C. Robertson McClung

I grew up far from the ocean, in the suburbs of Toronto, but from early on I was fascinated by the marine environment and imagined myself becoming a scuba diver--sequentially modeling myself on Diver Dan, Mike Nelson, and Jacques Cousteau. Then, in high school, I had the incredibly good fortune to fall under the sway of my biology teacher, Ben Smith. Mr. Smith loved all things biological and organized a biology club. We had aquariums (both fresh and salt water) and bred quite a colony of pet rats (my first was named Codon, although I was not really sure what that meant). Most importantly, Mr. Smith also wanted to learn to scuba dive, so he organized a course for a number of us and then planned a spring break trip to John Pennecamp Coral Reef State Park in the Florida Keys where we all obtained our open-water certification and spent a glorious week underwater.

In university, there was never any doubt I would major in biology. What I had not expected was that I would become extremely interested in plants--Queen's University had some amazing plant physiologists at the time including Dave Dennis, R.G.S (Tony) Bidwell, and David Canvin. Happily, that tradition has continued to this day. Somehow, I found a summer job working in the group of the noted phycologist, Jack McLachlan, at the National Research Council of Canada lab in Halifax, Nova Scotia. I finally managed to live by the ocean. Jack and his whole group, notably Carolyn Bird, were inspirational mentors. And I could combine diving and plants!

Back at Queen's, I did my honors research on bacterial nitrogen fixation as a potential source of nitrogen for an aquatic fern. It wasn't particularly successful, but it allowed my thesis advisor, J. Michael Bristow, to suggest I apply for a summer job working back in Halifax at Dalhousie University with David G. Patriquin, who was studying the role of bacterial nitrogen fixation associated with the roots of the salt marsh cord grass, *Spartina alterniflora*. It was incredibly interesting work. Spartina roots live in anoxic sediments where the source of oxygen is the root itself, creating a microaerobic environment within the root that is colonized by microaerophilic bacteria that are capable of nitrogen fixation. I joined Dave's lab as a graduate student and completed a Masters' degree. However, my greatest accomplishment of that period was meeting Mary Lou Guerinot. She was a PhD student in Dave's lab studying bacterial nitrogen fixation in the guts of sea urchins. When she finished her thesis, she took a postdoctoral position studying nitrogen fixation in the ocean with Rita Colwell at the University of Maryland. Mary Lou was gracious enough to let me tag along. I found a job with Robert E. Davis at the USDA Beltsville lab and had a chance to follow up on my Masters' work. Bob, Dave, and I characterized and named that micraerophilic nitrogen-fixing bacterium and Bob and I enumerated root endophytic bacterial populations that included many nitrogen-fixers.

Mary Lou realized that I wanted to complete a PhD and reasoned, as she had dictated our move to Maryland, we should relocate to wherever I got into graduate school and she could find a second postdoc. So off we went to Michigan State University in September 1981. Once again, we were labmates, working with Barry Chelm, a young molecular biologist studying aspects of the soybean-*Bradyrhizobium* nitrogen-fixing symbiosis. It was an incredibly exciting time! In my first year I took two courses that were profoundly influential. One was a course in molecular biology--the age of cloning and sequencing genes was in its early stages. The second was a course in microbial genetics with Pete Magee. Pete, through that course, really showed me how to approach scientific questions using mutational analysis to get the organism to tell you what was important. And after we'd

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been at Michigan State for about three months, Chris and Shauna Somerville arrived. Chris, of course, was one of the pioneers developing Arabidopsis as the model plant. The atmosphere at the Plant Research Lab was electric. There was an incredible mix of senior, more traditional plant physiologists, like Anton Lang, Hans Kende, and Jan Zeevart, and young molecular geneticists, including Barry, Lee McIntosh, and Chris and Shauna. Together they assembled an exhilarating community of graduate students and postdocs, many of whom we still count among our closest friends. We were all aware that it was a special time.

The time flew by and before we knew it, Mary Lou was offered a faculty position at Dartmouth College. I needed a postdoctoral position and on my visit to Dartmouth I met Jay Dunlap, a brand-new faculty member in the Biochemistry Department of Dartmouth Medical School. Jay introduced me to the biological circadian clock, which has been my passion ever since. Jay and his wife and collaborator Jennifer Loros were studying the filamentous fungus, *Neurospora crassa*. At the time, only one clock gene, the *period* gene of *Drosophila*, had been cloned (as an aside, that achievement by Mike Young, Jeff Hall, and Michael Rosbash was recognized with the 2017 Nobel Prize in Physiology). While Jennifer focused on identifying and characterizing clock-controlled genes, Jay, Barb Fox, and I set out to clone the *frequency* (*frq*) gene of Neurospora. Our chromosomal walk was a success and we published in 1989. It was the second clock gene cloned from any organism.

By this time, Mary Lou and I knew we wanted to stay at Dartmouth and, very happily, the Department of Biological Sciences in the College offered me a position that began in July 1988. But what to study? In Neurospora there was really one question--what was *frq* and how did it contribute to the circadian clock? And that was a main focus of Jay's rapidly expanding research program. So, I decided to make the lateral move to study the plant clock--back to my roots, as they say.

I find it hard to believe that was 32 years ago! Our initial efforts were primarily to define clock-controlled genes, drawing on my background in plant physiology to identify likely candidates for clock control. Over time, the experimental approaches have become more sophisticated. And over the last 15 years I've made a second lateral move from Arabidopsis into crops, mostly *Brassica rapa*. *B. rapa* has the added complexity of having undergone a whole genome triplication since its separation from Arabidopsis, which raises questions about the consequences of polyploidy for the circadian oscillator itself and for the output pathways by which the clock regulates the temporal expression of many aspects of plant physiology, including responses to biotic and abiotic stresses.

Joining the faculty at Dartmouth also changed the story from one featuring many fine and influential mentors, especially Ben Smith and my thesis and postdoctoral advisors, to a new chapter where I've tried to pay back by mentoring others. Any success I can claim needs to be shared among the full roster of my lab over the years. And I've noticed that the mentoring has become reciprocal--my lab's recent forays into genomics rely absolutely on the intelligence and fearlessness of my most recent postdocs, especially Ping Lou and Katie Greenham (who has recently moved on to a faculty position at the University of Minnesota).

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

The plant circadian clock can be pretty intimidating. It is complex. We love to think in nice linear (or maybe branched, if we are really bold) pathways, but many become uncomfortable addressing cyclic processes. I think my most important contributions have been in my efforts to demonstrate the pervasive influence of the circadian clock in plant processes, and in my efforts to make the clock accessible and understandable, to enable others to learn how the clock affects whichever particular aspect of plant biology is their passion.

In my lab we have identified and characterized quite a number of Arabidopsis clock components through forward and reverse genetic approaches. We have shown that the clock plays an important role in determining plant performance, both in Arabidopsis and in wild and cultivated species (monkey flower and soybean). With Hua Lu we have shown how the clock intersects with the plant immune system to

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respond to bacterial and oomycete pathogens. My move into Brassica over the past fifteen years could not have been accomplished without wonderful collaborators, notably Cynthia Weinig, Rick Amasino, Scott Woody, Brent Ewers, Lina Guadagno, Julin Maloof, and Todd Mockler. We have developed exciting genetic and genomic resources for the study of natural variation in this crop species. We have documented the role of the clock in the early stages of response to drought; even before the plants show obvious signs of drought stress, such as wilting, there are extensive changes in the activity of many genes and physiologic processes that vary according to the time of day. The circadian clock is emerging as a domestication or improvement trait in a number of crops. Our long-term goal is to identify allelic variants of clock genes that enhance crop performance in specific environments and thereby to enable crop improvement.

When did you become a member of ASPP/ASPB?

When I took my faculty position, I wanted my own personal subscriptions to Plant Physiology and The Plant Cell, which was brand new at the time. I really had no idea how important the society would become in my professional life.

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

The professional interactions supported by the society, especially through the annual meeting, have been for me, invaluable. In 1997, Ken Keegstra invited me to join the Committee on the Status of Women in Plant Physiology. Five years later I joined the Publications Committee, which I chaired from 2003-6. Then Rick Amasino asked me to consider running for president--it was an honor to be considered and even more of an honor to be elected. My term as Chair of the Board of Trustees ended in 2017. So, for 20 years I was involved in the leadership of the society. It was incredibly rewarding. Personally, I got to know many really interesting and generous people. And I was truly impressed by the efforts of the society to train and mentor its members and to facilitate their careers. Becoming a Founding Member of the Legacy Society was a logical step--I've spent my professional life associated with the society and reaped enormous benefit through my involvement. I want to help the society continue its pivotal role in plant biology and among plant biologists.

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

A career in science is not for the faint of heart. You have to work very hard and navigate a career where failure is inevitable--not every experiment works, not every grant proposal is funded, nor is every manuscript published. Yet I am convinced it is the best of all possible worlds. I get to get up every day and go to school and learn new things, importantly, with new people. I have had the incredible fortune to learn from wonderful mentors, to mentor wonderful people in my own lab, and to collaborate with many superb scientists, including many I regard as close friends. Here I want to echo Harry Klee in his legacy biography. Exciting science is done at the interface of disciplines and to do truly novel work often requires collaboration with experts in other disciplines. It can be challenging to find common vocabularies, but the rewards can be considerable. I've collaborated with ecologists, evolutionists, plant breeders, and computer scientists. On the way I've had to make several lateral moves--one thing for certain is that what is cutting-edge science when you begin your career will not be cutting-edge by the time you are in mid-career. So, embrace change and make the most of it--the reward lies in the voyage, not the destination.

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