Maureen Hanson

How did you spend your career?

I attended Duke University and majored in botany, my interest stimulated by a summer research experience at USDA-ARS Beltsville after my freshman year and then another summer at UC-Davis. As I was not sure whether I wanted to stay in plant science; I entered graduate school in a Biology department at Harvard, where I eventually decided to complete my Ph.D. in Lawrence Bogorad's lab working on protein synthesis in Chlamydomonas chloroplasts. His lab was an exciting place at that time, where people were engaged in multiple and diverse projects. I acquired an NIH fellowship to become one of Fred Ausubel's first Harvard postdocs. I worked with Petunia, which at that time was in the running to be "the" plant model system, as the small genome size of Arabidopsis and its other valuable properties had not yet been recognized. Like my Ph.D. lab, Fred's also was engaged in a variety of projects, a strategy I eventually continued in my own lab.

My first faculty position was at the University of Virginia in Charlottesville. I was the first female faculty member in the Biology department, and one of only three female biologists on campus, the other two being in the medical school. I am pleased to note that the campus-wide women's faculty organization we started back then is still in operation. As one of only three plant biologists on the entire campus, I was also in a minority field. The fact that plant biology was held in some disdain by certain faculty members there was obvious enough to my students that one commented that her esteem went up when she came with me in 1985 to Cornell, where both basic and applied research on plants was well-regarded.

At Cornell I was tasked with building up the Plant Molecular Biology area. A number of key hires were made soon thereafter, including June Nasrallah and Steve Tanksley. I led a McKnight Foundation training grant in Plant Reproductive Biology, then an NSF/DOE/USDA Plant Science Center, which had a strong training component, following by an NSF/DOE/USDA Training Group grant. I am pleased to see the success of many graduate students who completed degrees in our Plant Cell and Molecular Biology Program at Cornell during that era and now are leading scientists in their universities, biotech companies, or government agencies.

What do you consider to be your most important contributions to plant science?

Certainly, a major privilege has been to be part of the training of a large number of talented undergraduate, graduate students, and postdocs who have had successful careers in a variety of fields and types of institutions.

When I was an Assistant Professor, my lab's major contribution was to identify the mitochondrial gene that encodes cytoplasmic male sterility in petunia. This finding, along with Sam Levings' group's discovery of the maize counterpart, led to the understanding that CMS genes are created through abnormal recombination of mitochondrial sequences to produce open reading frames encoding toxic proteins. After moving to Cornell, an arduous map-based cloning effort in my lab by Stéphane Bentolila led to the identification of the petunia fertility restorer locus, so that both the mitochondrial CMS gene and its nuclear restorer became known in the same species. A nucleus-encoded pentatricopeptide repeat (PPR)-containing protein prevents the expression of the toxic petunia mitochondrial protein. Now this gene family is known to encode fertility restorers in a wide variety of species.

After postdoc Rainer Kohler joined the lab, I asked him to label both mitochondria and chloroplasts by targeting GFP to the organelles, using a jellyfish GFP altered in 1995 for plant expression by Jim Haseloff's lab. As a result, in 1996

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we were able to observe frequent fusion and splitting of mitochondria and, more importantly, were able to see the tubular extensions of chloroplasts that had not previously been accepted as genuine features of chloroplasts, despite having been described by Sam Wildman and his early predecessors. GFP allowed us to characterize them not only in chloroplasts but also in non-green plastids. A relatively new photobleaching method made it possible for us to demonstrate that a variety of proteins could flow through them. We had the privilege of naming the stroma-filled tubular structures "stromules" and as of 2020, a Google Scholar search turned up 707 entries carrying the word "stromule." These chloroplast appendages have since been found to be relevant to a variety of phenomena; my latest review on this topic appeared this year.

I became intrigued with the phenomenon of RNA editing in plant organelles when it was reported by the groups of Gray, Grienenberger, and Brennicke in 1991. Our initial work furthered the understanding of the cis-elements that are important to specify the correct C for editing to U. Subsequently, my group has identified two small gene families, some of whose members comprise part of the editing complex (the "RIP" and "OZ" families). We have also detected the presence of editing factors in the larger Organelle RRM (ORRM) family. There is much still to learn about organelle RNA editing and how the "editosome" forms and functions, and it remains an active area of research in my lab.

In 2010, I participated in an NSF/BBSRC-sponsored "Ideas" lab about enhancing photosynthesis and became part of a new collaborative group. Prior to that time, though working on chloroplasts, my lab's emphasis had been on genetics, gene expression, and cell biology. As a result of a collaboration with Martin Parry's group, initially at Rothamsted and now at Lancaster University, we have ventured into the realm of photosynthetic biochemistry and synthetic biology. Cheryl Kerfeld introduced us to the cyanobacterial beta-carboxysome, which we are attempting to establish in the chloroplast through complex and demanding engineering of the chloroplast genome. Along the way, we have gained knowledge about the function of chloroplast carbonic anhydrases and have taken up a new project to alter the properties of Rubisco.

Not long after my lab acquired the new photosynthesis project, I decided to begin research on a disease. After a family member was diagnosed with Chronic Fatigue Syndrome, also known as Myalgic Encephalomyelitis (usually now called ME/CFS), I attended a few conferences about the illness and was dismayed to see the absence of molecular approaches. I felt someone with molecular biology expertise, albeit with plants, could make important contributions to the pathogenesis of this understudied disease. A story, not for here, could describe the considerable effort I made to enter this field, one which has now led to my establishing and directing an NIH Center at Cornell devoted to understanding ME/CFS, all the while continuing the above-mentioned plant research areas. I have enjoyed developing a second set of valuable colleagues, unknown to most readers of this text, with whom I collaborate, and am glad that I am now able to make important contributions in a completely different field. I am pleased that the plant and biomedical parts of my lab have sometimes cross-fertilized one another.

When did you become a member of ASPP/ASPB?

I joined ASPP as a graduate student in the 1970's and soon after attended a rather disastrous annual ASPP meeting at Cornell. Back then, meetings of large Societies, including ASPP, were usually at large universities rather than at conference centers or posh hotels, and often featured uncomfortable unairconditioned dorm rooms for attendees, as occurred at Cornell. The meeting happened to be what I later learned was during one of the only two weeks in Ithaca when the temperature and humidity routinely are both in the 90's. I still recall the poorly planned banquet—after passing through the line, people emerged into a hall that had, to their surprise, no chairs or tables. Realizing that eating the slabs of meat on our plates was not feasible in a stand-up banquet, everyone, including many well-dressed attendees, spontaneously decided to sit on the floor. Little did I know that I would spend most of my career at Cornell despite this unfavorable impression.

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How did the Society impact your career, and what motivated you to become a Founding Member of the Legacy Society?

ASPP was slow to incorporate the new molecular biology of plants into its programming, leading me to co-founding the International Society for Plant Molecular Biology with Leon Dure in the early 1980s. I hope that the creation of this organization helped influence ASPP to modernize. Indeed, the name of the Society was later changed to ASPB, and the society soon fully embraced molecular approaches, as likely was inevitable. In my years at UVA, I found ASPP meetings valuable to connect with the plant colleagues I lacked at my home institution. At that time, the current plethora of plant-focused Gordon Conferences and Keystone Meetings did not exist. In the early 1980s I served on the Board of Trustees for ASPP and have frequently been a member or chair of the ASPB Lawrence Bogorad Award committee after I received the first award in 2006. The importance of plant biology and agriculture to human life is often overlooked by governments when it is time to dole out research funds (an imbalance made even more acute by the present pandemic). Having a national organization to raise the profile of plant biology and to advocate for research funding for plants is essential given the current and future emergencies around food insecurity.

What important advice would you give to individuals at the start of their career in plant science?

There has already been a great deal of good advice dispensed to early career individuals by the Legacy members, but I'll attempt to make a few comments.

Finishing one's Ph.D. is both a milestone and a crossroad. It is a good time for graduates to carefully evaluate their goals, rather than proceeding lockstep to a postdoc. Although there is no question that a successful postdoctoral period is usually essential for a position at a research university, government lab, or private research institute, it is often not needed for someone heading toward patent law, the biotech industry, or community college or small-college teaching.

If one does wish further training as a postdoc, then be sure to choose one's lab carefully. I'm always mystified why many highly qualified students join labs with large numbers of other talented postdocs working on the same or highly similar projects, while ignoring the fact they will then all be competing for the same academic jobs in a few years. I also think it is important to broaden one's education and start working with a system that is different from one's thesis topic. I've had a number of my own students successfully switch to an animal system when leaving for a postdoc and have had students with training on animal systems join my lab as postdocs to work on plants. But moving from one plant system or topic to another also gives new perspective.

Finally, I would add that one should not be afraid of starting something new. It can be scientifically rejuvenating and helps one deal with the ever-changing landscape of federal granting agency priorities.