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

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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- 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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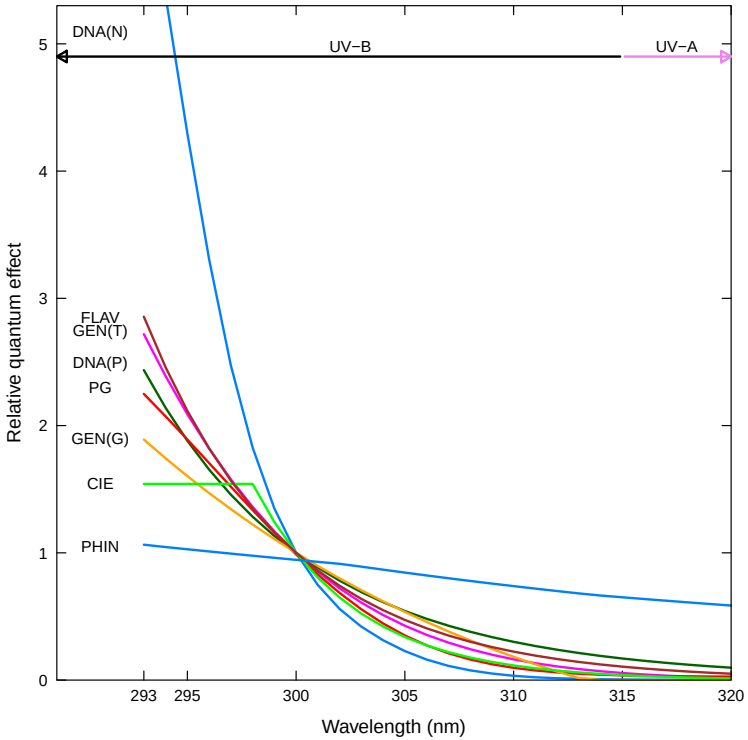

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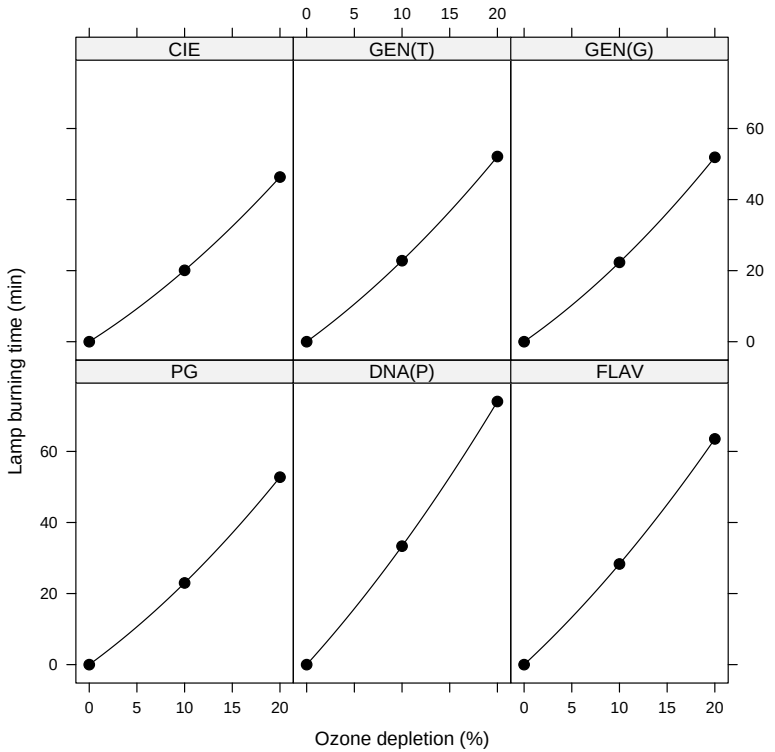

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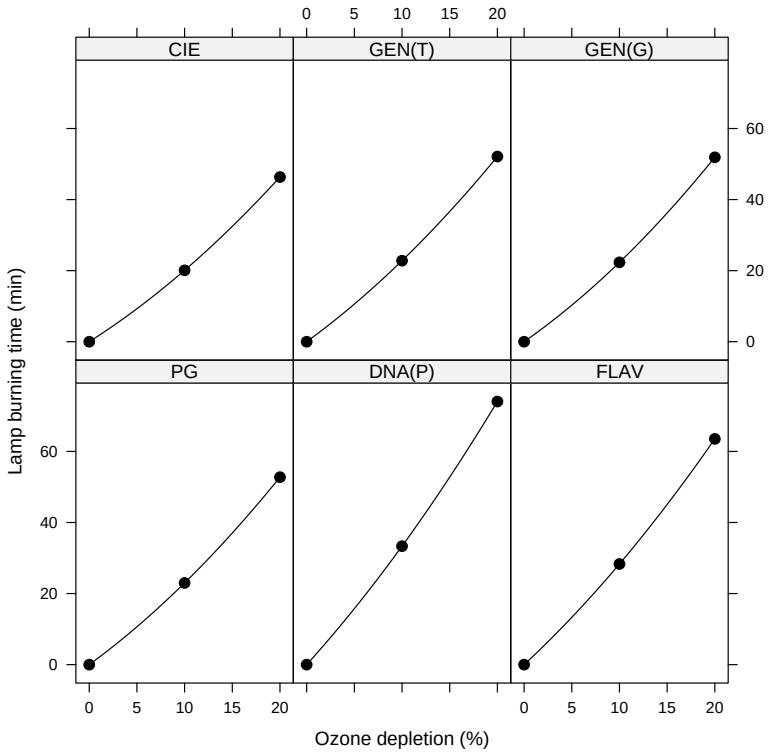

What is changing?
Changes in biologists' view of UV radiation's role

- 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

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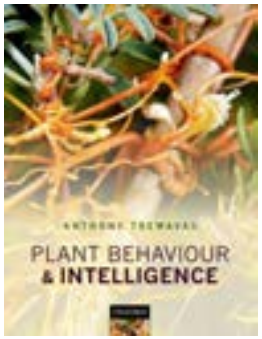

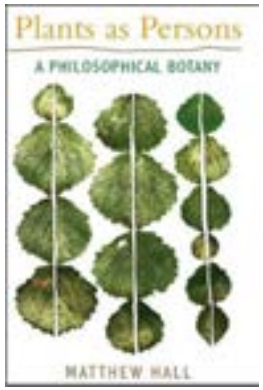

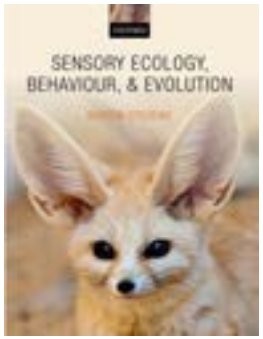

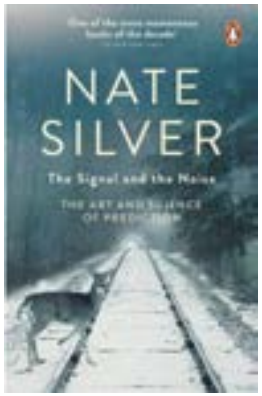

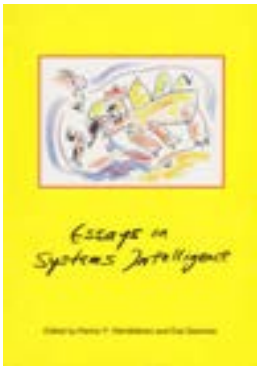

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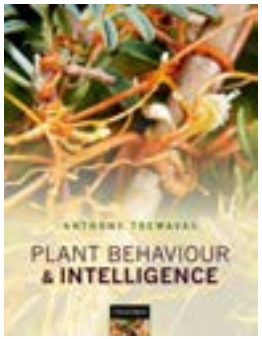

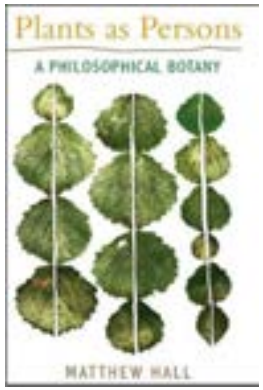

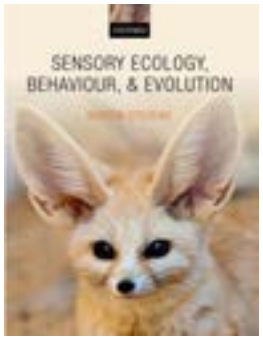

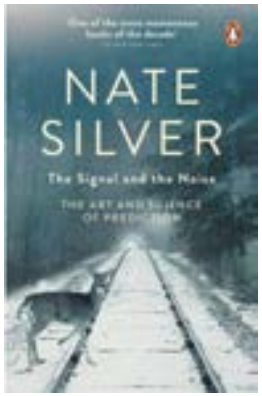

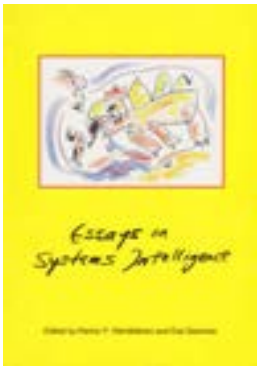

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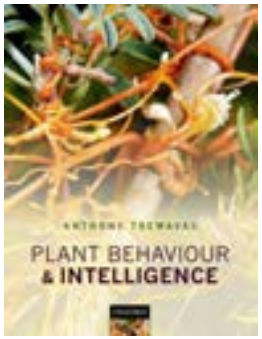

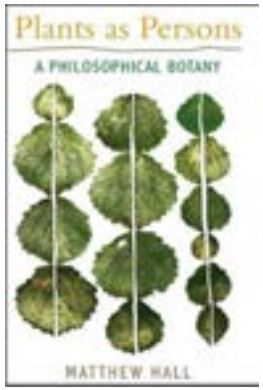

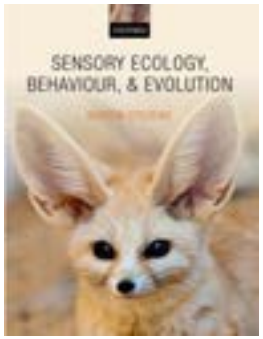

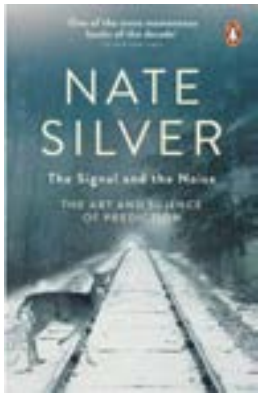

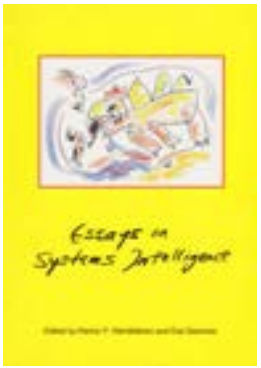

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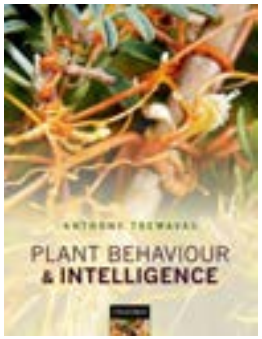

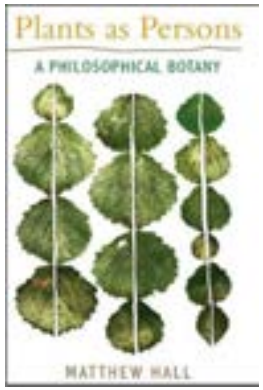

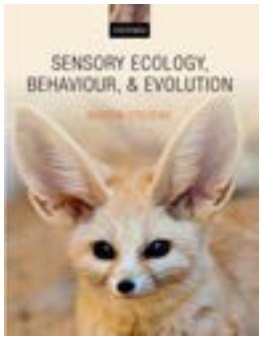

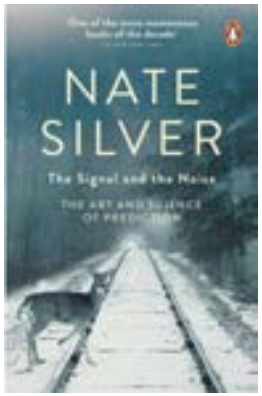

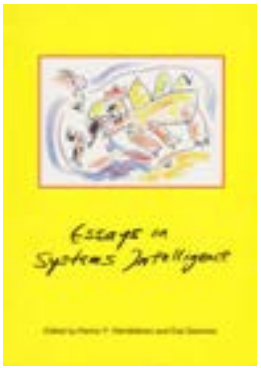

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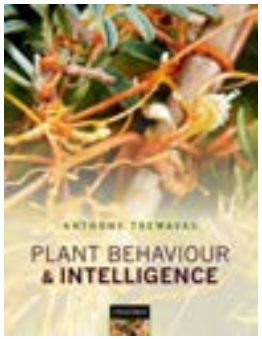

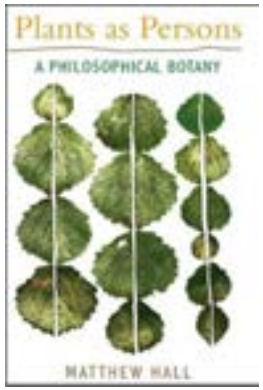

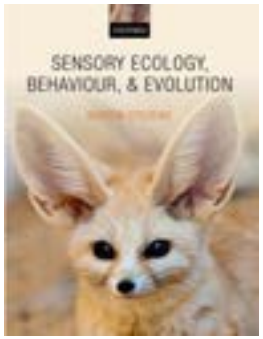

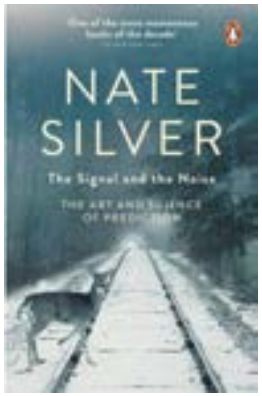

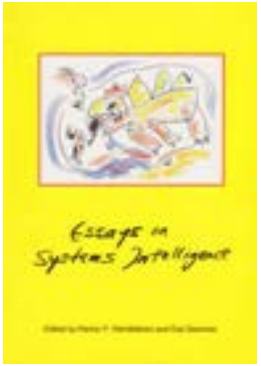

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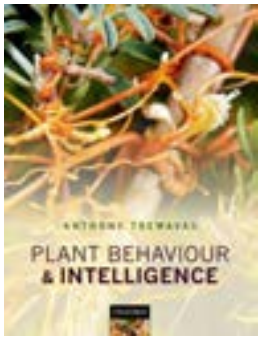

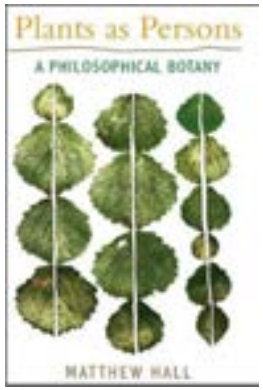

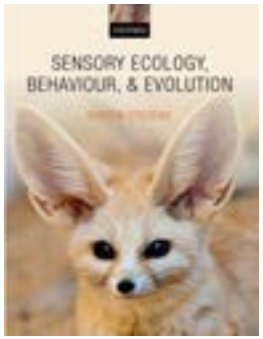

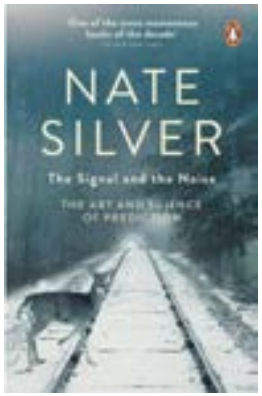

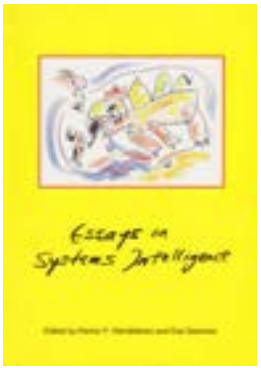

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What is the essence behind this war of words

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
6. Organisms exchange information 'messages' sometimes for mutual benefit, sometimes for deception

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How to answer *why* questions?

1. We know that plants can perceive UV radiation
2. If we accept that plants use UV spectral irradiance as a source of information. . .
3. . . . we need to find out what information UV radiation carries. . .
4. . . . and then do experiments to test if the response of the plant supports that this information is being really used

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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
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5. . . . plants' behaviour is not easy for humans to observe (slow. . .)
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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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Low UV irradiance triggers shade acclimation

New: one week old!

1. Old and demonstrated: low red:far-red ratio triggers *shade-avoidance*
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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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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
4. Spectral data, measured and simulated, is more valuable than summaries of effective radiation based on any single BSWF

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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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