ASPB Pioneer Member

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1) How did your career get started?

There were a lot of external forces that led to me become a researcher and biologist. Growing up, I was always a well-behaved girl from an educated family. School was easy and good grades came naturally. My parents were both physicists, and there were many books at home, profound conversations, and endless support for me, all of which helped direct me toward academia and education. I was heading to the university, but my future area of study was unclear. For a long time my wish was to become a mathematician, but this was rejected by my mom. I always valued her guidance, so I accepted her suggestion to go into biology instead. Now, while I am formally educated in biology, I still enjoy mathematics and am grateful to use many mathematical approaches in biological research, and I enjoy it. My childhood attraction to math is certainly still there, but my mother thought the field of biology had a lot of potential, and life proved that her vision back in the 1970s was correct.

I was accepted to the Department of Natural Sciences, but I was unsure of my choice and often thought about switching to another field of study. Before changing directions, my passion for biological research was ignited with the help of small ants. After my freshman year, I participated in a summer research project to investigate the interaction of different types of ants in the natural environment. For a month, we observed interspecies communication between ants that shared feeding territories. This short project resulted in a paper at the university research conference and I received an award. Although I have not worked with ants since, this unique early experience gave me the confidence and joy to become a biologist and researcher. It took me many years, two PhDs, several countries (Russia, France, Canada, and the U.S.), hard work, and a lot of commitment to get to where I am today. However, I think my scientific career started when I was 18, a young researcher, unsure of my future in biology, working with the ants, where I fell in love with research.

2) What do you consider your most important contributions to plant biology research?

I think that my most important contributions include deciphering molecular mechanisms required for the release of volatile organic compounds (VOCs) from cells into the atmosphere, and the elucidation of signal pathways involved in plant volatile perception. Plants produce an amazing diversity of volatile molecules, lipophilic low-molecular-weight compounds with high vapor pressure at ambient temperature, that play essential roles in growth, development, reproduction, defense, and communication, and they influence atmospheric chemistry and climate. They are also used by humans as flavors, fragrances, biofuels, insecticides, and pharmaceuticals. For plant VOCs to be emitted, they must cross the cell membrane(s), the aqueous cell wall, and sometimes the cuticle, before moving into the gas phase. The default assumption was that upon synthesis, volatiles simply diffuse out of cells passively. However, two major factors led us to rethink how volatiles are released from cells. First, as primarily nonpolar compounds, VOCs preferentially partition into membranes, making diffusion into aqueous compartments slow. Second, over years of studying the biosynthesis of plant volatiles, we and others found some examples where VOC emission rates could not be explained by a concentration-dependent diffusion. Therefore, assuming that emission is driven solely by diffusion, in collaboration with chemical engineers we calculated the concentrations of VOCs at each cellular barrier interface that would be needed to attain equivalent emission rates to those that had been determined experimentally. Unexpectedly, predicted concentrations of volatiles in membranes appeared to be extremely high, which would be detrimental to membrane integrity and function. This allowed us to propose that biologically mediated processes must be involved in the release of volatiles out of the cell to prevent toxicity. We then experimentally validated, in planta, the *in silico* model predictions by isolation, characterization, and downregulation of the first ATP-binding cassette (ABC) transporter capable of transporting phenylpropanoid/benzenoid volatiles across the plasma membrane in petunia flowers. We also discovered that the cuticle is not simply a passive diffusion barrier for volatiles to cross but plays a more complex role in the emission process than previously anticipated. It is an integral member of the overall volatile biosynthetic network and acts as a sink/concentrator for volatiles, thereby protecting cells from potentially toxic internal accumulation of these compounds. Moreover, using biochemical and reverse-genetic approaches combined with mathematical simulation, we showed that non-specific lipid transfer proteins facilitate VOC export across the cell wall to the cuticle.

Our most recent discovery included determining the mode of volatile perception and dissecting signaling cascades involved in cellular responses. Plants are constantly exposed to volatiles as a part of plant-plant and plant-microbe interactions, and within-plant signaling. The perception of volatiles and the subsequent downstream signaling cascades are essential parts of communication, especially considering that receiver plants or organs must decrypt the chemical language to distinguish authentic signals from background odors and respond to specific VOC cues. The absence of reliable molecular markers of the perception state in receiving plants greatly slowed progress in the investigation of plant olfaction. However, we discovered that in petunia flowers volatile terpenoids can move between different organs by natural fumigation (that is, gas treatment of an enclosed space), and the loss of volatiles significantly decreases fitness. Using this hormone-like function of volatile terpenoids as a visual marker for communication, we investigated the molecular mechanisms that underlie VOC perception and signaling. We showed that volatile communication in petunia relies on a karrikin-insensitive receptor, PhKAI2ia, which stereo-specifically perceives the (−)-germacrene D signal, triggering a KAI2-mediated signaling cascade and affecting plant fitness.

Although our most recent work focuses on molecular processes involved in releasing and perceiving plant volatiles, we also made several contributions to biochemical aspects of plant primary and secondary metabolism, which resulted not only in the identification of many biosynthetic genes but also the discovery of entire biochemical pathways leading to metabolite formation. Nevertheless, my most impactful accomplishment is educating and training young scientists and researchers. That is the part of my career that gives me real joy, satisfaction, and reward. I am very proud of the achievements of my former students and postdocs and know that I was able to contribute to this.

3) What advice would you offer a

young person considering a career in plant biology?

I believe aligning your interests with your strengths and building on your talent and individuality lays the foundation that is crucial for future success. It is important to understand yourself, to know your passion, what gets you excited, and what gives you satisfaction. Additionally, the methodology of acquiring new knowledge is constantly evolving, and biology is no exception. Don't resist it and be ready to learn and try new approaches. In the next couple of decades, plant biology will undergo a significant transformation: new methods, AI, and various other disciplines will join the field. Your success will rely on your flexibility and ability to harvest the latest advancements, technologies, and research trends. Finally, don't be afraid to live here and now, be open and take every opportunity that comes your way because you never know where it might lead. Don't be discouraged when things get tough (because they will), keep pushing forward, and never give up on your goals. Try to make your research enjoyable and exciting. Discoveries are always fascinating, and the key to success, as Albert Einstein says, "is not to stop questioning."