubásek, Petra Holišová, Kristýna Večeřová, Petra Rajsnerová, Otmar Urban. *Global Change Research Centre AS CR, Czech Republic.*

Interactive effects of UV radiation and drought on the accumulation of UV-screening compounds, photosynthetic and morphological parameters in selected herbs and grasses of the mountain grassland ecosystem

----------12.30–13.40h LUNCH BREAK----------

13.40-14.00h Short talk 2:

Meritxell Bernal[1], Dolors Verdaguer[1], Jordi Badosa[2], Anunciación Abadía[3], Joan Llusia[4], Encarnación Núñez-Olivera[5], Josep Peñuelas[4], Laura Llorens[1]. *[1]Environmental Sciences Department, University of Girona, Spain, [2]Laboratoire de Météorologie Dynamique, Ecole Polytechnique, France, [3]Department of Plant Nutrition, Aula Dei Experimental Station (CSIC), Spain, [4]CSIC-CEAB-CREAF Ecophysiology Unit, Autonomous University of Barcelona, Spain, [5]Complejo Científico-Tecnológico, Universidad de La Rioja, Spain.*

Interactive effects between UV radiation and low water availability on Laurus nobilis seedlings

14.00-14.20h Short talk 3:

Michal Štroch[1,2], Jakub Nezval[1], Hana Benešová[1], Ladislav Šigut[2], Václav Karlický[1,2], Irena Kurasová[1,2], Vladimír Špunda[1,2]. *[1]Faculty of Science, Ostrava University, Czech Republic, [2]CzechGlobe - Global Change Research Centre, Academy of Sciences of the Czech Republic, Czech Republic.*

Acclimation of the assimilation apparatus to supplemental UV-A or UV-B radiation in barley plants grown under low and high PAR

14.20-14.40h Short talk 4:

Vladimír Špunda[1,2], Michal Štroch[1,2], Jakub Nezval[1], Hana Benešová[1], Ladislav Šigut [1,2], Václav Karlicky[1,2], Irena Kurasova[1,2]. *[1]Faculty of Science, Ostrava University, Czech Republic, [2]CzechGlobe - Global Change Research Centre, Academy of Sciences of the Czech Republic, Czech Republic.*

Flexibility of the xanthophyll cycle mediated photoprotection and UV-screening efficiency after removal of stressful radiation conditions

14.40-15.00h Short talk 5:

Amsalu Gobena Roro, Micael Wendell, Jon Anders Stavang, Sissel Torre, **Jorunn E. Olsen.** *Department of Plant and Environmental Sciences, Norwegian University of Life Sciences, Norway.*

Interactive effect of temperature and UV-B in control of plant morphology

----------15.00–15.20h COFFE BREAK----------

Conference Program

2 nd SESSION

Topic B: UV effects on plant-animal interactions

Chair - Laura Llorens

15.20–16.00h Keynote lecture 2:

Alberto Fereres, Beatriz Dader, Saioa Legarrea, Aranzazu Moreno. *ICA-CSIC, Spanish Research Council, Spain.*

Insect behaviour and management options under UV-deficient enclosures

16.00–16.20h Short talk 6: **Inga Mewis[1],** Rita Zrenner[1], Angelika Krumbein[1], Christian Ulrichs[2], Erich Glawischnig[3], and Monika Schreiner[1]. *[1]Leibniz-Institute of Vegetable and Ornamental Crops Großbeeren/Erfurt e.V., Department of Quality, Germany, [2]Humboldt-Universität zu Berlin, Faculty for Agriculture and Horticulture, Division Urban Plant Ecophysiology, Germany, [3] Lehrstuhl für Genetik, Technische Universität München, Germany.*

UV-B irradiation changes specifically the secondary metabolite profile in broccoli sprouts and Arabidopsis – Induced signaling overlaps with defense response to biotic stressors

16.20–16.40h Short talk 7: **Sara Mela,** Roger Santer, Dylan Gwynn-Jones, Charles Phillips, Owen Jones. *Institute of Biological Environmental and Rural Sciences, Aberystwyth University, UK.*

Shedding Light on Insect Behaviour: The Role of UV in Herbivore-Plant Interactions

16.40-17.00 h Short talk 8: **Jason J. Wargent[1],** Jason P. Moore[2], Martin McPherson[3], Cathryn Lambourne[3], Patricia Croft[3], Joanna C. Heaton[4] and Nigel D. Paul[2]. *[1]Institute of Natural Resources, Massey University, New Zealand, [2]Lancaster Environment Centre, Lancaster University, UK, [3]Stockbridge Technology Centre Ltd, UK, [4]University of Central Lancashire, UK.*

Ecological responses to UV radiation: interactions between the biological effects of UV on plants and on associated organisms

INSIGHTS INTO THE FUNCTIONING OF ANOTHER COST ACTION:

17.00-17.20h Short talk 9- **Salvador Nogués.** *Department of Plant Biology, Faculty of Biology, University of Barcelona, Spain.*

Inside the Stable Isotopes in Biosphere-Atmosphere-Earth System Research COST Action

------18.45 - Guided tour through the old part of Girona------

Conference Program

Girona, 26 April 2012

3rd SESSION

Topic C: Changes at the ecosystem level in response to UV

Chair – Dolors Verdaguer

09.00-09.40h Keynote lecture 3:

Dylan Gwynn-Jones. *Institute of Biological Environmental and Rural Sciences, Aberystwyth University, UK.*

Long term impacts of enhanced UV-B radiation on plants and communities

09.40-10.00h Short talk 10:

Alenka Gaberščik, Katja Klančnik, Primož Gnezda, Igor Zelnik. *University of Ljubljana, Biotechnical Faculty, Department of Biology, Slovenia.*

UV reflectance in different stands in intermittent wetland

10.00-10.20h Short talk 11:

Alan G. Jones, Jenny Bussell, Nigel Rhys Bayliss, Dylan Gwynn-Jones. *Institute of Biological Environmental and Rural Sciences, Aberystwyth University, UK.*

Effects of elevated UV-B and species dominance on enzymatic decomposition processes in a sub-Arctic heath

10.20-10.40h Short talk 12:

Riikka Rinnan[1], Sami Mörsky[2], Jaana Haapala[3], Päivi Tiiva[2], Patrick Faubert[4], Sanna Saarnio[3], Pertti Martikainen[2], Jouko Silvola[3], Hanne Suokanerva[5], Kirsi Latola[6], Esko Kyrö[5], Toini Holopainen[2]. *[1]Department of Biology, University of Copenhagen, Denmark, [2]Department of Environmental Science, University of Eastern Finland, Finland, [3]Department of Biology, University of Eastern Finland, Finland, [4]Research Unit for Environmental Simulation, Institute of Biochemical Plant Pathology, Germany, [5]Finnish Meteorological Institute, Finland, [6]Thule Institute, University of Oulu, Finland.*

The UVOCARB project: Effects of UV-B radiation on gas exchange, vegetation and rhizosphere microbial communities of a peatland ecosystem

----------10.40–11.10h COFFE BREAK----------

4th SESSION

Topic D: Cryptogams and UV – Impacts and interactions

Chair – Dylan Gwynn-Jones

11.10-11.50h Keynote lecture 4:

Knut Asbjørn Solhaug. *Department of Ecology and Natural Resource Management, Norwegian University of Life Sciences, Norway.*

Cryptogams and UV – impacts and interactions

11.50-12.10h Short talk 13:

Javier Martínez-Abaigar, Gabriel Fabón, Laura Monforte, Rafael Tomás-Las-Heras, Encarnación Núñez-Olivera. *Complejo Científico-Tecnológico, Universidad de La Rioja, Spain.*

Effects of UV-B radiation on bryophytes

12.10-12.30h Short talk 14:

Anna Hyyryläinen[1,2], Françoise Martz[2], Pasi Rautio[2], Minna Turunen[3], Satu Huttunen[1]. *[1]Department of Biology, University of Oulu, Finland, [2]Finnish Forest Research Institute, Finland, [3]Arctic Centre, University of Lapland, Finland.*

Seasonal and interannual variation in Sphagnum chlorophyll under manipulated solar UV-B and temperature

----------12.30–13.40h LUNCH BREAK----------

13.40-14.00h Short talk 15:

Nancy de Bakker, Jelte Rozema, Rien Aerts, Peter van Bodegom. *Department of Ecological Science, Faculty of Earth and Life Sciences, VU University, The Neatherlands.*

The effects of UVB radiation on charophycean algae and bryophytes.

14.00-14.30h Meeting Discussion

14.45h Optional trip to visit the field experiment of the host research group in Cassà de la Selva (Gavarres litoral mountains)

----------21h END OF MEETING DINNER----------

Abstracts of Presentations

Jelte Rozema

Subdepartment Systems Ecology, Department of Ecological Science, Faculty of Earth and Life Sciences. VU University, Amsterdam, The Netherlands.
j.rozema@vu.nl

Short biography

Prof Dr Jelte Rozema. Studied Biology (Plant Ecophysiology-Population genetics and Mathematical Biology- 1968-1974).Ph D Thesis: Ecophysiology of Salt marsh plants (1978).

Rozema, J., van de Staaij, J., Björn, L.O. & Caldwell, M. (1997) UV-B as an environmental factor in plant life: stress and regulation, *Trends Ecol. Evol.*, 12, 22–28.

Author and editor of: Stratospheric ozone depletion: the effects of enhanced UV-B radiation on terrestrial ecosystems (1999-Backhuys Publishers, Leiden).

Rozema, J., van Geel, B., Björn, L.O., J. Lean,J. & Madronich, S. (2002). Paleoclimate: Toward Solving the UV Puzzle, *Science*, 296, 1621–1622.

Reports of EC funded project UVECOS in :

UV-B and Biosphere. 1997.Edited by J. Rozema, W.W.C. Gieskes, S.C. van de Gejin, C. Nolan and H. de Boois. Kluwer Academic Publishers.

Reports EC funded project UVAQTER in: Responses of plants to UV-B radiation .2001. Edited by J. Rozema, Y. Manetas, L-O.,Björn. Kluwer Academic Publishers.

Prof dr Jelte Rozema is full professor and holds a Chair Climate-Biopshere interactions at the Department of Systems Ecology of the Institute of Ecological Science, Faculty of Earth and Life Sciences, Vrije Universiteit, Amsterdam, The Netherlands.

Short institution presentation

We investigate how changes in climate and land-use alter biodiversity, trophic interactions and thereby the fates and rates of carbon, nutrients and water in ecosystems. We also study how these changes in turn influence atmospheric chemistry, surface hydrology and climate. The great diversity in functional traits of plant, animal and microbial species provides us with a unifying concept in these investigations.

Particular 'hotspots' of climate warming research are the cool and cold regions with their great organic carbon stocks and the coasts facing rising sea levels and salt infiltration. We investigate the present and past to predict the future, using methods ranging from field experiments and laboratory analysis to regional and global data synthesis and modeling.

Ozone depletion and enhanced UV: did it negatively affect plant growth in ecosystems and can we track past UV?

Jelte Rozema

Subdepartment Systems Ecology, Department of Ecological Science, Faculty of Earth and Life Sciences. VU University, Amsterdam, The Netherlands.
j.rozema@vu.nl

ABSTRACT

Anthropogenic pollution of the atmosphere has led to ozone depletion, but today the ozone column is no longer decreasing. Has increased solar ultraviolet-B (UV-B) radiation during the depletion period led to decreased biomass accumulation in terrestrial vegetation? We analyze published results of two kinds of field experimentation, i.e. *UV exclusion* and *UV supplementation* with a large number of plant species. For the complete data set of non-crop and crop species analysed our meta-analysis indicates that there is no statistical proof for a consistent effect of UV-B increases on plant biomass in the range occurring during the ozone depletion period on plant biomass. However, plant biomass of crop species was significantly reduced with increased UV-B. This may be ascribed to low levels of secondary compounds screened out during crop domestication. Such secondary compounds absorb UV-B, and may affect a.o. taste and may function as grazing deterrents.

Yet, other effects of enhanced UV-B than biomass reduction are ecologically relevant. Enhanced UV-B also induces changes in plant secondary chemistry, leaf surface characteristics and root exudation affecting trophic relationships, such as plant-insect and plant-microbe interactions.

Although recent stratospheric ozone depletion and increased UV fluxes over Antarctic and Arctic have been instrumentally assessed, quantitative data before 1926 is lacking. Unlike other climate variables, such as temperature and precipitation, there is no reliable proxy for the reconstruction of past solar UV radiation.

We consider the potential of well-preserved plant tissue pCA-content, impacted by solar UV, as proxy for past UV.

The potential for UV reconstructions based on cuticular pCA is, enormous, as shown for *Ginkgo*. Applying thermally assisted hydrolysis and methylation on a Paleocene *Ginkgo adiantoides* leaf revealed the presence of pCA besides typically oxidised fatty acid THM-py products. The UV absorbing properties of this over 55 million year old fossil cuticle appeared well preserved, as the UV-absorption spectra of fresh and fossil *Ginkgo* were similar.

T Matthew Robson

University of Helsinki, Division of Plant Biology, Department of Biosciences, P.O. Box 65, FI-00014, FINLAND (+35891911) bio-sci@helsinki.fi, matthew.robson@helsinki.fi

Short biography

Dr T. Matthew Robson is a physiological ecologist, originally from Gloucestershire in the UK, now working at Helsinki University within the SenPEP group. He undertook his doctoral studies at Utah State University under Martyn Caldwell studying the effects of solar UV-B radiation on the ecosystems of Tierra del Fuego in Southern South America. In this work he demonstrated that differential effects of UV on Sphagnum and emergent plants in a peatland ecosystem can change plant community dynamics, with consequences for fungi, microfauna, and nutrient cycling.

Matthew specialises in linking the effects of abiotic stresses on plant functional traits with consequences at the scale of the plant community and ecosystem. Following his doctoral studies, he worked at the Université Joseph Fourier in Grenoble, linking the above and below ground effects of land-use change in sub-alpine grasslands. Subsequently he spent three years at the Spanish National Center for Forestry Research in Madrid, investigating the physiological ecology of temperate tree species at their southern range limit. He has now returned to Finland, where he started his research career, and is currently investigating the interactive responses of birch seedlings to solar UV when combined with other abiotic factors.

Short institution presentation

The Department of Biosciences is the most extensive centre of biological research and teaching in Finland. Academic research at the Viikki Science Park Campus is internationally oriented with a wide variety of research topics, including several Centres of Excellence, as granted by the Academy of Finland. The department provides teaching in seven different major subjects: Biochemistry, Biotechnology, Ecology and Evolutionary Biology, General Microbiology, Genetics, Physiology, and Plant Biology.

Within the Division of Plant Biology, the SenPEP group, headed by Pedro Aphalo, investigates Sensory Photobiology and Ecophysiology of Plants. The group has been involved in UV research since the early 1990's. Research was initially focused on simulating ozone depletion using lamps, and this led to methodological studies testing the validity of different approaches to the filtration and supplemental of UVA and UVB. The group has build upon research from controlled and field experiments to produce a strong body of work detailing the effects of UV on growth and secondary metabolism in major Scandinavian tree species, and their interactions with other environmental factors, to explore the consequences of these effects for ecosystem function.

Solar ultraviolet-B radiation ameliorates some effects of drought

T Matthew Robson, *Saara Hartikainen, Pedro J Aphalo.*

Plant Biology Division, Department of Biosciences, P.O. Box 65, 00014 University of Helsinki, Finland.

ABSTRACT

We aimed to assess whether solar-ultraviolet (UV) radiation when combined with water deficit will have either an additive, synergistic, or ameliorative effect on the severity of stress imposed on silver birch (*Betula pendula* Roth.) seedlings. To test this proposal, plants were grown in a replicated fully-factorial experiment under nine treatment combinations filtering ultraviolet-A and ultraviolet-B from solar radiation together with differential watering to create water deficit conditions from June until August.

The effects of solar UV radiation on growth and seedling morphology were evident after the first month of treatments, and mostly persisted without increasing, over the second month. The attenuation of solar UVB and UVA&B reduced seedling growth and leaf size under water deficit, compared with seedlings receiving the full spectrum of solar radiation; whereas well-watered seedling growth was largely unaffected by UV attenuation. There was no interactive effect of filter-by-water treatment for leaf morphology, nor pigmentation, although epidermal flavonoid content was reduced by both water deficit, and the two UV attenuation treatments. The treatment combination differentially affected water relations, with seedlings under near-ambient UV exhibiting the largest predawn-to-midday leaf water potential difference. Treatment differences in gas exchange were small, but instantaneous water use efficiency was highest in seedlings under water deficit and near-ambient UV; a response that was consistent with other water-use traits.

Overall, these results reveal that the strong negative effects of water deficit are partially ameliorated by solar UV radiation, whereas well-watered silver birch seedlings are only very slightly disadvantaged by receiving solar UV radiation.

Karel Klem

Global Change Research Centre AS CR, Czech Republic.
klem.k@czechglobe.cz

Short biography

Education, degrees:
1987-1991 M.Sc., Mendel University in Brno, Faculty of Agronomy
Ph.D., Czech Agricultural University in Prague, Faculty of Agronomy Affiliations:
1994–2009: Junior scientist, Agricultural Research Institute Kroměříž,
2004-2009: Junior scientist, Agrotest Fyto Kroměříž
2009–present: Junior scientist, head of department, Global Change Research Centre AS CR, v.v.i., Department of impact experiments

Research interests:
Ecophysiology of photosynthesis under elevated CO_2 concentration, effect of UV-B radiation, drought stress and deficiency in plant nutrition, chlorophyll fluorescence emission, leaf and canopy spectral reflectance, asymmetric competition, growth allometry, canopy structure and morphology.

Short institution presentation

Global Change Research Centre AS CR, v.v.i. is a leading research department of the Academy of Sciences of the Czech Republic, which investigates the manifestations and impacts of the Global Change (GC) through the most modern scientific methods and techniques. The principal activity of the Centre is a comprehensive scientific research on issues of the GC and its impacts on the atmosphere, terrestrial biota and human society.

To meet this objective, the Centre uses the most powerful tools available, based on an interdisciplinary approach, including the development of new techniques and procedures. Within the European program ESFRI (European Strategy Forum on Research Infrastructures), the Centre is a component of the European integrated research system for carbon observation called ICOS (Integrated Carbon Observation System) and the infrastructure for airborne observation of the Earth´s surface called EUFAR (European Fleet for Airborne Research in Environmental Sciences).

Interactive effects of UV radiation and drought on the accumulation of UV-screening compounds, photosynthetic and morphological parameters in selected herbs and grasses of the mountain grassland ecosystem

***Karel Klem**, Petr Holub, Jiří Kubásek, Petra Holišová, Kristýna Večeřová, Petra Rajsnerová, Otmar Urban*

Global Change Research Centre AS CR, v.v.i, Brno, 603 00, Czech Republic

ABSTRACT

The main objective of the experiment was to investigate the interactive effects of UV exclusion and drought on the changes in accumulation of UV-screening compounds (flavonols), photosynthetic parameters and morphology in selected herbs (*Hypericum maculatum, Rumex obtusifolius*) and grasses (*Holcus mollis, Agrostis tenuis*) of the mountain grassland ecosystem.

Generally, UV and drought treatments had a similar effect on the accumulation of flavonols. UV exclusion resulted in a slight reduction of UV-shielding compounds, particularly in the grass species *Holcus mollis* (up to 36%) and partly also in *Rumex obtusifolius* (up to 15%), under the conditions of ambient precipitation. Likewise, drought treatment caused a gradual increase in the accumulation of flavonols compare to the ambient conditions in all species studied. Thus, the drought treatment reduced the differences in flavonol contents between the UV treatments.

Under the UV-exclusion, drought slightly decreased CO_2 assimilation rate, especially in species *Hypericum maculatum* and *Agrostis tenuis*. The presence of UV radiation caused the restoration of assimilation rate to the values typical for plants grown at ambient precipitation. We assume that this is due to protective mechanisms induced by UV radiation (accumulation of flavonols), which mitigate the negative impacts of drought on photosynthesis. Contrary to other species, decline of CO_2 assimilation rate caused by combination of drought and UV radiation was found in *Rumex obtusifolius*.

Among the morphological parameters, shoot length was mostly influenced by the UV and drought treatments. While UV radiation reduced shoot length in *Rumex obtusifolius* in other species it was affected particularly by drought.

Meritxell Bernal

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Short biography

Meritxell Bernal received her bachelor's degree in Biological Sciences at the Autonomous University of Barcelona (Spain) in 2006. In 2008 she obtained her master's degree in Environmental Studies at the Institute of Environmental Science and Technology (ICTA), with a research thesis entitled "Drought advances spring growth phenology of the Mediterranean shrub *Erica multiflora*" which was published in the international journal Plant Biology 2011, 13(2): 252-257. Since 2008 she is a PhD student at the University of Girona in the program of Experimental Science and Sustainability under the supervision of Dr. Laura Llorens and Dr. Dolors Verdaguer. The main goal of her PhD research is to study the ecophysiological plant responses to UV radiation and drought of Mediterranean plant species. During her PhD studies she has collaborated with several research groups: she worked at the research center Aula Dei (CSIC) of Zaragoza to analyze chloroplastic pigments of *Laurus nobilis* and *Pistacia lentiscus*, she also worked at the University of La Rioja to identify and quantify phenolic compounds of the two species mentioned above and, finally, she spend 6 months at the University of Eastern Finland to identify and quantify the leaf phenolic compounds of *Buxus sempervirens*.

Short institution presentation

The modern University of Girona was founded in 1991 although its roots go back to 1446 when the King Alphonse the Magnanimous granted Girona the privilege of awarding degrees in grammar, rhetoric, philosophy, theology, law and medicine. Nowadays, the University of Girona has 10 faculties, 11000 students and more than one hundred research groups. Regarding the Faculty of Sciences, it started in 1972 as the Science Section of the University College of Girona which belonged to the Autonomous University of Barcelona. In 1991 the Faculty of Sciences was created and became one of Faculties of the University of Girona.

The Faculty of Sciences has around 245 teaching and research staff and more than 1000 students. It comprises three Departments: Biology, Chemistry and Environmental Sciences. In the Department of Environmental Sciences, there are 6 research lines, one of them being the one developed by the research group GRTC00083. The research of this group is focused on the study of the effects of UV and drought, as well as their interactions, on Mediterranean plants and ecosystems.

Interactive effects between UV radiation and low water availability on Laurus nobilis seedlings

Meritxell Bernal*[1]**, *Dolors Verdaguer[1], Jordi Badosa[2], Anunciación Abadía[3], Joan Llusia[4], Encarnación Núñez-Olivera[5], Josep Peñuelas[4], Laura Llorens[1]

[1]Environmental Sciences Department, Faculty of Sciences, Universitat de Girona, C/ Mª Aurèlia Campmany 69 17071, Girona (Spain), [2]Laboratoire de Météorologie Dynamique, Ecole Polytechnique, 91128 Palaiseau (France), [3]Department of Plant Nutrition, Aula Dei Experimental Station (C.S.I.C.), Apdo. 13034, 50080 Zaragoza (Spain), [4]CSIC-CEAB-CREAF Ecophysiology Unit, CREAF (Center for Ecological Research and Forestry Applications), Edifici C, Universitat Autònoma de Barcelona, 08193 Bellaterra (Spain), [5]Complejo Científico-Tecnológico, Universidad de La Rioja, Av.Madre de Dios 51, 26006 Logroño (Spain)

ABSTRACT

Models predict summer increases in UV radiation and drought in the Mediterranean region. Hence, to predict potential plant community changes, it is important to elucidate the combined effects of these abiotic factors on plant Mediterranean species. To achieve this goal, one-year old seedlings of *Laurus nobilis* were grown outdoors under two levels of water-addition (low and well-watered) and three UV conditions: ambient UV, enhanced UVA or enhanced UVA+UVB (erythemally weighted UV doses were increased ≈23% above ambient).

Low-watered plants showed a higher biomass accumulation under enhanced UVA or UVA+UVB than at ambient UV, which might be associated with an observed UVA-induced increase in water use efficiency (WUE). Under water shortage, plants grown under enhanced UVA showed, at predawn, a higher de-epoxidation of the xanthophyll cycle (DEPS) than ambient plants and a lower lutein-5,6-epoxide content than ambient or enhanced UVA+UVB plants. At midday, low-watered plants grown under enhanced UVA showed a higher DEPS than those grown at ambient UV or enhanced UVA+UVB, having a lower lutein-5,6-epoxide content than those grown under enhanced UVA+UVB. Leaf content of phenols such as *p*-coumaric acid and one quercetin derivative were lower in UVA-treated plants than in ambient ones. Therefore, despite UVA-treated plants under low water availability seem to have a higher need for thermal dissipation of excess energy than ambient plants, they showed increased WUE and growth. UVB addition seems to counteract UVA effects on DEPS and on the lutein-5,6-epoxide/lutein cycle, without modifying its effects on WUE or growth.

Acknowledgements: This research was supported by the "Ministerio de Ciencia e innovación" of the Spanish government (CGL2007-64583; CGL2012-22283) and the University of Girona (SING11/3).

Michal Štroch, Ph.D.

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Short biography

Year of Birth: 1974; Education/ Position:
- B.Sc. (1995): University of Ostrava, Faculty of Science; M.Sc. (1997) and Ph.D. (2006): Palacký University in Olomouc, Faculty of Science; Research fellowship: Botanical Institute II, University of Karlsruhe, Germany, Dr. Claus Buschmann (2006)
- 2000-present: Assistant professor, Faculty of Science, University of Ostrava, Czech Republic

Research interests:
- ecophysiology and biophysics of photosynthesis in higher plants
- study of mechanisms, by which the assimilation apparatus of higher plants responds to short-term and long-term changes of environmental factors (intensity of visible and UV radiation, air temperature)

Selected papers:
Štroch et al. (2004) Non-radiative dissipation of absorbed excitation energy within photosynthetic apparatus of higher plants. Photosynthetica 42: 323-337 Štroch et al. (2008) Dynamics of the xanthophyll cycle and non-radiative dissipation of absorbed light energy during exposure of Norway spruce to high irradiance. J Plant Physiol 165: 612-622. Štroch et al. (2008) Epidermal UV-shielding and photosystem II adjustment in wild type and *chlorina f2* mutant of barley during exposure to increased PAR and UV radiation. Environ Exp Bot 64: 271-278. Štroch et al. (2010) Acclimation of Norway spruce photosynthetic apparatus to the combined effect of high irradiance and temperature. J Plant Physiol 167: 597-605

Short institution presentation

The research of the biophysics group at University of Ostrava deals with the impact of important environmental factors (radiation and its spectral quality, temperature, CO_2 concentration and further manifestations of climate change) on the photosynthetic apparatus of higher plants, including the mechanisms of regulation of incident radiation utilization and response of photosynthetic activity on the leaf, plant and partially canopy scales.

The experimental background for the research is based mainly on application of biophysical optical spectroscopy techniques in the investigation of structure and function of the assimilatory apparatus and development of biochemical methods for analysis of the assimilatory apparatus components including biologically active substances. Model experiments are realized using plants exposed to defined microclimatic conditions in growth chambers at our workplace. The field studies are carried out mainly at the experimental research site of Global Change Research Centre (Academy of Sciences; Czech Republic) in Bílý Kříž (Beskydy Mountains, NE-Czech Republic, 908 m a.s.l.), using the model canopies of Norway spruce and beech cultivated under elevated and ambient CO_2 concentration, Norway spruce stand and experimental meadows.

Acclimation of the assimilation apparatus to supplemental UV-A or UV-B radiation in barley plants grown under low and high PAR

***Michal Štroch*[1,2], *Jakub Nezval*[1], *Hana Benešová*[1], *Ladislav Šiguť*[2], *Václav Karlický*[1,2], *Irena Kurasová*[1,2], *Vladimír Špunda*[1,2]**

[1]Faculty of Science, Ostrava University, 30. dubna 22, CZ-701 03 Ostrava, Czech Republic,
[2]CzechGlobe - Global Change Research Centre, Academy of Sciences of the Czech Republic, Bělidla 986/4a, CZ-603 00 Brno, Czech Republic

ABSTRACT

The acclimation response of barley (*Hordeum vulgare* L.) assimilation apparatus was examined after transfer of plants grown under low and high PAR to conditions with the same level of PAR and supplemental UV-A or UV-B radiation of different intensities. The aim was to evaluate, how the level of PAR during growth of barley plants will affect the induction of regulatory and protective mechanisms in the course of exposure to UV radiation. The presentation will be focused especially on the changes of epidermal UV-shielding, functional state of photosystem II (PSII), the capacity of CO_2 assimilation rate and composition of photosynthetic pigments and phenolic compounds. On the contrary to UV-B radiation, supplemental UV-A exposure on barley plants acclimated to low PAR had no negative impact on the photosynthetic apparatus function. The used UV-A spectral region (350-400 nm) can be effectively used in photosynthetic reactions, thus compensating low level of PAR. The effect of UV-A and UV-B exposure was similar in plants grown under high PAR – PSII photoinhibition observed in control plants was enhanced despite increase of photoprotective xanthophyll-cycle dependent thermal energy dissipation. We found that PAR level itself during growth of plants was a key factor determining the degree of UV-shielding. We suppose that the ability to accumulate a considerable amount of UV-screening compounds by high PAR contributes to the resistance of PSII against UV-B radiation.

Acknowledgements: This research was supported by the Grant Agency of the Czech Republic (522/09/0468), Ostrava University (SGS17/PřF/2012), projects CzechGlobe (CZ.1.05/1.1.00/02.0073) and Institute of environmental technologies (CZ.1.05/2.1.00/03.0100).

Vladimír Špunda

Faculty of Science, Ostrava University, 30. dubna 22, CZ-701 03 Ostrava, Czech Republic; CzechGlobe - Global Change Research Centre, Academy of Sciences of the Czech Republic, Bělidla 986/4a, CZ-603 00 Brno, Czech Republic; vladimir.spunda@osu.cz

Short biography

Age: 49 years; Nationality: Czech Graduated: (1986) Palacky University Olomouc, Faculty of Science; Specialization: biophysics and chemical physics; Present position: Assoc. Professor, Head of Department, Department of Physics, Faculty of Science, University of Ostrava

Research field: chlorophyll *a* fluorescence, biophysics of photosynthesis, biophysical plant ecophysiology;

Main research projects (last five years):
2007 – 2009: Acclimation of the Norway spruce photosynthetic apparatus to changes of incident solar radiation. GACR:522/07/0759; 2009 – 2012: Dynamics and variability of epidermal UV-shielding and carotenoid-mediated photoprotection in higher plants due to radiation environment changes. GACR:522/09/0468

Recent papers:

Štroch M, Vrábl D, Podolinská J, Kalina J, Urban O, Špunda V (2010) Acclimation of Norway spruce photosynthetic apparatus to the combined effect of high irradiance and temperature. J Plant Physiol 167: 597-605.

Karlický V, Podolinská J, Nadkanská L, Štroch M, Čajánek M, Špunda V (2010) Pigment composition and functional state of the thylakoid membranes during preparation of samples for pigment-protein complexes separation by nondenaturing gel electrophoresis. Photosynthetica 48: 475-480.

Klem K, Ač A, Holub P, Kováč D, Špunda V, Robson MT, Urban O (2012) Interactive effects of PAR and UV radiation on the physiology, morphology and leaf optical properties of two barley varieties. Environmental and Experimental Botany 75: 52– 64.

Short institution presentation

Biophysics Group at the Department of Physics, Ostrava University: The group has 6 members. The research deals with the impact of important environmental factors (radiation and its spectral quality, temperature, CO_2 concentration and further manifestations of climate change) on the photosynthetic apparatus of higher plants, from the mechanisms of regulation of incident radiation utilization towards responses of photosynthetic activity on the leaf, plant and partially canopy scales.

Experimental background is based mainly on application of biophysical optical spectroscopy techniques in the investigation of structure and function of the assimilatory apparatus and development of biochemical methods for analysis of assimilatory apparatus components including biologically active substances. Model experiments are realized using plants exposed to defined microclimatic conditions in growth chambers at our workplace. The field studies are carried out mainly in co-operation with Global Change Research Centre AS CR at its Experimental research site Bílý Kříž (using the model canopies of Norway spruce and beech cultivated under elevated and ambient CO2 concentration, Norway spruce stand and experimental meadows).

Flexibility of the xanthophyll cycle mediated photoprotection and UV-screening efficiency after removal of stressful radiation conditions

Vladimír Špunda*[1,2]*, Michal Štroch[1,2], Jakub Nezval[1], Hana Benešová[1], Ladislav Šigut [1,2], Václav Karlicky[1,2], Irena Kurasova[1,2]

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ABSTRACT

Acclimation of spring barley (*Hordeum vulgare* L.) assimilation apparatus to high PAR level in absence of UV radiation and/or low PAR together with moderate UV-B radiation (that the plants can survive) result in both increased capacity of the xanthophyll cycle mediated photoprotection and enhanced UV-screening efficiency as compared to plants grown at low PAR.

However, considerably less information is available on the response of assimilatory apparatus after (1) PAR reduction and/or (2) removal of supplemental UV-B radiation, regarding the flexibility of mentioned protective processes. Therefore, we have studied the response of barley plants grown from seeds for 8 days: (1) at high PAR (1000 $\mu mol.m^{-2}.s^{-1}$) followed by reduction of PAR to low level (50 $\mu mol.m^{-2}.s^{-1}$); (2) at low PAR with supplemental UV-B radiation (0.05 $W.m^{-2}$) and then the UV-B sources were switched-off. Particularly, composition of photosynthetic pigments and phenolic compounds, the efficiency of UV-shielding and the regulation of light utilization within PS II were examined for 6 following days. The main aim of these experiments was to test the hypothesis that, not depending on the cause of induction, the efficiency of UV-shielding remains almost unaffected after removal of the radiation stress, whereas the xanthophyll cycle mediated photoprotective regulation of PS II function flexibly adjusts within several days to the level typical for the control plants grown under low PAR.

Acknowledgements: This research was supported by the Grant Agency of the Czech Republic (522/09/0468), projects CzechGlobe (CZ.1.05/1.1.00/02.0073), Institute of Environmental Technologies (CZ.1.05/2.1.00/03.0100) and Ostrava University (SGS17/PřF/2012).

Jorunn E. Olsen

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Short biography

Jorunn E. Olsen is professor in plant physiology at Department of Plant and Environmental Sciences at the Norwegian University of Life Sciences.

Her main area of interest is plant developmental physiology, particularly with respect to climatic responses/climatic adaptation, emphasizing light and temperature sensing and signaling, including hormone physiology.

The main processes studied in recent years have been thermoperiodic control of shoot elongation in herbaceous (model) plants and control of bud dormancy-related processes in trees. Currently also interactive effects of UV-B and temperature on plant morphology are investigated.

Short institution presentation

The Norwegian University of Life Sciences (formerly Agricultural University of Norway) has approximately 3500 students, mainly within life sciences, technology and social sciences including economy. The life sciences include agriculture, horticulture, forestry, fish farming, food science and basic sciences such as plant and animal biology, ecology, genetics, microbiology and chemistry. Department of Plant and Environmental Sciences, which has about 200 employees in total, includes basic and applied plant sciences, soil sciences, geology and environmental chemistry.

Interactive effect of temperature and UV-B in control of plant morphology

Amsalu Gobena Roro, Micael Wendell, Jon Anders Stavang, Sissel Torre, ***Jorunn E. Olsen***

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ABSTRACT

Upon global warming not only seasonal changes and increased temperature instabilities are expected, but also changes in diurnal temperature patterns with increasing night temperatures. This will affect plant growth, also since plants respond differently to temperature in light and darkness. Also, interactive effects between altered temperatures and environmental factors such as UV-B radiation and irradiance can be expected. Furthermore, responses to environmental factors can be exploited in the greenhouse industry to produce compact plants with limited use of harmful chemical growth retardants, thus obtaining more sustainable plant production.

We have demonstrated that the effect of temperature alteration in light on elongation growth in pea (*Pisum sativum*) and *Arabidopsis thaliana* is linked to transcriptional regulation of a gibberellin (GA)-inactivating gene (*GA2ox*). A temperature change in the night affects elongation less and does not affect *GA2ox* transcript levels. The aim of our present studies is to improve our understanding of how temperature interacts with different light climate parameters in regulation of morphology. The effect of lowered temperature on inhibition of shoot elongation was strongly enhanced in pea when irradiance was also increased. This was linked to additional stimulation of GA inactivation, apparently through enhanced activity of photomorphogenesis-related signaling. Daily periods of UV-B-exposure reduced shoot elongation in pea, and this response was substantially enhanced when UV-B was given in combination with a temperature reduction. As part of our investigations of the action of UV-B radiation and its interaction with temperature, hormone profiling during such treatments are carried out and will be discussed.

Alberto Fereres

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Short biography

Alberto Fereres, born 1959. Professor of the **Spanish Research Council (Consejo Superior de Investigaciones Cientificas, CSIC) at** ICA-CSIC**, Madrid, Spain.** MSc, **Purdue University**, Indiana, USA (1987)**.** Doctorate in Agricultural Engineering, Agricultural Engineering School of Madrid, Polytechnic University (1988). Post-doctoral visiting scientist at University of California, Riverside. 1989. Sabbatical: w/Professor M. Irwin. University of Illinois, Urbana, Champaign. USA (1997). Research Scientist at National Institute of Agricultural Research, INIA (1988-1990). Research Scientist at CSIC (1990-2004). Published 140 scientific papers and 20 book chapters on biology and ecology of aphids, aphid-virus-plant interactions, insect probing and feeding behavior, host plant resistance to insects and pest management of insect vectors of plant disease.

Other activities: Vice-director of the Center of Environmental Sciences of the CSIC. (1999-2001). Director of the Institute of Agricultural Sciences (ICA-CSIC) (2006-2011) and Director of the Center of Environmental Sciences (CCMA-CSIC) (2009-2011). Chairman of the International Committee of Plant Virus Epidemiology (ICPVE), part of the International Society of Plant Pathology (ISPP) (2007- to present). Associate coordinator of the Scientific Panel of Agricultural Sciences of CSIC (2004-2008). Member of the Steering Committee of the European Science Foundation programme entitled: "Behavioural Ecology of Insect Parasitoids – from theoretical approaches to field applications (BEPAR)" (2005-2009).

Short institution presentation

Instituto de Ciencias Agrarias del CSIC (Institute of Agricultural Sciences at CSIC) (ICA-CSIC) was born in 2006 after a long process of restructuration of the Center of Environmental Sciences of the Scientific Research Council (CSIC). It is located in downtown Madrid in a 10-story tower constructed in 1959 by the architect Miguel Fisac and catalogued as a building of historical-artistic interest. The building was internally rebuilt in 2009 with modern laboratories and excellent infrastructures. The availability of the Research Station La Poveda located at 23 km away allows researchers to conduct experimental work under field conditions.

The scientific structure of ICA includes two complementary areas: Environmental Contamination and Sustainable Crop Protection.

The research lines include urban and industrial waste recycling, evaluation and remediation of contaminated soil and water. Madrid, a large producer of urban and industrial wastes and toxic pollutants and a broad spectrum of industrial companies, makes the ICA an ideal place to work on these topics.

In the area of Crop Health and Protection, the ICA conducts research weed ecology, precision agriculture, pest management, host plant resistance to nematodes and insects, plant-insect interactions and plant pathogen-vector. The reduction in the use of agrochemicals has become a commonly accepted goal in all European countries and constitutes a central objective of ICA.

Insect behaviour and management options under UV-deficient enclosures

***Alberto Fereres**, Beatriz Dader, Saioa Legarrea, Aranzazu Moreno*

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ABSTRACT

UV radiation affects insect behavior in many different ways including orientation, navigation, host finding, feeding and interaction between the sexes. Insects have photoreceptors within their compound eye to perceive wavelengths in the UV-A and UV-B range as well as in the visible and far red radiation. It is well known that UV radiation stimulates insect takeoff and visible green-yellow radiation favors landing and settling. Changed UV radiation regimes may alter the behavior and performance of herbivorous insects both directly and indirectly, by modifying host plant traits.

Plastic films and nets provide and efficient way to control light quality and intensity within greenhouse environments. Insect vision can be manipulated by using UV-blocking cladding materials for the purpose of managing pests and limiting the spread of insect-borne virus diseases. We will report the impact of UV-absorbing plastic films and nets on the population density and spread of pests (aphids, whiteflies, thrips and lepidopterans) and insect-transmitted virus diseases (LMV, CMV, TSWV) of horticultural crops. We will also report on how the flight and host finding ability of some insect pests and their natural enemies is altered under UV-deficient environments. Aphids reduced their fecundity, population growth rate and spread on lettuce plants grown under a UV-deficient environment. Also, the population density of thrips and the incidence of thrips-borne viruses were reduced under UV-absorbing plastic films. Reducing ambient UV-light impaired the ability of *Myzus persicae* and *Aphidius colemani* to start their flight and locate their targets. Other insects such as *Tuta absoluta* and *Sphaerophoria rueppellii* were not so sensible to UV-deficient environments.

Inga Mewis

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Short biography

Educational background
1998 Diploma in Biology, Free University Berlin, Germany
2001 PhD. in chemical ecology and entomology, Free University Berlin/Technical University Munich, Germany. Cooperation with Central Luzon State University, Philippines

Professional experience
2001–2004 Postdoctoral Fellow in the Chemical Ecology Lab., Department of Entomology, Pennsylvania State University, USA.
2003/04/05 Visiting Scientist, Max-Planck Institute for Chemical Ecology (MPI), Jena, Germany.
2004–2009 Research associate and lecturer, Humboldt University Berlin, Faculty for Agriculture and Horticulture, Division Urban Plant Ecophysiology

Major research areas
Chemical plant defence and integrated pest management: I am interested in chemical compounds which mediate ecological interactions of herbivores, pathogens, and plants and how they are influenced by abiotic factors such as UV-B and water stress. Here I am focussing on the plant defensive response to different specialized insect herbivores and implications of changes within secondary metabolites on human health.

Short institution presentation

The Leibniz-Institute of Vegetable and Ornamental Crops Großbeeren/Erfurt e.V. (IGZ) works on the scientific base of ecologically meaningful and also effective production of horticultural products. Horticultural products should be of high quality, originated by an environmentally friendly cultivation and have to meet the consumer's demands. Vegetable plants are the basis for a valuable diet and various food trends as vegetable-based food can both: taste well and be healthy. Thereby our research supports sustainability, competitiveness of growers and tailored vegetable quality according to consumer desires.

Regarding consumer preferences in vegetable products, elicitor treatments may be used to obtain vegetables enriched with secondary plant metabolites for sale as fresh market products or used as bioactive additives for functional foods and supplements, thereby promoting higher consumption of these health-promoting substances.

UV-B irradiation changes specifically the secondary metabolite profile in broccoli sprouts and Arabidopsis – Induced signaling overlaps with defense response to biotic stressors

***Inga Mewis*[1]**, *Rita Zrenner*[1], *Angelika Krumbein*[1], *Christian Ulrichs*[2], *Erich Glawischnig*[3], *and Monika Schreiner*[1]

[1] Leibniz-Institute of Vegetable and Ornamental Crops Großbeeren/Erfurt e.V., Department of Quality, Theodor-Echtermeyer-Weg 1, 14979 Großbeeren, Germany; [2] Humboldt-Universität zu Berlin, Faculty for Agriculture and Horticulture, Division Urban Plant Ecophysiology, Lentzeallee 55-57, 14195 Berlin, Germany; [3] Lehrstuhl für Genetik, Technische Universität München, Emil-Ramann-Str. 8, 85350 Freising, Germany

ABSTRACT

UV-B effects on plant biochemistry have been usually associated with increases in phenolic compounds. However, little is known about UV-B mediated changes on other non-volatile secondary metabolites in Brassicaceae which contribute to the plant defenses against their enemies. Ecological relevant low to moderate UV-B doses (0.3 - 1 kJ m^{-2} d^{-1}) were applied to sprouts of the important vegetable crop *Broccoli oleracea* var. *italica* (broccoli) and *Arabidopsis thaliana* and elicited especially the accumulation of 4-methoxy-indol-3-ylmethyl glucosinolate and 4-methylsulfinylbutyl glucosinolate. Furthermore in *A. thaliana*, UV-B induced pronounced increases in levels of the phytoalexin camalexin involved in plant defense response to necrotrophic pathogens. The accumulation of secondary metabolites in broccoli sprouts and *A. thaliana* were related to transcriptional responses in Agilent one color microarray analyses. Corresponding to the accumulation of defensive metabolites, transcript of genes associated with salicylate and jasmonic acid signaling pathways increased. Interestingly, the UV-B induced up-regulation of the most responsive genes in broccoli sprouts was very similar to plant response induced by fungal and bacterial pathogens. Furthermore, the *Brassica* microarray data revealed a remarkable UV-B mediated induction of potential gene orthologous to genes of *A. thaliana* which are involved in the biosynthesis of camalexin. Concomitantly, plant pre-exposure to moderate UV-B doses had negative effects on the performance of the specialist caterpillar *Pieris brassicae* and the population growth of the generalist aphid *Myzus persicae* in broccoli sprouts and *A. thaliana*. However, the generalist performance of *Spodoptera exigua* and disease progression of two pathogens was promoted after plants pre-exposure to UV-B.

Sara Mela

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Short biography

Sara Mela is a first year PhD student at Aberystwyth University, studying the effects of visual cues – particularly ultraviolet wavebands – on insect behaviour. She graduated from Aberystwyth in 2011, with an undergraduate degree in Zoology and Microbiology. During her degree, she spent a year on a student internship in the Netherlands, working with Unilever's Exploratory Microbial Sciences Group. She contributed to cross-disciplinary research looking at the role of microbial populations in human gut health and immunology.

Supervised by Dr Dylan Gwynn-Jones and Dr Roger Santer at Aberystwyth, Sara's current research is funded by Knowledge Economy Skills Scholarships (KESS) and in partnership with AgriSense UK. Using whitefly (Family *Aleyrodidae*) and aphid (Family *Aphididae*) species as models, they aim to characterise visual and chemical properties of stimuli naturally attractive stimuli, and relate specific visual cues to landing and feeding initiation in phytophagous insects.

Short institution presentation

The Institute of Biological, Environmental and Rural Sciences (IBERS) is a world class award winning research and teaching centre at Aberystwyth University. IBERS is an internationally recognised centre of excellence and students' choice for the study of biological, environmental and rural sciences. IBERS is a new venture that has brought together staff from the Institutes of Rural

Sciences and Biological Sciences at Aberystwyth University, and the Institute of Grassland and Environmental Research (IGER). Around 300 research, teaching and support staff conduct basic, strategic and applied research in biology from the level of genes and other molecules to the impact of climate change and bio-energy on sustainable agriculture and land use.

Shedding Light on Insect Behaviour: The Role of UV in Herbivore-Plant Interactions

Sara Mela, *Roger Santer, Dylan Gwynn-Jones, Charles Phillips and Owen Jones*

Institute of Biological Environmental and Rural Sciences, Aberystwyth University, Ceredigion, SY23 3DA, WALES, UK.

ABSTRACT

Insect herbivores inflict serious damage on wild plant species and domestic crops. Visual signals are amongst the primary tools that insects use to locate potential plant hosts, providing key information during initial host detection and selection. There is significant interest in understanding the influence of light cues on herbivore behaviour and insect perception of lower wavelength ultraviolet (UV) radiation.

This talk will consider the role of UV wavelengths in insect pest behaviour. Many insects use UV cues to guide flight, and radiation composition may affect plant host location by herbivorous species. Sources that emit strongly in UV may contribute to insect orientation, defining the contrast between vegetation and the horizon. Surfaces that reflect UV can also guide behaviour; however, this mechanism is not well-defined. Differences between sources of UV emission and reflection will be discussed, and hypotheses proposed regarding their distinct roles in insect behaviour.

Many insect pests exist in the glasshouse environment, where UV-opaque cladding often reduces the quantity and quality of UV radiation compared to the external environment. As UV cues may guide insect flight, orientation and foraging, these behaviours may be altered specifically under glasshouse conditions. Polyphagous insects, such as aphid and whitefly species, are often found in glasshouses in temperate regions. These species will be discussed as potential models to understand how UV signals integrate with other visual information to guide behavioural responses under glasshouse and natural conditions.

Jason J. Wargent

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Short biography

Senior Lecturer, Massey University, New Zealand

My research is principally focussed on understanding plant physiological and molecular responses to environmental factors, principally ultraviolet (UV) radiation. Whilst plant responses to UV are numerous, comparatively little is understood regarding the possible exploitation of such endpoints to drive quality within modern crop production. One of our current experimental models is based upon the use of light-modifying technologies including approaches such as protective crop claddings, supplementary lighting, and canopy management tools, and our focus is on understanding various plant response mechanisms to UV which could contribute to aspects of crop quality. We are also interested in other implications of UV/plant response, particularly within the context of sustainable cropping technologies, such as plant/herbivore and plant/disease interactions. Whilst much of our work is focused in an applied context, little is known regarding events related to UV-B specific perception and signalling patterns, and we have been investigating putative mechanisms and subsequent whole-plant responses using various approaches in collaboration with other researchers.

Short institution presentation

Massey University is one of New Zealand's leading educational institutions. Massey is a state funded university, with a proud 70-year tradition of academic excellence and a strong national and international reputation. Our three city-based campuses across New Zealand cater for some 19,000 local and international students, and an additional 18,000 New Zealand students also study by distance education. Staff in many focus areas is internationally renowned, and leading edge research is being undertaken across all three campuses, including the areas of 'Agri-food', plant science, and ecology.

Massey enjoys working partnerships with various other leading research institutes in New Zealand, including Plant & Food Research, Landcare Research, and Massey is also host to the Riddet Centre for food innovation, one of New Zealand's Centres for Research Excellence. Postgraduate

Ecological responses to UV radiation: interactions between the biological effects of UV on plants and on associated organisms

***Jason J. Wargent*[1], *Jason P. Moore*[2], *Martin McPherson*[3], *Cathryn Lambourne*[3], *Patricia Croft*[3], *Joanna C. Heaton*[4] *and Nigel D. Paul*[2]**

[1]Institute of Natural Resources, Massey University, Private Bag 11222, Palmerston North 4442, New Zealand, [2]Lancaster Environment Centre, Lancaster University, Lancaster LA1 4YQ, UK, [3]Stockbridge Technology Centre Ltd, Cawood, Selby, North Yorkshire YO8 3TZ, UK, [4]University of Central Lancashire, Preston PR1 2HE, UK

ABSTRACT

Solar ultraviolet (UV)-B radiation (280–315 nm) has a wide range of effects on terrestrial ecosystems, yet our understanding of how UV-B influences the complex interactions of plants with pest, predator/parasitoid, pathogen, and related microorganisms remains limited. Concerns regarding the consequences of stratospheric ozone depletion have underpinned a large body of subsequent research focused largely upon plant response and related organisms, and as experimental approaches have evolved over time, 'standout' effects including reductions in leaf growth, and alterations in regulation of phenolic metabolism are often observable within a realistic range of UV-B fluxes. Yet, largely due to the plant-focused approaches to date in many studies, limitations in our knowledge remain regarding UV-B driven knock-on effects for herbivorous insects and pathogens. Here, we consider findings from our recent studies of plant and related organismal UV response using an integrated approach relying upon the use of biologically weighted UV doses to evaluate a series of experiments carried out under ambient solar conditions in the UK. Our key experimental system consisted of a series of typical plant/pest/pathogen interactions, as observed under a range of UV-spectrally modifying filters. In a zero UV-B environment, we observed reduced population growth of *Myzus persicae* (green peach aphid); we noted complex effects on the common pathogens *Botrytis cinerea* and *Bremia lactucae* (i.e., both UV-inclusive and UV-B zero treatments increased pathogen persistence), and we also observed a UV-B mediated decrease in leaf surface phylloplane microbes. Our findings highlight the need to integrate different experimental approaches within UV-B photobiology and photoecology.

Salvador Nogués

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Short biography

Date and Place of Birth: August 27, 1967; Barcelona, Spain.
Languages: English, French, Spanish and Catalan.
Permanent Address: Associate Professor (permanent position)

EDUCATION
- Graduated in Biological Science (5 years course degree), University of Barcelona, 1990.
- Master of Science, Department of Plant Biology, University of Barcelona, 1991.
- *Thesis*: Effects of enhanced UV-B radiation and water stress on the photosynthetic activity in *Pisum sativum* and *Hordeum vulgare*; supervisors: Neil R Baker, University of Essex (UK) and Leonor Alegre, University of Barcelona, 1995.
- *Postdoctoral*: UV-B radiation effects on the photosynthetic capacity on plants grown in field and greenhouse conditions, Neil R Baker, University of Essex (UK), 1996-98.
- *Membership of Professional Societies*: Full Member of the Spanish Society of Plant Physiology, the European Society of Plant Physiology and the American Society of Plant Physiologists.

SCIENTIFIC PUBLICATIONS: 51;
Web of Science Information:
Sum of the times cited: 1059;
Average citations per item: 22.06;
h-index: 21

Short institution presentation

The University of Barcelona is the largest public institution of higher education in Catalonia, catering to the needs of the greatest number of students and delivering the broadest and most comprehensive offering in higher educational courses. The UB is also the principal centre of university research at a state level and has become a European benchmark for research activity, both in terms of the number of research programs it conducts and the excellence these have achieved.

Its own history closely tied to the history of Barcelona and of Catalonia, our university combines the values of tradition with its position as an institution dedicated to innovation and teaching excellence: a university that is as urban, outward-looking and cosmopolitan as the city from which it takes its name.

Some basic UB figures:
87.486 students; 65 EHEA bachelor's degree courses; 6 second-stage llicenciatura degree courses ('llicenciatures de segon cicle'); 152 university master's degree courses; 71 doctoral programs; 440 postgraduate programs; 5.247 professors, lecturers and researchers

Inside the Stable Isotopes in Biosphere-Atmosphere-Earth System Research COST Action

Salvador Nogués

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ABSTRACT

Predicting impacts of global change on the Earth system requires detailed understanding of interactions between biota and biogeochemical processes in different environments and management regimes. Stable isotopes are a powerful tool for studying such interactions in natural and managed ecosystems, offering insights beyond classical methodologies.

As integrative, coordinated European platform for the use of stable isotopes in different (i.e. biosphere, atmosphere and Earth) system studies, the COST Action ES0806 titled 'Stable Isotopes in Biosphere-Atmosphere-Earth System Research´ (SIBAE) aims to (i) synthesize existing isolated stable isotope experiments on carbon, nitrogen, oxygen and water cycles to identify innovative process- and system-oriented research areas; (ii) assess current state-of-the-art models to improve process representation and to better link experimental and modelling communities; (iii) benchmark and advance innovative cutting-edge technologies for stable isotope analysis to stimulate interdisciplinary research; and (iv) train early-stage researchers from diverse disciplines.

Dylan Gwynn-Jones

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Short biography

Dr. Dylan Gwynn-Jones is a Senior Lecturer at IBERS, Aberystwyth University. He is a plant ecophysiologist interested in how environmental perturbations (including UV-B radiation, drought, temperature and nitrogen) impact on plants and their communities. His research therefore spans to other trophic levels including herbivory, litter decomposition and soil processes.

Dylan was one of the founders of the earliest plants and ecosystem UV-B research at Abisko. He has maintained the experiments at the site from the early 1990s to the present day. Furthermore, Dylan has contributed widely to UV-B and plant research field; as an expert referee to the UNEP reports on ozone depletion impacts and through research contributions over the past two decades.

Short institution presentation

The Institute of Biological, Environmental and Rural Sciences (IBERS) is a world class award winning research and teaching centre at Aberystwyth University. IBERS is an internationally recognised centre of excellence and students' choice for the study of biological, environmental and rural sciences.

IBERS is a new venture that has brought together staff from the Institutes of Rural Sciences and Biological Sciences at Aberystwyth University, and the Institute of Grassland and Environmental Research (IGER). Around 300 research, teaching and support staff conduct basic, strategic and applied research in biology from the level of genes and other molecules to the impact of climate change and bio-energy on sustainable agriculture and land use.

Long term impacts of enhanced UV-B radiation on plants and communities

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ABSTRACT

Concern about ozone depletion impacts in the late 1980s resulted in a number of experiments looking at the effects of enhanced UV-B on plants and communities. Such experiments started as simple classical growth experiments using basic indoor equipment but over time became increasingly technically advanced. Research effort often focussed on treatment delivery and flaws in methodology rather than the biology studied. The more technically complex field experiments subsequently developed in the mid to late 1990s had limited life spans as they were high in maintenance. In later years, with less concern about ozone depletion impacts, research has focussed more on the effects of ambient UV radiation using basic filter technology.

Throughout this period of research change we have identified that the main route for plant responses to UV radiation is via alterations in plant chemistry (particularly secondary metabolites) which has consequences to herbivory, decomposition and belowground diversity. In this presentation we aim to highlight very long term responses using a study based in Abisko on a sub-arctic heath community. This experiment was the first field experiment worldwide looking at the effects of enhanced UV-B on a natural community. The experiment spans the entire research period that has looked at the effects of UV-B on terrestrial ecosystems (1991 to present). Basic but reliable technology that was available in the early 1990s was used to enhance UV-B radiation and this study and it represents our only opportunity to understand decadal plant and community responses to enhanced UV-B radiation.

Alenka Gaberščik

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Short biography

Alenka Gaberščik received her Ph. D in 1991 in Biology from the University of Ljubljana. From August 1983 to October 1998 she worked as a researcher at National Institute of Biology. Since October 1998 she has been working at the Department of Biology, Biotechnical Faculty, University of Ljubljana. She is involved in bachelor, master and doctoral programmes giving lectures on plant ecology, ecosystems, nature conservation and environment protection.

Her current interests are
(1) the influence of UV-B radiation on plants and possible interactions with other stresses,
(2) ecology of plants in aquatic ecosystems and
(3) the development of the tools for implementation of EC Water Framework Directive.

For more than 20 years she is researching the world known phenomenon - the intermittent Lake Cerknica. She is a member of different scientific organisations, president of Association of Biologists of Slovenia, editor of scientific journal Acta Biologica Slovenica and a member of EASAC Environment Steering Panel.

Short institution presentation

Biotecnical faculty is part of the University of Ljubljana. The mission of the faculty is to offer bachelor, master and doctoral study programmes in the areas of biology, microbiology, agriculture, forestry, wood and food science and biotechnology and landscape planning. All the educational research disciplines incorporate the issues of management of natural resources namely biota, soil, water and space. The research work includes high quality basic research and the research oriented toward sustainable management of natural resources.

UV reflectance in different stands in intermittent wetland

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ABSTRACT

The presentation summarises preliminary results on UV reflectance in different stands in intermittent wetland. The stands were selected in the area with high homogeneity. Both monospecific (e.g. *Polygonum amphibium*, *Euphorbia lucida*, *Phalaris arundinacea*) and mixed stands were monitored. We examined reflectance spectra in the range from 290 to 887 nm. Twenty scans of each stand were performed. Stands were monitored from 2 to 4 times during the season. At each sampling selected properties of plants and plant stands were estimated.

We hypothesised that the majority of photons in UV-A and UV-B spectra will be absorbed in the plant tissue. However the reflection spectra in visible and UV-A range were shaped according expectations, while in UV-B range the results were very variable. In some stands the measured values were scattered around zero, while in many of them relatively strong reflectance in UV-B range was observed. The pattern was changing during the vegetative season. The comparison of stands' response with single plant response showed little accordance; therefore we presume that the reflection is likely to be a consequence of the stand structure. Further investigations are needed to elucidate this phenomenon.

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Short biography

Dr. Alan Jones is a postdoctoral research associate at Aberystwyth University, working in Dr Dylan Gwynn-Jones' research group. His NERC funded research investigates combined drivers of vegetation change, including UV-B, in a sub-Arctic high-latitude ecosystem. Alan gained his PhD in Plant Ecology from Imperial College, London, having demonstrated evidence of widespread disturbance in heathland ecosystem functioning in the UK attributable to elevated atmospheric nitrogen deposition. A previous postdoctoral position at the University of Tasmania, Australia, contributed to the development of a conceptual model that described processes of eucalyptus forest degradation, occuring due to wildfire absence. This was supported directly by evidence from an extensive biogeochemical survey of native forests.

Alan specialises in the mechanisms of plant-soil interactions, including extracellular soil or litter enzyme activities and nutrient turnover, to understand their relationships with external drivers of ecosystem-level change.

Short institution presentation

The Institute of Biological, Environmental and Rural Sciences (IBERS) is a world class award winning research and teaching centre at Aberystwyth University. IBERS is an internationally recognised centre of excellence and students' choice for the study of biological, environmental and rural sciences.

IBERS is a new venture that has brought together staff from the Institutes of Rural Sciences and Biological Sciences at Aberystwyth University, and the Institute of Grassland and Environmental Research (IGER). Around 300 research, teaching and support staff conduct basic, strategic and applied research in biology from the level of genes and other molecules to the impact of climate change and bio-energy on sustainable agriculture and land use.

Effects of elevated UV-B and species dominance on enzymatic decomposition processes in a sub-Arctic heath

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ABSTRACT

Enhanced UV-B exposure at high latitudes is a potentially important factor affecting rates and pathways of organic matter decomposition in plant communities. UV-B is believed to impact on secondary metabolite production in leaves and such secondary compounds can be inherited in plant litter with implications via litter inputs and soil. Furthermore, UV-B directly affects the soil and litter surface, altering litter structure (by photodegradation) and decomposer microbial communities, respectively. Decomposition is inherently slow in high latitude environments as dictated by substrate (litter) quality and microbial activity limited by temperature and moisture availability

In this study we investigated whether enhanced UV-B and plant litter type (species) influence the rate of litter breakdown by focussing on the rates of extracellular enzyme activities in soil and litter (acid-phosphatase and phenol-oxidase). The enzyme activities were measured on material from heath vegetation exposed to enhanced ambient UV-B radiation over two decades in Abisko northern Sweden (68^{o}N). To investigate the importance of plant type for enzyme activity we collected soil and litter samples from replicated plots varying in dwarf shrub species dominance (*Empetrum hermaphroditum*, *Vaccinium myrtillus*, *Vaccinium vitis-idea* and *Vaccinium uliginosum*). Results suggest that enhanced UV-B reduced enzyme activities but these effects were not statistically significant. However, there were far stronger impacts via litter type with the dominant heath species *E. hermaphroditum* showing between 25 and 80 per cent higher levels of enzyme activity overall, compared with sampling beneath the other plant species. The investigation suggests that the detectability of elevated UV-B on enzymatic decomposition may potentially be overwhelmed by inherent variations in *Empetrum* dominance within the elevated UV-B experiment. The finding also evidences the tight nutrient cycling processes occurring within dominant stands of this key high latitude heath community.

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Short biography

Dr. Riikka Rinnan is an associate professor at the Terrestrial Ecology Section, Department of Biology, University of Copenhagen in Denmark. Her research focuses on ecosystem responses to environmental changes (increasing UV-B radiation, climatic warming, ground-level ozone etc.), particularly in the Arctic. Her research interests include ecosystem gas exchange, especially biogenic volatile organic compound (BVOC) emissions, plant-microbe interactions and plant ecophysiology.

Native of Finland, Dr. Riikka Rinnan received her MSc (1999) and PhD (2003) in Environmental Sciences from the University of Kuopio (now University of Eastern Finland), Finland under her maiden name Riikka Niemi. She has been a postdoctoral researcher at the University of Kuopio, the University of Copenhagen in Denmark and Lund University in Sweden.

Short institution presentation

Founded in 1479, the University of Copenhagen is the oldest university in Denmark. With over 37000 students and more than 7000 employees, the University of Copenhagen is the largest institution of research and education in Denmark. The Department of Biology is the largest institute at the Faculty of Science of the University of Copenhagen. At present the staff includes more than 400 employees, and the research areas span from molecular research to marine biology.

The UVOCARB project: Effects of UV-B radiation on gas exchange, vegetation and rhizosphere microbial communities of a peatland ecosystem

Riikka Rinnan, *Sami Mörsky[2], Jaana Haapala[3], Päivi Tiiva[2], Patrick Faubert[4], Sanna Saarnio[3], Pertti Martikainen[2], Jouko Silvola[3], Hanne Suokanerva[5], Kirsi Latola[6], Esko Kyrö[5], Toini Holopainen[2]*

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ABSTRACT

Peatland microcosm experiments conducted in the late 1990's showed that methane (CH_4) emission from the waterlogged peat may be altered by enhanced UV-B radiation via effects on plants. To find further evidence on this, we conducted a field experiment with modulated UV-B exposure simulating 20% depletion in the ozone layer on a pristine mesotrophic fen in Northern Finland (67°22'N, 26°39'E) in 2002-2008. We studied CH_4 emission, CO_2 exchange, emission of reactive volatile organic compounds (VOCs), soil microbial communities and soil chemistry at plot level, and photosynthesis-related parameters, growth, plant anatomy and chemistry at plant level. We found that despite slight increases in the concentrations of CH_4 precursors and altered microbial communities in the peat under enhanced UV-B, there were no significant effects on net CH_4 emission. However, the ecosystem dark respiration was slightly lower in the UV-B treatment possibly due to the responses belowground. Photosynthesis and the cell fine structure of the dominant plant species, *Eriophorum russeolum*, were unaffected, but there were alterations in the concentrations of soluble sugars and UV-absorbing compounds. Enhanced UV-B had limited effects on VOC emissions from vegetation. However, during a warm period, the emission of the most emitted individual compound, isoprene, increased by enhanced UV-B. In this presentation, the main results of the long-term field experiment are reviewed.

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Short biography

Born in 1955. Master degree in plant physiology at University of Trondheim in 1984. PhD in plant physiology at the Norwegian University of Life Sciences with the thesis "Influence of photoperiod and temperature on dry matter production in plants" in 1991. Since 1991 associate professor and later full professor in plant physiology at the Norwegian University of Life Sciences in Ås.

Main research topic has been lichen ecophysiology and especially functional roles of secondary lichen metabolites. Especially chlorophyll fluorescence techniques has been used both for the study of photosynthetic performance and for estimation of UV screening efficiency in lichens and also in fruits and vegetables. UV-induction of secondary compounds in lichens and also of flavonoids in fruits and vegetables has been studied. Responsible for teaching student courses in plant ecophysiology and in photobiology.

Short institution presentation

Norwegian University of Life Sciences (UMB) is situated 35 km south of Oslo. It was founded in 1859 as the only Norwegian Agricultural Postgraduate College. It has 8 departments; Animal and Aquacultural Sciences; Chemistry, Biotechnology and Food Science; Ecology and Natural Resource Management; Economics and Resource Management; Landscape Architecture and Spatial Planning; Mathematical Sciences and Technology; Plant and Environmental Sciences; International Environment and Development Studies.

In 2011 in total 3660 students including 1280 bachelor students, 2170 master students and 456 PhD students studied at the University. 21% of the students were international students. The subject area of Department of Ecology and Natural Resource Management includes fundamental biology and ecology, natural resource management and forest science.

Cryptogams and UV – impacts and interactions

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ABSTRACT

Effects of UV on cryptogams will first in general be compared with effects of UV on higher plants. Thereafter, studies with enhanced UV on especially lichens and mosses in natural ecosystems will be reviewed. Experimental studies on effects of UV on synthesis of UV-absorbing compounds in lichens will be discussed in more detail. Some of these fungal synthesized UV-B absorbing compounds seem not to be necessary for protection against present levels of natural UV-B although their synthesis is induced by UV-B. However, some of these compounds may have other effects as protection against high visible light or as antiherbivory substances. Possible advantageous effects of UV-B on cryptogams by reducing the amount of pathogens will be shortly discussed.

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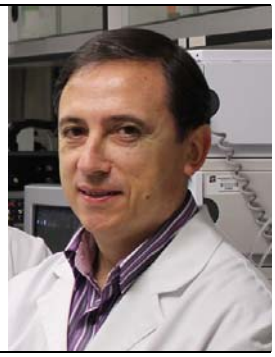

Short biography

Born in Pamplona (Navarra, Spain). Graduate in Biology (Universidad de Navarra, 1984), PhD in Biology (Universidad de Navarra, 1989), Assistant professor (Universidad de Navarra, 1985-88), Associate professor (Universidad de Zaragoza, 1988-92) and permanent professor (Universidad de La Rioja, 1992-present). Professor (Catedrático) of Botany at the Universidad de La Rioja since 2009. I mainly teach Botany (at least I try).

My research is focused on: 1) the ecophysiology of bryophytes (mosses, liverworts and hornworts) and grapevine, mainly in relation to UV radiation; and 2) the use of mosses as pollution biomonitors. 22 peer-reviewed papers on UV. President of the Spanish Bryological Society since 2009. Supporter-sufferer of Real Madrid.

Short institution presentation

The Universidad de La Rioja (UR) is a public institution of higher education based in Logroño, a comfortable northern Spain city of 150 000 people located in La Rioja, probably the most famous Spanish wine region with more than 400 cellars. Segregated in 1992 from the Universidad de Zaragoza, the UR currently teaches 19 degrees adapted to the European Higher Education, including Agriculture Engineering and Enology as the degrees most related to biology. The UR also has a program of masters, summer courses and courses of Spanish language and culture for foreigners. The total number of students at UR is around 7000 and the teaching-and-research staff is composed of about 450 people. There is a Faculty of Science (840 students and 168 teachers in 5 degrees and 6 masters), and a Department of Food and Agriculture (40 members).

One of the main research topics in the UR is everything related to wine and grapevine. The UR belongs to the Campus of International Excellence "Iberus" since 2010, together with the public universities of Zaragoza, Navarra and Lérida.

Effects of UV-B radiation on bryophytes

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ABSTRACT

Ultraviolet (UV) radiation is an ecological factor that has accompanied life since its origins and whose study has increased greatly since the discovery of the stratospheric ozone reduction. This reduction leads to an increase in UV-B radiation at ground level, which may damage photosynthetic organisms. Some habitats frequently dominated by bryophytes may be particularly affected by enhanced UV-B, such as circumpolar bogs and mountain streams above the timberline.

Here we describe the effects of UV-B on bryophytes, on the basis of laboratory and field experiments. In the laboratory, UV-B stress may be preferentially indicated by a decrease in the maximum quantum yield of photosystem II (F_v/F_m), chlorophylls/phaeopigments ratios, chlorophyll *a*/*b* quotient, and net photosynthesis rates. Thus, the effects of UV-B on bryophytes do not seem to be very different to those found in other photosynthetic organisms. However, bryophyte responses to UV-B are still poorly understood, and thus further study is recommended, taking into account that responses depend on both the species and the interacting environmental factors.

The bryophytes studied mostly seem to be UV-B-tolerant, in some cases due to the accumulation of protecting UV-absorbing compounds. Liverworts seem to have higher amounts of both constitutive and inducible UV-absorbing compounds than mosses. This difference could support the recent finding that both groups are more phylogenetically distant than previously thought.

Bryophytes have been used as bioindicators of numerous pollution processes and environmental changes, and we propose the use of certain individual UV-absorbing compounds of the liverwort *Jungermannia exsertifolia* subsp. *cordifolia* as UV-B biomarkers.

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Short biography

Anna Hyyryläinen is a PhD student at the University of Oulu (Finland) and, starting 2009, an outside researcher at the Finnish Forest Research Institute (Rovaniemi Unit).

Her principal field of interest is bryology. She graduated from Vilnius University (Lithuania), as a MSc in biology. The Master thesis focused mainly on population biology of bryophytes (the topic "Specifics of bryoflora of Vilnius University Botanical Garden in Kairenai and some patterns of populations functioning of thalloid liverwort *Marchantia polymorpha L.*"). The Bachelor thesis was based on floristic studies (the topic: "Mosses of Varnikai botanical zoological reserve").

In 2007 she joined the team of professor Satu Huttunen, to do the PhD research in the field of plant ecophysiology at the University of Oulu. In her doctoral studies she focuses on UV effects on peat mosses. In 2007 she worked at the Artic Centre (University of Lapland) as a research assistant, and in 2008 as a project assistant at the University of Oulu. During 2007-2010 she was involved in ECOREIN project (The ecological and socioeconomical responses of global change on reindeer pastures, 2001-2011).

Short institution presentation

The University of Oulu is an international research and innovation university engaged in multidisciplinary basic research and academic education. It is one of the largest universities in Finland with an exceptionally wide academic base. The fields of Information Technology; Biosciences and Health; Cultural Identity and Interaction; and Environment, Natural Resources and Materials have been defined as special research focus areas. The University cooperates closely with industry and commerce, and has broad connections with hundreds of international research and educational institutions. One of its units, Thule Institute, promotes multidisciplinary research in the field of environmental and northern issues and natural resources. Its research programs include Global Change in the North, Northern Land Use and Land Cover as well as Circumpolar Health and Wellbeing.

METLA

The Finnish Forest Research Institute (Metla) was established in 1917. It is one of the biggest forest research institutes in the whole Europe. Metla is a governmental institution, subordinate to the Ministry of Agriculture and Forestry of Finland. Its goal is to develop solutions to the challenges posed by the care, products, services and intangible value of forests, to promote, through research, the economical, ecological, and socially sustainable management and use of forests.

Seasonal and interannual variation in Sphagnum chlorophyll under manipulated solar UV-B and temperature

***Anna Hyyryläinen*[1,2]**, *Françoise Martz*[2], *Pasi Rautio*[2], *Minna Turunen*[3], *Satu Huttunen*[1]

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ABSTRACT

Sphagnum mosses play a key role in regulating and sustaining one of the most vulnerable ecosystems on Earth: peatlands. Little is known about the synergetic effects of solar UV-B radiation and temperature on various species of peatmosses. A long-term field experiment was carried out in northern Finland to follow the seasonal and interannual changes in *Sphagnum* chlorophyll under attenuated UV-B and varying temperature. The environmental conditions were manipulated using UV-B absorbing filters. The treatments included 1) ambient conditions 2) –UVB, polyester filters (solar UV less than 1% below 315nm, temperature increased by 0,5-1ºC) 3) control, cellulose acetate filters (ambient UVB, increased temperature). Each of the studied species of *Sphagnum* (*S. balticum*, *S. jensenii* and *S. lindbergii*) showed a specific seasonal pattern of changes in chlorophyll content under experimental conditions. In the beginning of the growing season 2008, the chlorophyll content in the dominating *S. lindbergii* was double in ambient plots compared to control and -UVB treatments. However, by the end of August, in all the treatments it reached similar values. In the end of summer 2008, *S. lindbergii* showed a significant increase in total chlorophyll, while it decreased in the other two species under the same conditions. Different responses of the studied peatmosses to the changes in the environmental conditions may result in their different occurrence in the habitat.

Nancy de Bakker

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Short biography

Nancy de Bakker obtained her MSc degree in marine biology from the University of Groningen, The Netherlands. Her PhD research at the VU University Amsterdam focused on the effects of UVB radiation on charophytes and bryophytes. This research was part of the European UVAQTER project, a cooperation between research groups from The Netherlands, Sweden, Slovenia and Germany.

Having finished the project, she has been working as an ecologist at the environmental consultancy firm, b&d Natuuradvies in Haarlem and participated in some research projects at Leiden University. Her thesis "The effects of UVB radiation on charophycean algae and bryophytes" is available online at http://dare.ubvu.vu.nl/handle/1871/23931.

Short institution presentation

The UV research presented at the UV4Growth conference was conducted at the Department of Systems Ecology of the Faculty of Earth and Life sciences of the VU University Amsterdam. This research group studies the effects of climate and land-use change on biodiversity, trophic interactions and thereby the fates and rates of carbon, nutrients and water in ecosystems (http://www.falw.vu.nl/nl/onderzoek/ecological-sciences/systems-ecology/index.asp).

b&d Natuuradvies is an environmental consultancy firm that works in the fields of urban ecology, vegetation monitoring, and ecological river bank monitoring and management (http://www.bendnatuuradvies.nl).

The effects of UVB radiation on charophycean algae and bryophytes

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ABSTRACT

Effects of UVB radiation on both charophytes and bryophytes had been studied only to a limited extent before. Both plant groups are considered to be 'lower' plants. Their plant protection mechanisms against UVB radiation are largely unknown.

Charophytes live in shallow freshwater systems. Here, several environmental conditions like reflection and attenuation, alter radiation conditions (including UVB). In addition, submerged vegetation, especially charophytes, contribute to increasing water transparency, facilitating deeper penetration of UVB radiation. Ozone depletion may lead to further UVB radiation in these systems. Charophytes appeared to be sensitive to UVB radiation, but under natural conditions the water column may act as external UVB screen. However, under specific condition the fluctuating water table may result in UVB exposure to charophytes for certain periods annually.

Bryophytes live in many different habitats worldwide. They depend on sufficient air humidity to be physiologically active. Their ability to survive desiccation and absorb nutrients from fog and rain give them the opportunity to grow in many habitats. Studies on algae revealed that habitat conditions, such as UVB exposure, influenced the sensitivity to UVB radiation. If this is a general rule, UVB sensitivity in bryophytes may also be affected in accordance to the degree of UVB exposure at their respective habitats. We studied UVB effects in nine bryophyte species from three habitats in The Netherlands. Habitat origin seemed to influence the sensitivity of species against UVB radiation, with, paradoxically, increased sensitivity in species from those habitats that experience higher exposure to UVB under natural conditions.

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Published by University of Girona
Address: Maria Aurèlia Capmany, 69, Girona 17071 (Catalonia), Spain. http://www.udg.edu/

Title: Abstracts of the "Plant responses to UV radiation: from individuals to ecosystems" WG4 mini-conference of UV4growth COST-Action FA0906, Girona, Catalonia, Spain, 25-26 April 2012
Edited by: Verdaguer D. & Llorens L.
ISBN 978-84-8458-389-9