CONVERSATIONS WITH SCIENTISTS

Joseph Moran: Searching for the Origins of Life

April 2020

University of Strasbourg

"The biggest breakthroughs come from curious scientists studying fundamental problems in areas that seemingly have no application. But once that problem gets resolved, it only then becomes clear that it can solve problems in totally different areas.... That's why it is incredibly important for governments to fund basic research."

Joseph Moran is a professor at France's University of Strasbourg, director of its Laboratory of Chemical Catalysis at the Institut de Science et d'Ingénierie Supramoléculaires (ISIS), and head of its graduate program in Complex Systems Chemistry. Born in 1982 in a suburb of Montreal, Canada, Moran earned a bachelor's degree and a Ph.D. in chemistry from the University of Ottawa in 2004 and 2009, respectively. He spent six months as a visiting scientist working with John Pezacki in chemical biology at the National Research Council (NRC) Canada, and two years as a Natural Sciences and Engineering Research Council (NSERC) postdoctoral fellow studying metal catalysis with Michael Krische at the University of Texas in Austin. In 2012, Moran joined the faculty of ISIS-University of Strasbourg to work with Nobel laureate Jean-Marie Lehn.

Moran is the recipient of a number of honors and awards, including the 2018 C&EN Talented 12, the 2018 Jean Normant Prize and the 2017 Guy Ourisson Prize. A talented musician, Moran believes that "science is as creative as art." All one needs is "motivation, talent and the desire to go into the unknown." An eternal optimist, Moran reminds his students: "Success is walking from failure to failure with no loss of enthusiasm."

Moran's research focuses on "the application of concepts from systems and supramolecular chemistry to catalysis and the chemical origins of life." A young research group, Moran and his team are working in three areas: "self-organized reaction networks to understand the origin of life, vibrational strong coupling for organic chemistry and catalysis, and development of catalytic synthetic methodology."

Below are Joseph Moran's April 26, 2020 responses to questions posed to him by Today's Science. *Some of the questions deal with how he became interested in science and began his career in organic chemistry, while others address particular issues raised by the research discussed in The Origins of Life Gets a New Recipe.*

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The Origins of Life Gets a New Recipe

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Q. When did you realize you wanted to become a scientist?

A. I didn't realize that I wanted to become a scientist until after the second year of my university studies in Chemistry, when I got the chance to work in a research lab for the summer. To be honest, I wasn't even aware that a career in research was a possibility.

Q. How did you choose your field?

A. I was a top student in high school but didn't know what I wanted to do as a career. I was interested in many things, and spent nearly all of my free time on music, theatre and playing soccer. My parents suggested Medicine, so I decided to study Chemistry as a path to get into med school, because Chemistry was the subject where I had the highest marks. I never intended to become a chemist when I signed up for that degree.

Q. Are there particular scientists, whether you know them in person or not, that you find inspiring?

A. I am very lucky to work in a small institute with many top scientists, including four Nobel laureates in Chemistry. They are all inspiring in their own way. Two scientists who I would have loved to have met before they passed away were Christian De Duve and Harold Morowitz. They were well known scientists for other reasons, but I always found their writings on the origin of life to be very inspiring. Luckily, you can find some interviews on YouTube. [See The Origins of Life Just Got a Little Less Mysterious, September 2019; Far from Improbable, the Origin of Life May Have Been Inevitable, December 2006.]

Q. What do you think is the biggest misconception about your profession?

A. I'll give you two.

I think the biggest misconception about research is about how breakthroughs are made. You would think that if you wanted to cure cancer, you just divert funds from other areas to cancer research, and problem solved. But that's not how it works. Often, the best solution to an important problem in one area is something in an another area that hasn't even been discovered yet. It is impossible to predict. The biggest breakthroughs come from curious scientists studying fundamental problems in areas that seemingly have no application. But once that problem gets resolved, it only then becomes clear that it can solve problems in totally different areas, like cancer, energy or electronics. That's why it is incredibly important for governments to fund basic research.

The second biggest misconception is that scientists don't have to worry about the humanities and people skills. They sit in the lab by themselves and only need to know science and math. Nothing could be further from the truth. You are constantly discussing, networking, marketing, solving interpersonal conflicts and writing persuasively. If you are running a lab, those skills are just as important as scientific skills.

Q. If I understand correctly, your study demonstrates that geochemical processes could accomplish something that one might think requires living organisms, and thus suggests a possible path for life to come about. Is there any kind of experiment or evidence that might turn "this was possible" into "this is what happened"?

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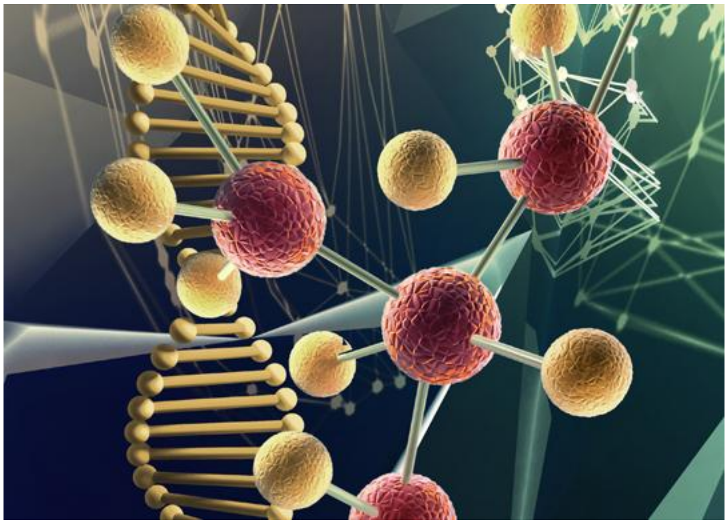

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"We have lots of evidence coming from different lines, we can reconstruct scenarios by doing experiments, etc. But even if everything lines up perfectly, we will never know with certainty how life started. The best we can hope for is a convincing narrative that accounts for all the evidence."

A. Any question with a historical component can never be answered with 100% certainty, because we can never revisit the past. Origins of life research has a historical component, just like investigating a crime scene. We have lots of evidence coming from different lines, we can reconstruct scenarios by doing experiments, etc. But even if everything lines up perfectly, we will never know with certainty how life started. The best we can hope for is a convincing narrative that accounts for all the evidence. However, for me, the most interesting part of origins of life research is not the historical component. By doing this research, we are learning about what it means to be alive.

Q. Are the kinds of processes that you describe in your study still occurring under special conditions now, or would they only have occurred billions of years ago, under conditions that prevailed then?

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are quite efficient at doing the same reaction using enzymes that have evolved for billions years, and they tend to be found wherever CO_2 and H_2 gas is naturally abundant. It would be difficult for the non-living processes to compete for the same chemical resources.

Q. One of the reasons we are interested in origin of life studies is because they have implications for the possible discovery of life on other planets. What do you see as the implications of your study for extraterrestrial life?

A. I think it is much too early to extrapolate to other planets, because this is only a very small part of the origins of life puzzle. There are so many other pieces that the current work doesn't solve. Other approaches all have their own issues as well. I'm convinced that in the next 10 years or so, the consensus view on the origin of life will be very different from what it is now. This field is still in its infancy.

Q. Where do you spend most of your workday? Who are the people you work with?

A. I'm a professor, so I teach undergraduate and graduate courses, run a graduate school in Complex Systems Chemistry and lead a research group of around 15 Master's students, Ph.D. students, postdoctoral researchers and permanent research staff. I spend the most amount of time in my office doing administrative work or writing related to those things, but I also spend time in the classroom teaching, in the labs talking to my students, or on the road giving invited lectures at conferences or other universities around the world. I do not like administrative work, but I suppose it's the price I pay for all the other fun things I get to do as part of my job.

Q. What do you find most rewarding about your job? What do you find most challenging about your job?

A. I love thinking about possible solutions to the problems we face in the lab, and discussing results with my coworkers. I also love watching trainees in my lab slowly become scientifically independent. It is truly satisfying! The constant rejection of grants and papers is challenging at first, but you learn to live with it. I'd have to say the most challenging part of my job is the steady stream of meetings and administrative work that needs to be done. It seems to become a larger fraction of my day with each passing year. I hope to one day do less of this or have an assistant that can do these things for me!

Q. What has been the most exciting development in your field in the last 20 years? What do you think will be the most exciting development in your field in the next 20 years?

A. The last 20 years has seen the development of many powerful analytical techniques that let us understand the structure and composition of matter, including in living organisms. It is much easier to know the structure of a protein or virus, or to know the composition of a complex mixture of compounds, which helps our ability to move forward in almost every area.

Q. How does the research in your field affect our daily lives?

A. We are all alive. People view the world in different ways, but I'd like to think that we all wonder what life really is and whether it might be elsewhere than Earth. My work will eventually help people get some answers to those questions through science.

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Q. For young people interested in pursuing a career in science, what are some helpful things to do in school? What are some helpful things to do outside of school?

A. Learn to find the beauty in every subject and give an honest effort. This alone will get you incredibly far. Develop interests outside of school, whatever they are. For me it was music, theatre and sports. Spend quality time with friends and family to keep you grounded and happy.

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