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Mario Molina

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By Jose Castro

Photograph of Dr. Mario Molina. Courtesy of Wikimedia Commons.[1]

I met Mario Molina (1943–2020) in Mexico City in 2004 at an academic conference where he defended his environmental plan to improve the city's air quality. By this time, Dr. Molina had already won a Nobel Prize in Chemistry in 1995 for his work in atmospheric chemistry. In 1973, he discovered that the compounds known as chlorofluorocarbons, or CFCs, used in aerosol sprays, plastic foams, and refrigerants could destroy the oxygen compound that forms the ozone layer. This was groundbreaking work that

[1] Distributed under CC BY 3.0 CL. Gobierno de Chile, "Mario Molina (cropped)," via Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Mario_Molina_(cropped).jpg.

revealed the danger CFCs pose to climate change and their role in the depletion of the ozone layer which ultimately awarded him the Nobel Prize. On October 7, 2020, Dr. Molina passed away due to a heart attack. He dedicated his life as a scientist to finding ways to better care for the environment and humankind. Dr. Molina's prestige was the result of his work for humanity.

A full list of Dr. Molina's awards, grants, and medals would be pages long. Besides being awarded the Nobel Prize, he also earned the Esselen Award of the Northeast section of the American Chemical Society in 1987. The American Chemical Society in Chicago gave Dr. Molina the Willard Gibbs Medal and the American Chemical Society Prize for Creative Advances in Environment Technology and Science in 1998. Between 1997 and 2010, he was awarded honorary degrees from Harvard, Duke, and other prestigious universities around the world.[2] Dr. Molina was a tireless scientist who worked up until the days before his death and who, from a very young age, fostered a curiosity for chemistry that led him to be recognized all over the world.

Mario Molina was born in Mexico City on March 9, 1943. Since childhood, he had a curiosity for chemistry. One of his aunts, Esther Molina, who was a chemist herself, saw his aptitude for science and helped him do chemistry experiments at home in a small laboratory that he had built in the bathroom. His passion for science and chemistry continued throughout his adolescence. By 1965, he had earned a bachelor's degree in Chemical Engineering at the National Autonomous University of Mexico (UNAM).

After receiving his undergraduate degree, he decided to study in Europe for two years, however, he never put aside his aspirations to obtain his PhD in the United States. In his autobiography on the Nobel Prize website, Dr. Molina humbly acknowledges his weaknesses in science during his early career:

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[2] Kate S. Petersen, "Institute Professor Emeritus Mario Molina," *Mit News*, October 9, 2020, https://news.mit.edu/2020/mario-molina-environmental-dies-1009.

> After finishing my undergraduate studies in Mexico, I decided to obtain a PhD degree in physical chemistry. This was not an easy task; although my training in chemical engineering was good, it was weak in mathematics, physics, as well as in various areas of basic physical chemistry—subjects such as quantum mechanics were totally alien to me in those days.[3]

In 1967, he earned a postgraduate degree in Polymerization Kinetics at the Albert Ludwig University of Freiburg, West Germany. Before applying to the PhD program at the University of California, Berkeley, he decided to study mathematics on his own. He then returned to Mexico City to work as an Assistant Professor at the UNAM in 1968. Dr. Molina eventually obtained a PhD in physical chemistry from the University of California, Berkeley in 1972.

At the University of California, Berkeley, Dr. George Pimentel (1922–1989), the inventor of the chemical laser, was his instructor. Dr. Pimentel helped the doctoral student in his research and dissertation and was, as Dr. Molina stated, "an excellent teacher and a wonderful mentor; his warmth, enthusiasm, and encouragement provided me with inspiration to pursue important scientific questions."[4]

In 1973, Dr. Molina decided to go to the University of California at Irvine to work with Professor F. Sherwood Rowland (1927–2012) as a postdoctoral fellow. Together they developed the "CFC-Ozone Depletion Theory." With this theory, they discovered that the dwindling of the ozone layer was caused by increasing concentrations of ozone-depleting chemicals known as chlorofluorocarbons (CFCs). Dr. Molina wrote, "we realized that

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[3] Mario J. Molina, "Mario J. Molina Biographical," Nobel Media AB 2021, accessed March 28, 2021, https://www.nobelprize.org/prizes/chemistry/1995/molina/biographical/.
[4] Ibid.

the chlorine atoms produced by the decomposition of the CFCs would catalytically destroy ozone. We became fully aware of the seriousness of the problem when we compared the industrial amounts of CFCs to the amounts of nitrogen oxides which control ozone levels."[5] Dr. Molina and Dr. Rowland saw the damage CFCs do to the atmosphere and the climate on earth. They began to exchange information with different scientists at the University of California, Berkeley, and other universities throughout the world, because they knew that if something were not done to stop this, there would be a significant depletion of the earth's stratospheric ozone layer.

On June 28, 1974, Dr. Molina and Dr. Rowland published their results in *Nature,* a scientific journal*,* and decided to draw the attention of the media, policymakers, and other scientists. They faced significant criticism for their findings. In 1977, "the chief of one aerosol manufacturer alleged that their theory was 'orchestrated by the Ministry of Disinformation of the KGB.'"[6] Moreover, "[o]fficials from the Manufacturing Chemists Association and Du Pont emphasized that Rowland and Molina's theory was 'purely speculative.'"[7] Of course, CFC manufacturers like Du Pont could not prove that to be true and, by fall, "officials at the National Academy of Sciences formed the first of several study committees that would eventually confirm the validity of Rowland and Molina's hypothesis."[8]

Even though Dr. Molina and Dr. Rowland rang the alarm bells in 1973, they were not taken seriously until "the U.S. National Academy of Sciences (NAS) released a report in 1976 that confirmed the essential premises of Molina's ozone depletion hypothesis, and more resources were assigned to study the

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[5] Molina, "Mario J. Molina Biographical."

[6] Laine Jones, "Ozone Warning: He Sounded Alarm, Paid Heavy Price," *Los Angeles Times*, July 14, 1988, https://www.latimes.com/archives/la-xpm-1988-07-14-mn-8873-story.html.

[7] Ibid.

[8] Ibid.

problem."[9] Even then, the world was not aware of the significance of Dr. Molina's findings until "an alarming observation in 1983 by British scientist Joseph Farman and colleagues [proved] that the ozone levels in the stratosphere above Antarctica had been dropping dramatically."[10]

Dr. Molina and Dr. Rowland then decided to promote their theories around the United States. By 1985, 197 countries signed "the Vienna Convention for the protection of the ozone layer, and, in 1987, they agreed to the Montreal Protocol with the establishment of goals and concrete actions to limit and eliminate the production of industrial gases that deplete the ozone layer."[11]

The "CFC-Ozone Depletion Theory" eventually earned Dr. Molina the Nobel Prize in Chemistry in 1995 alongside Dr. Rowland from the University of California at Irvine. Dr. Molina was the first Mexican-born Nobel laureate in science. In Mexico, Dr. Molina decided to spend part of his Nobel Prize money to award scholarships to young students in public schools "so they could study abroad, as he did at the beginning of his career."[12] He wanted to bring science to children because he was convinced that through education, society can be transformed.

In 1982 he decided to move from the University of California at Irvine, where he was a professor and researcher, to NASA's Jet Propulsion Laboratory to continue his research on the Ozone layer. From 1989 until his death in 2020, he taught classes

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[9] "Mario J. Molina, Ph.D. — Academy of Achievement," Academy of Achievement, October 10, 2020, https://achievement.org/achiever/mario-j-molina-ph-d/.

[10] "Mario Molina," Science History Institute, October 9, 2020, https://www.sciencehistory.org/historical-profile/mario-molina.

[11] Julia Carabias, "Mario Molina, Científico Mexicano Excepcional [Mario Molina, Exceptional Mexican Scientist]," *Revista Nexos*, October 12, 2020, https://www.nexos.com.mx/?p=50667.

[12] Sonia Cornoa, "Mario Molina, el nobel pionero sobre el calentamiento global [Mario Molina, the Nobel Pioneer on Global Warming]," *El Pais*, October 7, 2020, https://elpais.com/mexico/2020-10-08/mario-molina-el-nobel-pionero-sobre-el-calentamiento-global.html.

and lectures at different universities throughout the United States and Mexico, like the Massachusetts Institute of Technology (MIT), the University of California at San Diego, and the UNAM in Mexico City.

When I met Dr. Molina in 2004 at the Technology University of Mexico (UNITEC), he shared his plan to fight air pollution in Mexico City. In 2005, Dr. Molina established the Centro Mario Molina, also known as the *Mario Molina Center for Strategic Studies on Energy and the Environment,* which was dedicated to finding solutions to the challenges related to climate change, sustainable development, and the efficient use of energy. With the help of the Mexican government, private companies, and the people, he launched an initiative in the Centro Mario Molina to put together a plan to reduce air pollution in the city. He suggested renewable sources like solar and wind, among other sustainable resources, to improve the air quality in the city. Dr. Molina declared:

> The goal was to make sure that the work has an impact in society and that it affects public policy. We had success working with air quality in Mexico because it was a very polluted city. And so with many colleagues starting then, we were able to work with the government so that the city became much cleaner.[13]

Dr. Molina was recognized by governments for his humanitarian work. He collaborated with then-President Barack Obama as a member of the United States President's Council of Advisors on Science and Technology throughout Obama's presidency, and on August 8, 2013, Obama announced that Dr.

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[13] Angeta W. Levinovitz, "A Conversation with Mario Molina," Tyler Prize for Environmental Achievement, May 19, 2011, https://tylerprize.org/laureates/laureate-conversations/2021-conversation-mario-molina/.

Molina was a recipient of the Presidential Medal of Freedom.[14] In 2014, he was given the Knight Medal of the Legion of Honor by then-President of France, Francois Hollande, and in 2017, he was inducted into the California Hall of Fame.[15] After Dr. Molina's passing in 2020, Al Gore, who was Vice President from 1993 to 2001, wrote in *The New York Times* that he "never backed down from political pressure, always speaking truth to power, grounded in science and reason."[16] Dr. Molina influenced climate change policies during the Obama administration, encouraging the accession of the United States into the Paris Agreement in 2016, which then-President Donald Trump left in 2017 and current President Joe Biden rejoined in 2021.

Due to his work as a climate activist and efforts in encouraging Latino children to pursue science as a career, he became an inspiration for many of those young immigrants who come to the United States to earn an education. Those young students who seek social change and world well-being through science look at Dr. Molina as an example. Arriving as an immigrant to the United States and pursuing his dream of having higher education, he saw few Latino students in scientific fields in universities. Therefore, he wanted to promote scientific education and careers in minority communities. Dr. Molina achieved this goal by participating "in the Society for the Advancement of Chicano and Native American Scientists and the American

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[14] "Mario Molina Receives Presidential Medal of Freedom For Helping Save Ozone Layer," Institute for Governance and Sustainable Development, August 9, 2013, https://www.igsd.org/mario-molina-receives-presidential-medal-of-freedom-for-helping-save-ozone-layer/.

[15] Petersen.

[16] John Swartz, "Nobel Laureate Mario Molina Dies at 77," *The New York Times*, October 14, 2020, https://www.firstpost.com/tech/science/nobel-laureate-mario-molina-dies-at-77-after-sounding-alarm-for-ozone-layer-depletion-in-1974-8912111.html.

Chemical Society School program, which encourages underrepresented groups to become scientists."[17]

While he was working at the University of California, San Diego, Dr. Molina worked to mitigate the contagion of COVID-19. On June 11, 2020, the publication of the "Proceedings of the National Academy of Sciences," a document on the spread of the virus through the air, was deemed controversial in the scientific and epidemiological world. Dr. Molina concluded that, "Our results show that the airborne transmission route is highly virulent and dominant for the spread of COVID-19."[18] Epidemiologists denounced Dr. Molina's claims, arguing that he was not an epidemiologist or a doctor and his methodology had flaws and false statements. Dr. Molina replied to the critiques declaring,

> We are part of a different community, which is mainly connected with air quality and therefore very familiar with the properties of tiny particles called "aerosols." These penetrate humans to the lungs causing multiple deaths. We have close collaboration with epidemiologists, but with those who have worked on air quality issues and who are aware of the deaths caused by breathing aerosols of polluted air.[19]

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[17] Bonnie Denmark, "Recipiente del Premio Nobel Mario Molina [Nobel Prize Recipient Mario Molina]" *Visionlearning* SCIRE-1, no. 9 (2015), https://www.visionlearning.com/es/library/Adentro-de-la-Ciencia/58/Recipiente-del-Premio-Nobel-Mario-Molina/211.

[18] Mario J. Molina, Renyi Zhang, Yixin Li, Annie L. Zhang, and Yuan Wang, "Identifying airborne transmission as the dominant route for the spread of COVID-19," *Proceedings of the National Academy of Sciences* 117, no. 26 (June 30, 2020): 14857-14863, https://www.pnas.org/content/117/26/14857.

[19] Mario J. Molina, "Carta Aclaratoria [Explanatory Letter]," *El Universal*, June 6, 2020, https://www.eluniversal.com.mx/ciencia-y-salud/ciencia/carta-aclaratoria-de-mario-molina.

Dr. Molina criticized then-President Trump's stance against the use of face masks and sought to raise awareness for their use in mitigating the spread of COVID-19.

Dr. Mario Molina died on October 7, 2020, aged seventy-seven, due to a heart attack, but his legacy in science and academia continues. Most importantly, he leaves behind a warning for humanity about the damage we are doing to our world. The day before he died, Dr. Molina "signed a newspaper petition asking for the expansion of bike paths in Mexico City" to reduce car use in the city and lower pollution levels. [20] In a statement issued after Dr. Molina's passing, Al Gore recognized that he was a "trailblazing pioneer of the climate movement."[21]

Dr. Molina was a member of the National College (El Colegio Nacional) in Mexico City. This institution is an honorary academy where the members consist of the most prestigious Mexican artists and scientists. Dr. Molina was participating in conferences on health and the environment in the days just before his death. He had scheduled online conferences along with other Mexican scientists and intellectuals, like Dr. Julio Frenk who is president of the University of Miami. Juan Villoro, president of the National College, declared that,

> [Dr. Molina] was a person who contributed decisively to trying to reverse the harmful role of the human being against nature, and in these times of pandemic, in these times in which coexistence with nature is becoming more and more challenging, it seems to me central to highlight the importance of his legacy.[22]

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[20] Rodolfo Dirzo and Adrián Fernández, "José Mario Molina: Life and legacy of a man who helped to save Earth's ozone layer," *Proceedings of the National Academy of Sciences* 118, no. 1 (January 5, 2021).

[21] Swartz.

[22] Yanet Aguilar Sosa, "Hace dos días Mario Molina estuvo muy activo en la reunión de El Colegio Nacional [Two days ago, Mario Molina was very active

Mario Molina's life should be remembered for his love of science and his work for the environment and humanity as a whole. He leaves behind institutions that continue his scientific work in Mexico and the United States where his legacy will continue to inspire new generations of students to work in the pursuit of human well-being. With the work done by Dr. Molina, we must be able to raise awareness about the damage we are doing to our environment and observe the ways we can use science to save our planet.

in the meeting of El Colegio Nacional]," *El Universal,* October 7, 2020, https://www.eluniversal.com.mx/ciencia-y-salud/vio-juan-villoro-muy-activo-mario-molina-hace-dos-dias.

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Author Bio

Jose was born and raised in Mexico City. He obtained his first Bachelor of Science in Communication Studies in Mexico in 2006 and his second Bachelor of Science in History at California State Polytechnic University in 2018. He is currently a docent at the Workman and Temple Family Homestead Museum and is pursuing a Master of Arts in History at California State University, San Bernardino. His love for books and history led the retired DJ and radio producer to seek a new career as college professor and public historian to help young, underrepresented students pursue higher education. He is interested in the history of California, history of Mexico, and the history of Christianity in North America.