Nobel Prize Winner Sherwood Rowland:

A Conversation

COURTESY OF SHERWOOD ROWLAND

Nobel Prize-winning chemist F. Sherwood Rowland probably never intended to be an environmental whistle-blower. But in the 1970s, when he and his postdoctoral associate Mario Molina at the University of California-Irvine studied a set of compounds called chlorofluorocarbons, or CFCs, they realized that they had uncovered a problem. They found that, if left unchecked, CFCs posed a serious threat to life on earth.

In 1974, they published their findings in the journal *Nature*. They reported that long-lived volatile CFCs, unreactive compounds here at ground level, gradually rise into the stratosphere. There in the presence of ultraviolet radiation, they set about destroying our thin protective shield of ozone molecules with an alarming chemical appetite. In fact, a single chlorine atom released from one of these molecules could destroy tens of thousands of ozone molecules.

Scientists from other countries extended the research. Paul Crutzen of the Max Planck Institutes in Germany studied nitrogen oxide emissions and warned of properties similar to CFCs. Finally, in 1987, world leaders ratified the Montreal Protocol, which effectively eliminated the use of CFCs after 1995—coincidentally, the year that Rowland, Molina, and Crutzen shared the Nobel Prize for their work in atmospheric chemistry.

Recently, National Chemistry Week Manager David Harwell asked Dr. Rowland to reflect on how his career in science developed. Was he always focused on science alone? His answers might surprise you.

DH: You started high school when you were only twelve! What was that like?

SR: *A few years ago, after the Nobel award, someone sent me an old clipping from the hometown newspaper, the* Delaware, Ohio, Gazette. *It was mostly about my older brother who had done exceptionally well as a high school freshman on the Ohio State test in first year latin and had essentially aced the second year latin test as well. A footnote mentioned that his 7-year old brother had scored the highest mark among third graders in the city. When school resumed in the fall, I was placed in the 5th grade.*

I was always among the tallest in my age group, so I was not physically smaller than my classmates in high school—although they were on the average 2.5 years older. By my senior year, I was the tallest person in the school, but you must realize that this was when somebody 6'1" in a school with roughly 100–150 students in each grade could be the tallest. Then I grew another four inches in the next two years while in college!

DH: What sports did you play growing up?

SR: *I played basketball and softball from a young age; I was a good player for my age group in basketball, but not for my class in school, so I was a nonplaying "scrub" for two years. I played JV in my junior year and varsity in my senior year, but was definitely not a star—just a player.*

The basketball coach was a math teacher. In fact, he majored in math under my father at the local college, Ohio Wesleyan University. The coach persuaded me to take up tennis in the spring of my sophomore year, and I lettered in tennis in junior and senior years. I also lettered in debate in my senior year. I took part in extracurricular activities but was not socially active until after I entered college.

I think athletics were important for me in high school, although I was still in many ways a loner. After high school, I organized, managed, and played third base on a softball team. This was long before our present "Little League" era in which the adults organize and supervise what the kids do from pre-kindergarten on. During the summer after my second year in graduate school, I was the playing manager of the Oshawa Merchants, which won the semi-pro baseball championship of Canada that year.

People who play sports get a unique "non-ivory tower" experience when what you do every day is printed in the

newspaper the next day, along with comments about where you succeeded or failed or where your opponent did likewise—not to mention hearing it all on the local radio news. Question asked of a sports-playing scientist whose name had appeared in the newspaper: "What did it feel like when someone asked you for an autograph?" My response: "Do you mean, after I became a scientist?"

DH: Did you always want to be an atmospheric chemist?

SR: *Atmospheric chemistry didn't exist as a subject when I was in graduate school. Radiochemistry—application of radioisotopes to chemistry—was very new in the immediate post-World War II period, and it had many applications.*

As for my classes in atmospheric chemistry—I didn't take them; I taught them! I taught chemical kinetics in the 1950s and atmospheric chemistry in the 1970s. Radiochemistry was given at the University of Chicago by Professor Willard Libby, my research supervisor and a subsequent Nobel Prize winner (Chemistry, 1960) for the invention of carbon-14 dating. Since carbon-14 is produced in the atmosphere by cosmic ray bombardment, I became aware of the possibilities of applications of radioactivity outside the laboratory.

DH: Why did you focus on chlorofluorocarbons as the topic of your research?

SR: *My research group had for several years used CFCs in the laboratory as "inert" targets for making radioactive chlorine and radioactive fluorine—although the fact that we used them as targets indicates they weren't completely inert. So when they were discovered in the atmosphere, I wondered what might happen to them there. The only chemicals my postdoctoral associate Mario Molina and I looked at initially were CCl_3F and CCl_2F_2, two of the CFCs. Later on, of course, we looked at many others.*

DH: Is teamwork important in your research? Is it ever more "comfortable" to work alone?

SR: *One of the primary reasons, maybe the only one, for being a research scientist is to push yourself beyond your "comfort zone". When you are asking questions for which you have reasonably good answers, then you aren't really doing experiments—you are just applying what you already know in a situation slightly different from before. Clearly, having a new idea sometimes arises from solitary thinking about areas of uncertainty. And sometimes it arises from interactions between colleagues.*

Partnerships and collaborations bring together people with different backgrounds—or "comfort zones" if you want—and these different viewpoints may very well help you zero in on the correct answer to your new problem.

I had a small bit of experience in atmospheric chemistry, and Mario Molina basically had none when we began collaborating on the fate of chlorofluorocarbons. The problems were well outside both of our comfort zones.

DH: Did your life change after winning the Nobel Prize?

SR: *Certainly! Every scientist grows up hearing about the achievements of Nobel Prize winners. But I think that it may have changed less for Crutzen, Molina, and myself than for many Nobel Prize winners because each of us had already become "public scientists"—scientists whose work had been described regularly on the front pages of the* New York Times, Time Magazine*, the* New Yorker, People Magazine*, and* Rolling Stone*; and on the TV networks. Because of the global importance of our work, we began receiving extensive media attention in the early 1970s, 20 years before being awarded the Nobel.*

DH: Has the ban on the release of CFCs had any effect on the atmosphere?

SR: *The first controls on the release of chlorofluorocarbons to the atmosphere were enacted in Oregon in 1975, and in the next year, for the entire United States, and thereafter for Canada and Scandinavia. After the discovery of the Antarctic Ozone Hole in 1985, the controls became international with the Montreal Protocol in 1987, and then, as modified later, with a total ban on the further manufacture and use of CFCs.*

We know from the continuing measurements in the atmosphere that the countries of the world are obeying this ban, and the growth in CFC concentrations has stopped and has begun to reverse. However, because these molecules have long lifetimes in the atmosphere, they will still be measurably present for many decades. But the reversal has taken place already.

In fact, there are many simultaneous stories going on in the atmosphere, and if you study the amounts and locations of various gases, you can tune in on these stories.

David Harwell is the manager of National Chemistry Week, a program of the Membership Division of the American Chemical Society.