Research Profiles

Interview with Steve Flint

T. Matthew Robson, ORCID: 0000-0002-8631-796X
ViPS, Department of Biosciences, University of Helsinki, Helsinki, Finland

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Introduction

I interviewed Steve Flint about his career as a researcher. Steve has participated in many of those studies in plant UV research that have laid the foundations for the development of the field. He has been a contributor to the UNEP panel assessing the environmental effects of ozone depletion and its interactions with climate change, and worked with Martyn Caldwell on action spectra since the 1970's: to the present day he participates in field experiments all over the world, recently with Ron Ryel and Paul Barnes investigating diurnal patterns in UV-absorbing compounds.

I know Steve from our time together working with Martyn Caldwell at Utah State University, where Steve generously allowed me to invade his lab while writing up my dissertation! Steve is amongst the shrewdest and most passionate scientists whom I have meet, with a staggering depth of knowledge of UV research and an eye for detail allows him to set up impressive and innovative experiments.

Questions and answers

Q How did you get started in research?

A I didn't have opportunities for undergraduate research, probably both because this was less common in the early '70s and I was at a smaller school that was less research oriented. One different thing that I did was take a couple of summer classes at a bigger institution (University of Washington in Seattle) between Junior and Senior years. (In the US, university tuition is particularly expensive if you are not a resident of that state. But summer is different—usually the out-of-state tuition is not charged. So as a Californian I attended the University of Washington that summer at resident rates.) That summer, plant ecology captured my interest more than freshwater invertebrates. We had a supplemental reading list, and the physiological ecology articles intrigued me. Instrumentation was much simpler – for example people measuring transpiration could publish comparative work where they never calculated absolute values, just the relative instrument responses.

Q And what about UV research? When did that first come on the scene?

A After finishing my MS (seed germination and weed ecology) I found temporary work for about 14 months in a poisonous plants lab. Then Martyn Caldwell had a postdoc that moved away, and I was in the right place at the right time to start working for him as a technician in '79. My initial work was treating germinating pollen with UV. Never expected the work in Utah to last for over 27 years—when Martyn retired, I continued doing the same work with Ron Ryel. I've been gone from Utah for almost 10 years now and still have things to write up!

Q Why did people think to start studying UV radiation? What were the expectations of its effect then?

A When Martyn began his field work on UV effects in the '60s, people knew that UV was more intense in the Alpine since mountain climbers experienced problems with sunburn. However, little work had been done with plants in the field. Laboratory work done in those days was not very helpful as the lamps that were used produced shortwave UV not found in sunlight. Ozone depletion was not an impetus for research till the

Figure 5.1: Steve Flint on Mauna Kea in 2005 during the measurement campaign when diurnal changes in epidermal UV transmittance first came to light—see Barnes et al. (2008). Photo kindly provided by Paul W. Barnes.

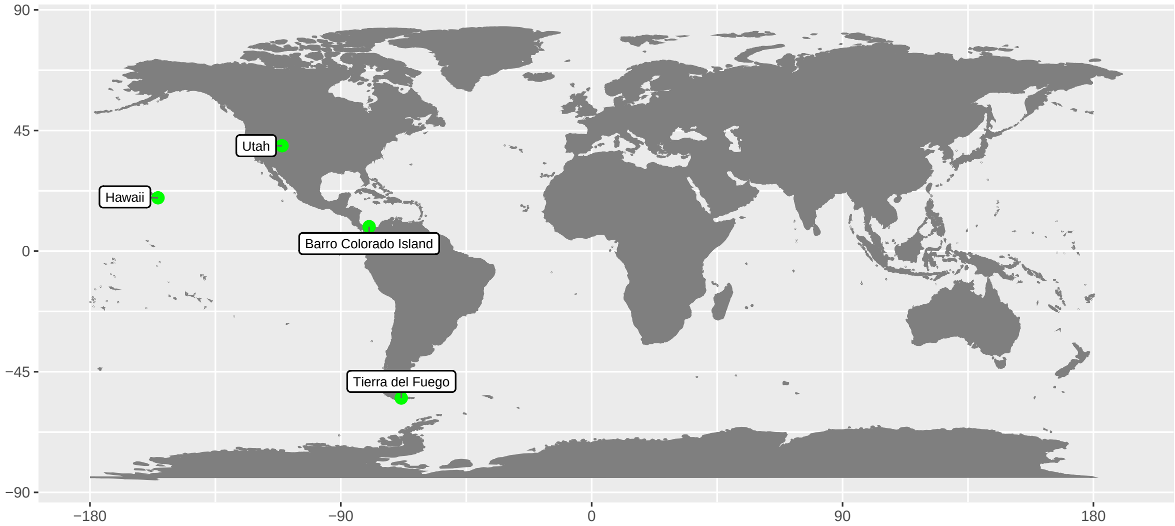

Figure 5.2: Sites where Steve D. Flint has done research.

'70s, and the ozone hole was not discovered till the '80s.

Q When the ozone hole was discovered did you (& others) already have an idea about how much / little effect this change in UV irradiance might have on plants?

A We already had suspicions that the effects would be fairly subtle. It is ironic to look back on this now and realize the major ozone hole effects are not UV related but are caused by changes in Southern Hemisphere wind patterns! (See Robinson and Erickson 2015)

Q You've worked in lots of exotic places! Where did you most enjoy doing field research?

A Tierra del Fuego. Waking up and seeing the wind howling from the west whipping up waves in the Beagle Channel almost every morning, and realizing Darwin's awkward square-rigged ship had to sail into it, made our problems keeping the filters intact seem fairly trivial.

Q What was it like doing field research with Martyn Caldwell?

A In the early days before I got to Logan the Desert Biome (International Biological Program) was funding a lot of people and USU had research in the cold desert—a remote site in Curlew Valley, north of the Great Salt Lake. Martyn had people doing field gas exchange, measuring root growth with root boxes, etc. and probably was in the field a lot those first few years ('68–'72). He even found time to go to the Arctic in summer of '70 and take some UV measurements. When I got to Logan (Utah) in '74 the ozone depletion issue had surfaced and I don't think he spent much time in the field after that. He typically had research going on two separate topics—UV was one and ecophysiology of cold desert plants was the other. This kept him in the office more than in the field.

Q Who was it most fun to do field work with?

A I should probably incriminate some people here…Actually, on the field projects away from Logan, I was most often involved in getting the projects set up. So I was following Martyn's lead and not getting in the field much myself!

One very different experiment occurred early in the Hawaii work with Ron Ryel. Ron had purchased a UV-A PAM for non-destructive epidermal transmittance measurements. Since this instrument was new on the market, we thought we would get a quick survey paper out before other people had a chance to do something similar. We knew that on the big island of Hawaii that mullein (*Verbascum thapsis*) grew from sea level to 13 000 feet (ca. 4 000 m). There should be a detectable gradient of epidermal transmittance as UV increased with elevation. We started with measurements at mid elevation, then went down to the coast and were shocked to see lower epidermal transmittance! We went back to the first site (we had marked the measured leaves) and the transmittances had changed. This diurnal change became the focus of several papers, and the original UV gradient epidermal measurements (from 2003 and 2004) are still not published!

Q When I was working on the Chile/Argentina border in Tierra del Fuego we had some run-ins with the border police, the *carabineros* from Chile and the *guarda parques* from Argentina. Did you ever get into scrapes with officialdom related to your field experiments?

A No run-ins come to mind, but this reminds me of an interesting story: In Panama (only a short time after Noriega was removed from office) there was occasional unrest in Panama City. People would warn us that there was chaos ahead, with burning tires etc., and suggest we take a taxi rather than the usual bus that ran through the area where the demonstrations were happening.

Q How did you and Martyn Caldwell get the idea to make an action spectrum? Tell us about the equipment you used?

A Martyn began this work during his doctoral research at Duke. Because the effectiveness of UV increased so dramatically at shorter wavelengths, it was clear that a function was needed to represent this so that "weighted UV-B" could be reported. Part of his work was experimental: irradiating leaves to quantifying epidermal tissue damage at different wavelengths. (A "home-made" monochromator was available at Duke; in the 90's it was no longer being used at Duke and we were able to move it to Logan for our action spectra work.) The second part was a literature review of existing action spectra. Together this became the "generalized plant response" in the early '70s, yet none of the spectra involved whole-plant responses of plants grown in light! This was why we continued to pursue the action spectra work.

Q What is the most difficult aspect of designing and making a good UV experiment, in your opinion?

A Selecting a proper control. Much more difficult than it would appear. In the early days people would occasionally try to compare plants under lamps with those in the open. That clearly wasn't appropriate, but this problem still surfaces once in a while. Then there was the problem of people hanging lamps at different heights. Many researchers trained in physiology do not realize how subtle differences in visible light (e.g., different shading by lamps hanging at different heights) can influence plant growth and confound an experiment. We did one experiment in Hawaii to address "global dimming", where we used an open plastic mesh (like would be used to keep birds off crops) as a source of 12% shade. For various reasons the results were mostly minimal, which is probably why few people have seen this work.

Q What is the most (and least) UV resistant plant species that you have ever worked on? (In my opinion *Nothofagus antarctica* is pretty resistant to most stresses!).

A Wheat seemed pretty tough—WoBey (ed. Wolfram Beyschlag) couldn't impair photosynthesis even with remarkably high UV.

Mustard family would be my guess as most sensitive. We didn't do much with them—one of the problems is some of the crop mustards are so sensitive to insects. Even if the seed are pesticide treated there are still insect problems. I did briefly grow a *Brassica* in a mechanistic field experiment (UV treatment vs. a control where solar UV-B was removed) and saw a reduction in shoot mass. Your question got me interested, so I looked to see if others found similar results—turns out only a few people have treated *Brassica* in the field. Surprising.

Q What is the most recurring problem that you find when reviewing papers related to UV?

A Experimental realism, closely followed by not having a good control and pseudoreplicating. As we learn more about plant responses and see how the acclimation responses even fluctuate on a diurnal basis, it is clear that realism in experiments is all that much more important. [We had a figure in Climatic Change (Caldwell and Flint 1994, Fig. 4) showing how most greenhouse and growth chamber conditions did not compare well with real field conditions (Fig. 5.3). Surprisingly some growth chamber trials were more realistic than the greenhouse!]

Control issues have ranged from filters that block different amounts of PAR in filtered sunlight experiments to hanging lamps at different heights to achieve different doses.

Pseudoreplication—using the plant rather than the plot—can give unrealistically "good" statistical results by increasing the degrees of freedom. Sometimes the plant (or pot) can be reasonably used as a replicate if there is rotation. But one always wonders if there are some under-replicated studies published with "good" results and a corresponding number of similarly under-replicated studies with no results that are never published?

Q Finally, is there a nagging unanswered question in UV research that you would have loved to get to the bottom of?

A Many people are headed in the right direction looking at the various indirect effects.

One thing that has bothered me is we are still using about the same system in field supplementation as in the '70s—fluorescent lamps. Someone should try using these huge UV lamps used in the printing process to cure ink. (I'm talking of big scary electronics here—thousands of watts.) They could be hung high; there would be no shading, and one could have a gradient of the dose. It might take some work filtering to get the right spectrum but would be a novel and potentially more realistic approach.

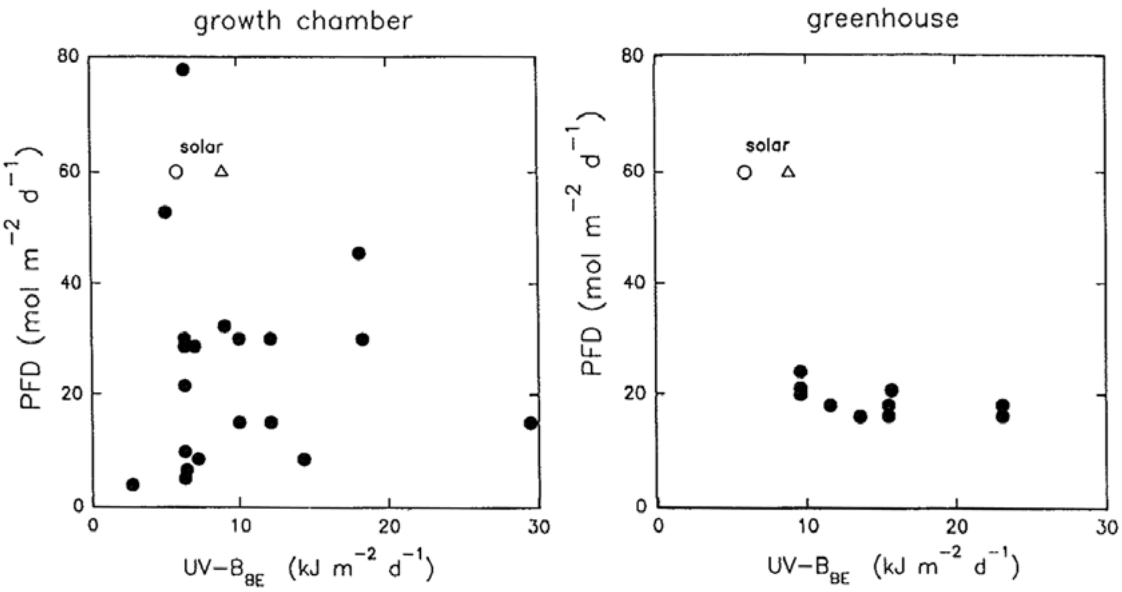

Fig. 4. Average daily integrated biologically effective UV-B using the generalized plant action spectrum weighting function (Caldwell, 1971) normalized to 300 nm (UV–B$_{BE}$) and total photon flux in the 400–700 nm waveband (PFD) employed in growth chamber and greenhouse experiments (•). For comparison, measured solar UV–B$_{BE}$ and PFD on a clear day (3 August 1993) at 1450 m elev. and 41° N latitude (○) and the corresponding value computed (using the measured values as a basis) for a 20% reduction of the ozone column (△). The same papers as surveyed for Figure 3 were used in this depiction.

Figure 5.3: Reproduced from *Climatic Change* (Caldwell and Flint 1994, , Fig. 4) with permission from the publisher, ©1994 Springer.

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Ten Key publications

Bibliometrics for Stephan D. Flint: H-index 38 from 86 publications, cited in 2930 articles. (Source: WoS, visited in April 2016.)

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Invitation If you know of someone whose life in UV-research you think would make an interesting feature for the uv4plants bulletin, let us know. Suggest an interviewee or do the interview yourself and submit it for publication!

