Plants and flood risk in *Annals of Botany*

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Special Issue on *Vulnerability to, and management of, plant communities in the face of increased flood risk*

Publication due Spring 2020

Primary research, reviews, viewpoints, and research-in-context articles are welcomed.

Deadline for Submissions: 15 March 2019

Please send an outline proposal by 30 December 2018 to office@annbot.com

Guest Editors

Tjeerd Bourma (Royal Netherlands Institute for Sea Research, NIOZ) and Hanna Mossman (Manchester Metropolitan University, UK)

AoB Editor

Mick Hanley (University of Plymouth, UK)

The increased likelihood of extreme weather events poses a major flood risk, but only recently have we begun to examine how plants and plant communities, respond to, and recover from, prolonged immersion in fresh- or saline-water. In addition, we understand remarkably little about the role vegetation plays in mitigating flooding. This Special Issue brings together new research on how agricultural, and (semi-) natural coastal and riparian vegetation respond to flooding, and how we can incorporate habitats like sand dunes, mangrove forests, and wetlands into integrated flood defense strategies.

The *Annals of Botany* Special Issue will cover:

- The ecophysiological effects of freshwater and seawater flooding on plants
- Observed and/or modelled community-level transitions resulting from acute flooding scenarios
- Disruption of plant-microbial and/or plant herbivore interactions
- Ecosystem service provision and the economics of plant communities as flood defences
- All habitats relevant to understanding flood defence; ranging from sub-tidal seagrass meadows to upland mires

Plants and flood risk in *Annals of Botany*

Waterlogging tolerance in the forage legume *Melilotus siculus*

Annals of Botany 121: 699-709, 2018
doi: 10.1093/aob/mcx202

Messina (*Melilotus siculus*, Fabaceae) is a waterlogging-tolerant annual forage legume, but data were lacking for the effects of waterlogging on nodulated plants reliant on N_2 fixation. **Konnerup *et al.*** find that plants inoculated with the appropriate rhizobia, *Ensifer* (syn. *Sinorhizobium*) *medicae*, formed nodules. Nodulated plants grew similarly well as plants fed NO_3^-, both in drained and waterlogged conditions. In waterlogged conditions the relatively high respiration rates of nodules relied on O_2 movement via the secondary aerenchyma (phellem) in hypocotyl, roots and the outer tissue layers of nodules, which we demonstrated using microelectrodes.

Authors: Dennis Konnerup, Guillermo Toro, Ole Pedersen, and Timothy D. Colmer

Responses of a coastal halophyte to combined salinity and hypoxia

Annals of Botany 119: 965-976, 2017
doi: 10.1093/aob/mcw282

Suaeda maritima is a halophyte commonly found on coastal wet lands in the intertidal zone. Due to its habitat, *S. maritima* has evolved tolerance to high salt concentrations and low oxygen conditions (hypoxia) in the soil caused by periodic flooding. **Behr *et al.*** analyse the metabolic and physiological adjustment of *S. maritima* to combined salinity and hypoxia. The results show that the combination of high salinity and oxygen depletion cause an ionic imbalance and an increase of metabolites associated with osmotic stress. Alanine fermentation and a partial flux of the tricarboxylic acid (TCA) cycle contribute to control the anaerobic energy metabolism during hypoxic conditions in the root.

Authors: Jan H. Behr, Alain Bouchereau, Solenne Berardocco, Charlotte E. Seal, Timothy J. Flowers and Christian Zörb

Aquatic adventitious roots of alligator weed and capacity for oxygen absorption

Annals of Botany 118: 675-683, 2016
doi: /10.1093/aob/mcw051

The formation of aquatic adventitious roots is a common response of terrestrial plants to flooding. Previous research has found that aquatic adventitious roots on submerged plants can absorb water and nutrients but no experimental evidence hitherto has shown that adventitious roots can absorb oxygen, which benefits the submerged plants. In this study, **Ayi *et al.*** (pp. 675–683) demonstrate that the aquatic adventitious roots of alligator weed (*Alternanthera philoxeroides*) formed upon submergence can absorb O_2 from ambient water, thereby increasing the oxygen content in plant tissues. This enables the efficient utilization of carbohydrates for vigorous root growth and extending the plant's life-cycle.

Authors: Qiaoli Ayi, Bo Zeng, Jianhui Liu, Siqi Li, Peter M. van Bodegom, and Johannes H. C. Cornelissen

Potential benefits of flood-induced adventitious roots depend on duration of submergence

Annals of Botany 120: 171-180, 2017
doi: 10.1093/aob/mcx049

The formation of aquatic adventitious roots (ARs) is considered an important adaptation to the adverse conditions of flooding. These roots replace the original root system, the growth of which is inhibited by oxygen deficiency in the flooded soil. New ARs are supposed to increase fitness during flooding by improving nutrient uptake. However, they may also incur costs to the plant's energy and carbohydrate budget. **Zhang *et al.*** show that the balance between the potential benefits and costs depends on the duration of partial flooding in *Solanum dulcamara* (Bittersweet). Net benefits were found in long-term but not in short-term flooding, indicating an adaptive role of ARs only during long-term flooding.

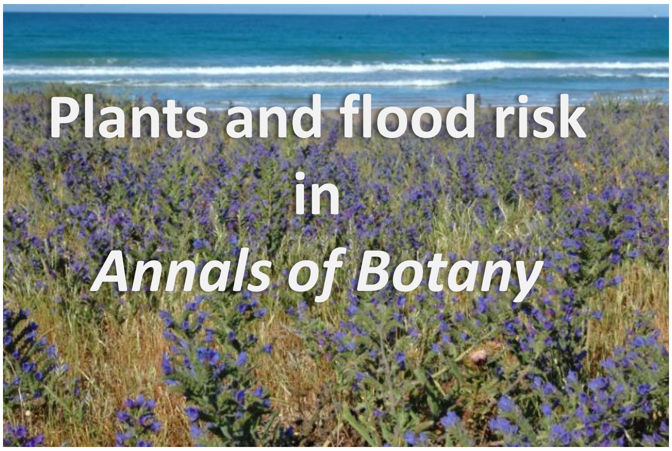
Authors: Qian Zhang, Heidrun Huber, Simone J. M. Beljaars, Diana Birnbaum, Sander de Best, Hans de Kroon and Eric J. W. Visser

White clover and seawater flooding

Annals of Botany 119: 477-485, 2017 doi: 10.1093/aob/mcu118

A combination of sea-level rise and increased storm surge events is likely to result in more frequent and severe episodes of salt water inundation into coastal vegetation. **White *et al.*** study responses of white clover (*Trifolium repens*), cultivated from parent ecotypes collected from a natural soil salinity gradient, to short-duration seawater flooding. They find short-term changes in leaf salt ion and solute concentrations, and longer-term negative impacts on plant growth (stolon elongation) and flowering. These responses are more pronounced in plants collected from less-saline soils, suggesting an adaptive capacity within some clover ecotypes that might confer resilience against future flooding.

Authors: Anissia C. White, Timothy D. Colmer, Greg R. Cawthray, and Mick E. Hanley



Cuticle hydrophobicity, gas films, flood tolerance and gas exchange in *Glyceria fluitans*

Annals of Botany 120: 521-528, 2017
doi: 10.1093/aob/mcx083

Some terrestrial plants possess superhydrophobic leaves that are water-repellent, and so can retain a thin gas film during submergence. This leaf gas film confers flood tolerance by enhancing exchange of O_2 and CO_2 from the floodwater. Floating sweet-grass (*Glyceria fluitans*) can form aerial as well as floating leaves. **Konnerup and Pedersen** used evolution of O_2 to measure underwater photosynthesis in relation to dissolved CO_2 on leaf segments with or without gas films. O_2 microelectrodes were used to assess cuticle resistance to O_2 uptake of floating leaves in the dark. *G. fluitans* showed high rates of underwater photosynthesis at environmentally relevant CO_2 concentrations. Interestingly, floating leaves performed better than aerial leaves, and so are particularly adapted to situations where the plant is partially, or occasionally, completely submerged.

Authors: Dennis Konnerup and Ole Pedersen

Hydraulic constraints to growth along a salinity gradient

Annals of Botany 115: 397-407, 2015
doi: 10.1093/aob/mcu257

The mechanisms underlying the characteristic growth enhancement of halophytic eudicots under saline conditions are unknown. **Nguyen *et al.*** combine physiological and anatomical analyses to study growth responses of the mangrove *Avicennia marina* to salinities ranging from fresh- to seawater conditions, and find that seedlings fail to grow in 0–5 % seawater, whilst maximal growth occurs in 50–75 % seawater. Anatomical studies show variation in rates of development and composition of hydraulic tissues that are consistent with salinity-dependent patterns in water use and growth. Specifically, seedlings grown in freshwater are slow to form the second vascular ring and it contains very few xylem vessels compared with those grown with salt, resulting in restricted availability of water to sustain carbon gain and shoot growth under freshwater conditions.

Authors: Hoa T. Nguyen, Daniel E. Stanton, Nele Schmitz, Graham D. Farquhar, and Marilyn C. Ball

Plant salt tolerance: adaptations in halophytes

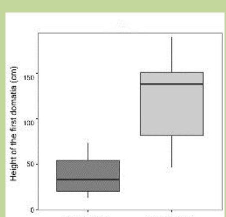
Annals of Botany 115: 327-331, 2015
doi: 10.1093/aob/mcu267

Background Most of the water on Earth is seawater, each kilogram of which contains about 35 g of salts, and yet most plants cannot grow in this solution; less than 0·2 % of species can develop and reproduce with repeated exposure to seawater. These ‘extremophiles’ are called halophytes.

Scope Improved knowledge of halophytes is of importance to understanding our natural world and to enable the use of some of these fascinating plants in land re-vegetation, as forages for livestock, and to develop salt-tolerant crops. In this Preface to a Special Issue on halophytes and saline adaptations, the evolution of salt tolerance in halophytes, their life-history traits and progress in understanding the molecular, biochemical and physiological mechanisms contributing to salt tolerance are summarized. In particular, cellular processes that underpin the ability of halophytes to tolerate high tissue concentrations of Na^+ and Cl^-, including regulation of membrane transport, their ability to synthesize compatible solutes and to deal with reactive oxygen species, are highlighted. Interacting stress factors in addition to salinity, such as heavy metals and flooding, are also topics gaining increased attention in the search to understand the biology of halophytes.

Conclusions Halophytes will play increasingly important roles as models for understanding plant salt tolerance, as genetic resources contributing towards the goal of improvement of salt tolerance in some crops, for re-vegetation of saline lands, and as ‘niche crops’ in their own right for landscapes with saline soils.

Authors: Timothy J. Flowers Timothy D. Colmer



Postponing the production of ant domatia as a strategy promoting an escape from flooding in an Amazonian myrmecophyte.

Annals of Botany, 122: xxx-xxx, 2018
doi: /10.1093/aob/mcy098

Authors: Thiago J Izzo, Maria Teresa Fernandez Piedade, and Wesley Dáttilo