RETROSPECTIVE

Mario J. Molina (1943–2020)

Visionary environmental chemist

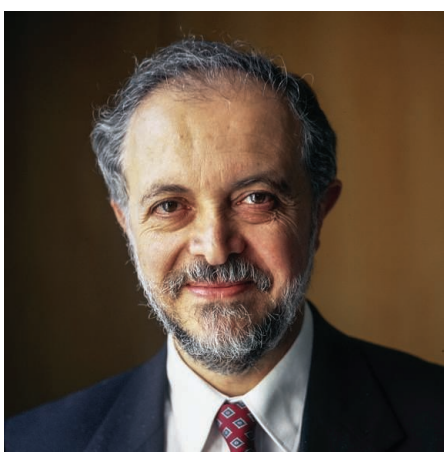
By **Kimberly A. Prather**

Mario J. Molina, an environmental chemist who dedicated his life to explaining and solving key societal challenges, died on 7 October. He was 77 years old. Molina showed how chlorofluorocarbons (CFCs) were destroying Earth's protective ozone layer over Antarctica and worked to ban them. He also spearheaded efforts to improve air quality in Mexico, the United States, and Asia. He was one of the first to sound the alarm that continuing business as usual would likely lead to a climate catastrophe. With his passing, the world has lost a tireless advocate for our environment.

Born in Mexico City on 19 March 1943, Molina loved science at an early age, converting a bathroom in his family home into his own personal chemistry laboratory. He received his bachelor's degree in chemical engineering at the National Autonomous University of Mexico in 1965, his master's degree from the Albert Ludwig University of Freiburg, Germany, in 1967, and his Ph.D. in physical chemistry from the University of California, Berkeley, in 1972. In 1973, Molina became a postdoctoral fellow at the University of California, Irvine (UCI), in the lab of chemist F. Sherwood Rowland, who would become his lifelong friend and collaborator. Molina spent the next 30 years teaching and researching at UCI, the Jet Propulsion Laboratory, the Massachusetts Institute of Technology, and the University of California, San Diego (UCSD). In 2005, he established the Molina Center for Strategic Studies in Energy and the Environment in Mexico City.

As part of their Nobel Prize–winning efforts on the environmental fate of the widely used refrigerants and propellants known as CFCs, Molina and Rowland were the first to propose that once CFCs made their way into the stratosphere, they could be broken down by solar radiation into chlorine atoms that could destroy the ozone layer. They published their predictions in 1974, but their calls to stop all production of CFCs fell on deaf ears because there was no evidence yet of ozone degradation. By 1985, evidence of a hole in the ozone was building. Molina published his laboratory findings in 1987, showing that stable chlorine-containing gases could catalytically break down and lead to ozone loss, bolstering a key connection between lab studies and global observations of the ozone hole.

Throughout his career, Molina advocated for scientists to apply scientific research directly to solve societal problems. With Rowland, he helped implement the Montreal Protocol, which is considered the most successful and effective environmental global treaty ever negotiated and implemented. It provides an inspirational success story of how fundamental chemistry can be used to address global environmental problems. In 1995, Molina became the first Mexican-born scientist to receive a Nobel Prize in Chemistry, which he shared with F. Sherwood Rowland and Paul J. Crutzen for "contributing to our salvation from a potential global environmental catastrophe."



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I met Molina in the late 1990s at a conference. He was gracious, soft-spoken, and generous from the moment I nervously introduced myself. Over the years, Molina became my mentor, scientific collaborator, colleague, and close friend. While working on climate and air quality policy issues at his center in Mexico City, he joined forces with scientists at UCSD on fundamental chemistry issues related to atmospheric chemistry and climate and helped establish the National Science Foundation Center for Aerosol Impacts on Chemistry of the Environment (CAICE), headquartered at UCSD. As director of CAICE, I was honored to have Molina as my science adviser, providing guidance and support as our team strove to reproduce realistic tropospheric aerosol surfaces representative of the marine atmosphere. Molina often marveled at how his lab studies on chemistry occurring on stratospheric surfaces were far easier than our efforts to reproduce more chemically complex tropospheric marine aerosol surfaces. This represents Molina's character perfectly—always downplaying his own (Nobel Prize–winning) accomplishments.

Molina dedicated substantial time to communicating the urgent need to enact policies grounded in science. He encouraged scientists to avoid getting caught up in figuring out every final detail before working to implement fixes. He applied this philosophy to the ozone hole, air quality, climate change, and ultimately COVID-19. This year, he spent extensive time communicating how to protect against airborne transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). His efforts, and those of many of the scientists he trained and mentored, myself included, are now leading to greater public awareness of the critical need for wearing masks to save lives.

Molina was an elected member of the National Academy of Sciences, the National Academy of Medicine, the Vatican's Pontifical Academy of Sciences, El Colegio Nacional de México, the Mexican Academy of Sciences, and the Mexican Academy of Engineering. He also served on the U.S. President's Council of Advisors on Science and Technology under former presidents Bill Clinton and Barack Obama. He has been recognized with 29 honorary degrees and many awards, including the Presidential Medal of Freedom in 2013.

I first realized that I was not alone in considering Molina a hero when we worked together in Mexico City (where he introduced me to the very best of our shared favorite food, molé). Throngs of people surrounded him wherever we went. I had never seen a scientist treated like a rock star before, and I will always remember how gracious he was—smiling, answering questions, and taking pictures with his "fan club."

Molina's inspirational combination of outstanding science and global impact has shaped my own career and the lives of many others. By setting an example, he showed the importance of communicating science to implement positive change. He loved teaching and interacting with students and served as a role model for generations of scientists. The world has lost an exceptional scientist and an even better human being in Mario Molina. I am sure that, like so many of us, Mother Earth has shed tears of her own over the loss of one of her greatest champions. ■

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