Changing views in plant UV-research

From *damage* to *protection* to *source of information*

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OMI ten years of observations seminar at FMI
2 September 2014

This file is based on the talk I presented on 2 September 2014, at the seminar commemorating the 10th anniversary of the OMI instrument, held at the Finnish Meteorological Institute, Helsinki, Finland.

Department of Biosciences, University of Helsinki, Finland.
http://blogs.helsinki.fi/aphalo/

Outline

Our experiments in the field

Our collaboration with FMI

1. Important: our own data on the responses of plants plus simulated spectral data from FMI allow improved understanding
2. Most important: confrontation of different viewpoints and development of new ideas
3. Why does it work: open minded attitude on both sides and willingness to look at the big picture of ‘how things hang together’
4. Joint publications: 11 refereed journal articles and a handbook on UV research methods
5. Future plans: several and diverse

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Example: assessing experimental methods

- System: outdoors UVB enhancement with lamps
- Question: errors due to use of a ‘wrong’ *biological spectral weighting function* (BSWF)
- Answer: in some protocols not so much (shown) but much more in other cases
- Note: similar calculations were repeated for different localities and dates

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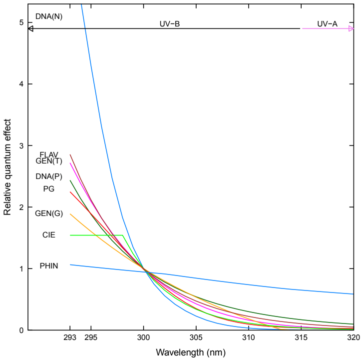

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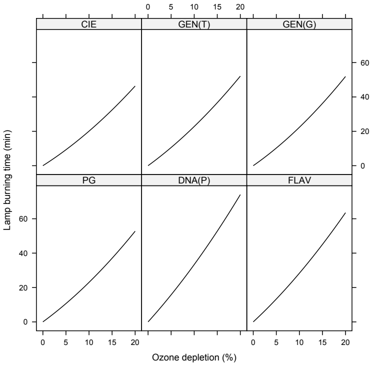

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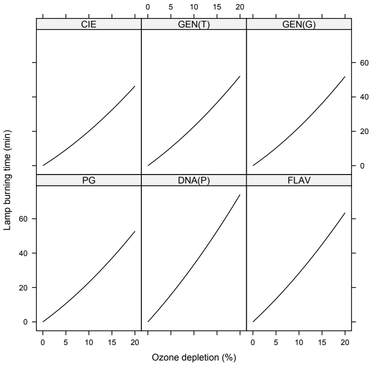

What is changing?

Changes in biologists' view of UV radiation's role

- Awareness: UV radiation plays important *ecological roles*...
- ... ⇒ UV climatology is needed for biological research
- Awareness: some reversible responses to UV radiation are fast (even hours or less)...
- ... ⇒ fine temporal resolution is important.
- Responses in the lab and field are frequently different...
- ... ⇒ use of mutants and molecular methods in the field...
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How questions versus *why* questions

- Pending task: Bridging the gap between molecular and ecological understanding
- We mostly know *how* UV perception and physiological responses work
- We do not really know *why* plants have acquired during evolution UV photoreceptors
- *How* questions have been mostly deciphered in the lab
- *Why* questions need to be studied in the field and through modelling
- Much of what we think we know about *why* questions on UV and plants are just *guesses*

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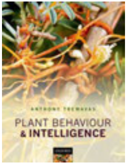
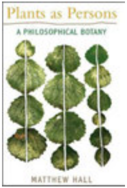
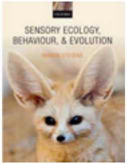
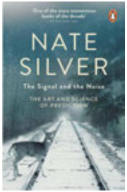
A turmoil of borrowed terms and ideas

Recent controversial concepts in plant biology









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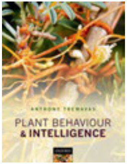

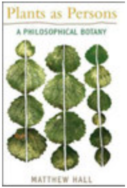

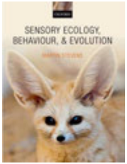

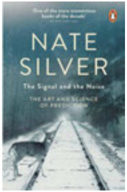

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- Plant behaviour → Mild controversy
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- Plant neurobiology → Rejected

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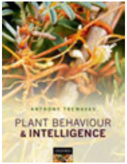

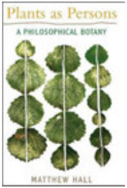

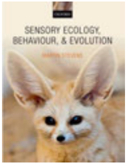

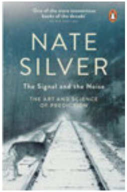

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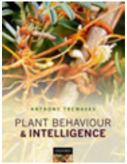

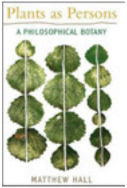

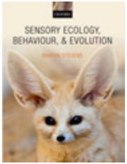

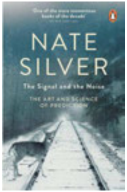

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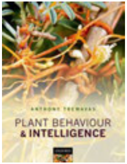

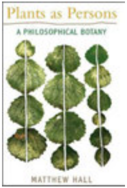

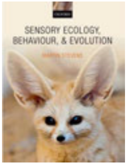

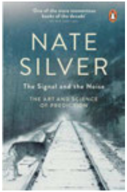

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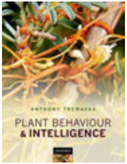

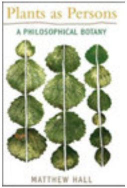

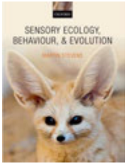

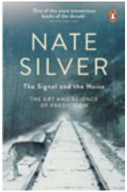

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Information and organisms

1. Organisms including plants *solve problems* to be able to survive and reproduce
2. Organisms use information from their environment to *predict future events*
3. Organisms need to adjust timing, function and structure based on possible future *events* to minimize *risk of death*. . .
4. . . . and to *best profit* from '*favourable times*'
5. Organisms have memory, in other words, store and integrate information in time
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How to answer *why* questions?

1. We know that plants can perceive UV radiation
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Sensory ecology approach

1. Focus on the acquisition and use of information by organisms
2. Well developed discipline for animals
3. Less developed for plants
4. Why?
5. . . . plants' behaviour is not easy for humans to observe (slow. . .)
6. . . . intellectually we find the idea of brainless organisms *solving problems* and *assessing risks* alien
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What sensory ecology tells us

1. Information sources are crucial to the performance and survival of organims. . .
2. . . . ⇒ cross-correlations among variables and their lags, and autocorrelations, are key sources of information
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Phenolics as sunscreens

Old but challenged

1. Old: epidermal phenolics are sunscreens
2. Not so old: phenolics are antioxidants
3. New: optical negative feedback role in UV perception
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UVB exposure enhances drought tolerance

Old: but *why* never formally tested

1. High UV irradiance triggers enhanced drought tolerance. . .
2. Question: is it theoretically possible to forecast future soil drying from UV exposure?
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Hypothesis old and new

New: UVB photoreceptor in sunlight

1. UVR8 has peak absorption near 280 nm...
2. ...but also a *long tail into the UVA*
3. ...and solar spectral irradiance has a very steep opposite slope
4. Question: what region of the solar spectrum is most effective for excitation of UVR8?
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Why is all this important?

In bold terms—real world is subtle and complex

1. If plants and other organisms are highly dependent on environmental correlations for their success...
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1. Very few biologists have the capability (equipment and knowhow) for acquiring on-site quality-assured UV data for their experiments
2. Biological studies of UV responses strongly depend on availability of good UV climatology data
3. Time series of UV-irradiance that can be matched in time and space with time series of other meteorological variables are extremely useful
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Thanks for listening!

Contact and acknowledgements

For additional information on our research, please have a look at our web site at http://www.helsinki.fi/bioscience/senpep/.

I can be contacted at mailto:pedro.aphalo@helsinki.fi

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