Crossing Boundaries in Biology

Luis Wilfrido Atienza
October 16, 2017
lw.atienza@gmail.com

Dr. Cheryl P. Andam takes my Skype call from her office in the University of New Hampshire, where she works as an assistant professor and researcher, specializing in microbial genomics and evolution. Behind her are a few paintings of landscapes, nature scenes. It's only 8:00 in the morning in New Hampshire, but she is already energetic and excited to talk.

Dr. Andam studies how microorganisms, such as bacteria, have evolved over millions of years, resulting in the incredible diversity we see today.

One of her particular research interests is horizontal gene transfer, or HGT, which can affect how scientists look at the evolutionary lineage of different species.

"It's just so fascinating, how you can view evolution happening for millions and millions of years, and this particular process has been happening at the same time, and it has driven the formation of new species," said Dr. Andam, when asked what about the topic interested her.

HGT is the process by which genetic material can be shared between distantly related organisms. In plants and animals, parents pass on their DNA to their offspring in a process called vertical inheritance. Basically this is the process through which you inherit genes from your parents.

However, in many species of microbes, HGT is more prevalent. This can introduce new characteristics into these species, changing how they function. Because HGT affects the genetic code of these species, it has a significant impact on the evolutionary history of any one organism since the genes present in any individual may have come from different species, not just its own.

Dr. Cheryl P. Andam, a University of New Hampshire researcher on different microbiology aspects, such as horizontal gene transfer.

One way in which this can happen is through structures called plasmids—DNA molecules distinct from a bacteria's main genetic code. What is special about plasmids is that these smaller pieces of genetic code can be transferred between individuals. A microorganism that picks up a plasmid from another microorganism will then also be able to use that DNA, as if it were part of its own genetic code. This is one way that resistance to antibiotics, for example, can spread rapidly through populations of bacteria. And while plasmids are one way that HGT can happen, it is not the only one.

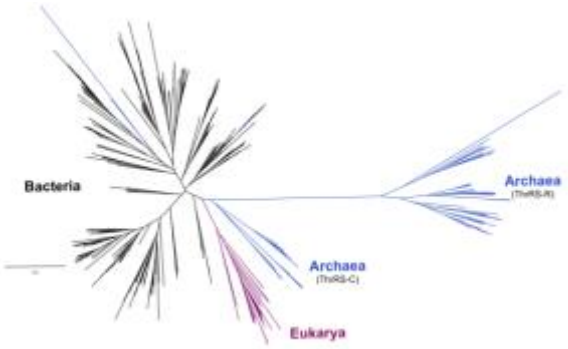
"The process of gene transfer involves different mechanisms, it's not just one cell taking up DNA from another cell or from the environment, there are different mechanisms, there are different types of processes," said Dr. Andam. HGT occurs not only between individuals of the same species but also between species in different domains, she added.

So while many scientists will choose to focus on a single group of organisms, or a few genes, Dr. Andam looks to follow the broader story of evolution, through whichever species it takes her to, following clues that cross species, and even domains, much like the genes she is studying.

And while some would find studying so many different kinds of organisms challenging, Dr. Andam seems to relish the challenge and the opportunities for her to explore the entire tree of life.

"I don't study just one gene; I don't study just one organism," she said. "Anything that acquires genes from somewhere else, that would make me want to do research on that particular organism."

Even when the many groups of species that need to be studied are put aside, researching the impact of HGT on evolution is a difficult task, requiring knowledge of microbiology, genetics, computational biology, and evolutionary biology. However, Dr. Andam seems to thrive in areas where she can explore many different topics, and fields, to come up with something interesting and unique.



Dr. Cheryl P. Andam studies HGT to construct models like this, showing how different groups of bacteria evolved.

Source: Andam CP, Gogarten JP. Biased gene transfer and its implications for the concept of lineage. Biol Direct 2011; 6:47.

When asked what she likes best about being in research, she immediately mentioned the independence that it brings. "You can come up with your own ideas and projects, nobody will tell you what to do, what kind of projects to do."

A look through her publication history shows just how important this ability to explore is for her, with work relating to microbial population genetics, ancient microbe evolution, and drug resistance, just to name a few. And all these points of interest help her try to answer some fundamental questions about evolution.

"The major question that I ask is 'what causes the tremendous diversity that we're seeing now?' Not just among eukaryotes, but especially among microorganisms. What drives that diversity? And starting from that, you can now dig deeper and ask yourself if it's this particular process or it's this environmental system that causes this diversity to explode in a particular area."

--

Though studying microbial evolution takes up most of her time now, Dr. Andam did not always intend to work in this field. Her transition into the field of microbiology was not something she planned. Before beginning her genomics research, she graduated with a degree in forestry from the University of the Philippines Los Baños. After she graduated, she was accepted into a lab in Binghamton University, New York, where she started working on microbes that live in plant roots. When she looked at the evolutionary history of their genes, she found the genes to have different origins.

"I couldn't say it was my plan to go into gene transfer and evolution at first," she said. "But later on, it just was the only thing I was interested in." Never letting any doubts get the best of her, she entered this new field of work and pursued her newfound interest.

Even the challenge of moving halfway across the world to live in another country couldn't faze her since it allowed her to ask the questions she wanted to ask.

"I never felt homesick," she said, talking about moving from the Philippines to New York. "I really wanted to explore new places and new research, so that wasn't a problem for me."

Her curiosity and fascination with the world of microbes seem to be something that has been driving her exploration for a good part of her career. And this interest in science goes back a long time.

While attending the University of the Philippines Rural High School, she performed an activity during one of her science classes: she cut a flatworm into segments and watched as they regenerated into

whole organisms. She says this was one of the starting points for what would become a career-defining fascination with biology.

That fascination carried her through not just a bachelor's degree but also a master's degree from Binghamton University, a Ph.D. from the University of Connecticut, and a postdoctoral position each at Cornell University and at Harvard School of Public Health.

From her start cutting up flatworms, she now runs her own lab at the University of New Hampshire and mentors undergraduates and graduate students. Currently one of her main research projects involves examining *Streptomyces*. These bacteria are the major natural producers of many antibiotics we use in hospitals and veterinary clinics. Some *Streptomyces* species are found living in symbiosis with insects, where they produce antibiotics that the insects use to protect themselves or their food sources against infections. She now collects these bacteria from the gut of other animals to determine if *Streptomyces* have similar benefits in other animals, and how these bacteria and their animal hosts evolve in response to each other. This isn't a glamorous job—to do it, she collects fecal samples from different animals—but Dr. Andam never lets that get her down and manages to find the bright side that keeps her excited about her work.

"Now I have a whole new respect for fecal material; there are just so many microbes found in there!" she said, laughing. Whether she is in the field collecting samples, in the lab, or just going about her daily life, Dr. Andam never stops thinking about the different opportunities she has to explore and learn something new.

"I would walk from my apartment, and I see a lot of opportunities—like a rotten apple on the sidewalk, or a banana peel, even termites and ants, even a trash can. There are so many possibilities in those little things that you would normally ignore. I don't find my research routine; I'm really fascinated with discovering things from benign and little things."

True to her word, another research project she is working on is to determine bacterial diversity in the carcasses of different wild animals such as foxes, raccoons, skunks, otters, and muskrats, which can harbor pathogenic bacteria transmissible to humans.

--

While Dr. Andam has come a long way from Los Baños and is enjoying a great career in the United States, she hasn't forgotten her home country. Recently she visited the Philippines, for only the third time in the last 12 years, as part of the Department of Science and Technology's Balik Scientist program.

She was hosted by the Philippine Genome Center of the University of the Philippines, where she was able to get acquainted with local research and develop collaborative endeavors with scientists from UP. She spoke highly about the program, and looks to make a productive, long-term contribution to it.

"I'd like to be able to give back," she said, "[by] encouraging young scientists in the Philippines to broaden their horizons in terms of research. Hopefully, some of [the students I worked with] have seen me as an inspiration, or an adviser."

She seemed truly eager to impart not only her scientific knowledge but also her excitement, offering some advice to young scientists: "Don't let rejections and failures keep you from trying to achieve something," she said.

Dr. Andam has also been working on establishing projects to help promote genomic research in the country. Among other plans, she is looking to work with UP Manila to understand the emergence of antibiotic resistance and how pathogenic bacteria are evolving in the country. She is also looking to work with UP Los Baños on using genomic approaches to analyze *Streptomyces* samples found in caves for drug discovery.

She is looking to contribute as much as she can to the country because, according to her, "the Philippines has to get into the genomic era, too."

--

Dr. Andam is trying to bring her science not only to other countries but also to other fields. Aside from science, she is a history enthusiast. According to her, she owns more history books than science books. In combining these two interests, she has written a review paper looking into ancient pathogens and is looking to start a second master's degree, in history, specializing in the history of science.

She also loves to swing-dance and to paint. When she mentions the latter, she points her webcam at the paintings behind her. She painted them herself. She is even trying to bring science into art and mentions

a project in collaboration with a local museum—teaching students how to paint pictures by streaking bacterial cells on petri dishes.

Whether it's looking at how organisms from across biological domains can share genes, finding opportunities for research in the most mundane place, helping science cross over to different countries, or bringing a scientific mind to art and history, Dr. Andam has made a living exploring intersections that few others usually look at.

"I think that's how I look at my career, or how I pursue my research," she says. "To put together two different things and come up with something wonderful."

Luis Wilfrido Atienza graduated from the Ateneo de Manila University, with a BS in Biology, and a minor in poetry. He currently works as a copywriter for a sustainability agency, and spends some of his free time writing about science.