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Nancy A. Moran: The Winding Path of a Brilliant Scientific Life

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Nancy A. Moran is the Leslie Surginer Endowed Professor of Integrative Biology at the University of Texas at Austin (UT). She was a professor at the University of Arizona from 1986 to 2010 and at Yale University from 2010 to 2013, and she has been at UT since 2013. Nancy is a member of the American Academy of Microbiology, the American Academy of Arts and Sciences, and the National Academy of Sciences, and she has won numerous awards over her career. She is interested in how biological complexity arises in associations of organisms, with a particular focus on symbioses between insects and microbes. In writing this chapter, I wanted to explore the questions "How did she get to where she is now?" and "When was her career path clear to her?" The answers to these questions not only reveal the (perhaps surprising) way that Nancy became a scientist but also show how the structure of modern education might hurt the chances of a young person who finds herself in a similar situation today.

Nancy was raised in Dallas, TX, as one of eight siblings in a large Catholic family. Her father owned a drive-in movie theater, and her mother was a homemaker who had grown up on an Oklahoma farm during the Great Depression. As a child, Nancy had an innate affinity for the natural world. As she puts it, "I was definitely the little girl with bugs in jars." However, the idea that one could catch and study insects as a profession was completely unknown to her, as very few of her relatives had attended college.

Nancy went to a Catholic high school where, despite her early interests in insects and nature, she hated biology class. It was taught by an uninspiring

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Figure 1 Photo of Nancy A. Moran.

and slovenly monk—nuns didn't teach biology—and the course left her with the impression that biology was gross. She realized in February of her junior year that she had enough credits to graduate in May, so she did. However, she left with what she describes as "no plan at all."

Through some of her mother's connections in the Catholic Church, she was admitted to the University of Dallas as an art major. While there, she took a challenging art course that made her realize how difficult life would be as a professional artist. She was also tiring of her religion-based education, so she transferred to UT-Austin after her freshman year at Dallas. At UT, Nancy started with an emphasis in philosophy, but again with what she describes as "essentially no direction at all."

While continuing to take art and philosophy courses, she found her way into the Plan II Honors Program at UT. This program provided her considerable flexibility in the courses she chose, essentially allowing her to design her own personalized major. While still more or less a philosophy major, she took introductory biology in the spring of her junior year to help fulfill the breadth requirements of Plan II. It was a revelation. Nancy realized that biology was not, in fact, gross but rather fascinating, complex, and intellectually vast. She still fondly remembers the book used in the course, William Keeton's *Biological Science*.

Graduating in Plan II required her to do a senior thesis. Nancy selected the topic of mate choice in pigeons, which led to a broader interest in the evolution of sex. It was during the writing of this thesis that she realized it was possible to "do science" as a career. With no real sense of how to pick a graduate school, she asked students at UT if they had ideas, and several suggested the University of Michigan.

At Michigan, Nancy worked first with Richard Alexander because of her interests in insects, but she was also able to interact with two giants of evolutionary biology, John Maynard Smith and William D. Hamilton, who became her doctoral co-advisor along with Alexander. Even these lofty influences didn't lay the groundwork for what one might call a traditional path after graduate school. Before she started her first faculty position at the University of Arizona, she chose to do a postdoc at Northern Arizona University followed by a National Academy of Sciences exchange fellowship in the former Czechoslovakia. These two choices were made partly because of the science happening in Flagstaff and České Budějovice but mostly, as she says, because she "just wanted to go to those places. I wasn't thinking about making the right career moves."

Even her (now well-known) choice of working on insect endosymbionts was due somewhat to chance. She first studied aphids because of her interests in sexual evolution and phenotypic plasticity, and this work led to her reading the work of Paul Buchner, one of the pioneers of insect symbiosis in the early 20th century. But it was an out-of-the-blue phone call from Paul Baumann, a microbiologist at the University of California, Davis, with the suggestion that they collaborate on aphids and their intracellular bacteria that pushed her in the direction of symbiosis. This aphid endosymbiont work eventually expanded to include other sap-feeding insects and, more recently, to her research into the gut microbiomes of bees.

Reflecting on the nonlinearity of her career path, and her relatively late entry into the formal biology curriculum in college, Nancy worries that the structure of modern high schools and universities has evolved to place too much emphasis on choices made early in life. It isn't clear to her that many girls are necessarily interested in science during their early teenage years, or may have been taught to believe that science "isn't for them," and so the shunting of young people into science, technology, engineering, and math (STEM) paths during middle and high school tends to disfavor girls. By the time these young women get to college, even if they later develop an interest in STEM fields, they have often taken watered-down nonmajor science and math classes as freshman and sophomores. At that point, it becomes logistically and (often) financially difficult to change to a STEM major because many of their completed math and science courses don't count in their would-be new major. It's not difficult to hear Nancy's story and wonder how much talent we are missing today by inadvertently diverting young women away from viable STEM options.

In thinking about my own experience in Nancy's lab, which I will share now, I wonder how her life experiences shaped her approach to science and

mentoring students. While my own experience is just one example, I hope it gives a sense of the impact she had on me personally and scientifically. But, of course, I am not the only one. The list of Nancy's successful trainees is long—very long.

When I arrived with my dog to start my postdoc in Tucson, AZ, in the fall of 2006, I was lost. Not physically lost (it's easy to drive from St. Louis to Tucson), not emotionally lost (I was excited to finally live with my wife again after 6 months of living apart), but scientifically lost. I was incredibly lucky to have worked with brilliant and kind people during my undergraduate and graduate training, but these amazing experiences had left me with close to no idea of what I was going to do with my life. The 17-hour drive with my dog brought little further clarity.

I was a collector of scientific techniques. I thought x-ray crystallography and electron microscopy sounded cool, so I did those. I thought computational biology sounded fun, so I tried that. Genomics seemed neat, so, sure, why not dabble? But towards the end of graduate school it occurred to me that I had never actually tried biology. Of course I had always worked on biological problems, but I had never been out in the field, had never seen one of my study organisms in the wild, and had never thought about how interactions between organisms in nature might shape the way that things work in the lab.

I decided to try and do a postdoc with someone who did this kind of work. But what field? I had always loved microbiology, so that was a given. I thought that host-microbe interactions seemed pretty cool, so that was a possibility. One of my committee members asked me if I knew the work of Nancy Moran, and I said (probably something like), "Yeah, sorta." But experience had taught me that when this particular committee member suggested something, I should probably listen. I read Nancy's papers and was blown away. The work was incredible—interesting, creative, diverse, rigorous, and, importantly, the kind of biology I wanted to try.

I wrote what couldn't have been an overwhelmingly impressive email to Nancy asking about the possibility of doing a postdoc ("Dear Nancy, I am an amateur microbiologist, with no training in evolutionary biology or entomology. I am decent with computers, so I think I could be OK at genomics but I've never really done it. Sincerely, John.") But somehow, Nancy said I could come. Looking back now, her positive response to my email was the key turning point in my scientific life. Nancy helped me cobble all of the various techniques I had collected over the years into a semicoherent theme. She patiently helped me with my (vast) misunderstanding of evo-

lutionary biology. She showed me how to write a paper, how to give a talk, how to write a grant, and how to think about scientific problems. She gave me the direction I had been looking for, and by doing so, she gave me my career.

If I had been her only postdoc, or her only student, one might be able to put my turning out okay down to luck. However, when I look at the list of my fellow lab alumni, I think about the amount of time she has put into these people. Could I have been the only one who needed her insight, her patience, her high expectations, her experience, her clear thinking, and her cool head? Could I have been the only one who benefitted from the numerous professional opportunities she so generously gave? Of course not. Add this output of successful scientists to her impressive output of publications and it becomes rather easy to see why Nancy is one of the most highly regarded microbiologists of the modern era.

CITATION

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