

CONVERSATION

Early-career researchers: an interview with Brooke Flammang

Brooke Flammang is an Assistant Professor at the New Jersey Institute of Technology, where she investigates how organisms interact with their environment and how these interactions drive the evolutionary selection of morphology and function. She received her Bachelor's degree in Marine Biology from Fairleigh Dickinson University before moving to Moss Landing Marine Laboratories for her Master's degree and completing her PhD with George Lauder at Harvard University in 2010. She was awarded the Dorothy H. Skinner award in 2013 and the Carl Gans award in 2017 by the Society for Integrative and Comparative Biology.

How did you become interested in science?

Around the time that I was 10 years old, I came home and announced that I was going to be a marine biologist; I don't remember what triggered it. Everyone thought it was very funny, but I was totally in love with the ocean. My parents were exceptional, they humoured me and I even had a saltwater tank in my bedroom, which smelled atrocious, like low tide all the time.

I also had a lot of really supportive teachers in all subjects, especially Charlie Renshaw, my high school marine biology teacher. He is phenomenal. I loved his class and I wanted to do more, so he got hold of a shark for me to dissect – a spiny dogfish. I'm fairly sure that he paid for it out of his own money, although he denies it. He let me stay after school dissecting this shark, except that it smelled so bad that the rest of the school complained and I ended up out in the parking lot with a desk that he dragged there for me. It was one of the best things ever.

Where did you go to university?

After high school I was a little bit lost. I am a first-generation college student and despite having all these fantastic people on my side pushing me to achieve whatever goals I could aspire to, I didn't have any mentorship in terms of the direction I should be taking. I chose a liberal arts college that gave me a full scholarship and sent me to Hawaii for a semester, but it was relatively small so I didn't get any research experience. We had a little bit of field experience in Hawaii but it wasn't the same as having the opportunity to work with professors on campus who had research labs. After that, it took me 2.5 years to get into a Master's degree program because I lacked experience.

What did you do in the interim?

I needed a job so first I substitute taught Spanish and French in Connecticut, which was exciting, because I don't speak French. I had always been interested in anatomy and physiology, so then I worked on an ambulance and became a nationally registered paramedic. It paid the bills while I was applying to grad schools. I was aiming for Master's programs, because I felt that I needed more experience and I wasn't confident about getting into a PhD program. I also started attending scientific conferences. I had found out that the American Society of Ichthyologists and Herpetologists (ASIH) conference was in Pennsylvania that year, so I registered, showed up and started trying to meet people.

Brooke Flammang works at the Department of Biological Sciences, New Jersey Institute of Technology, University Heights, Newark, NJ 07102, USA.
E-mail: flammang@njit.edu



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Can you tell us about your experiences as a paramedic?

It was amazing. The feeling that you experience when you bring someone back to life, there is nothing else like it. You are dealing with the stress of the situation, but you are able to make a positive difference for someone. At the same time, when you lose someone it can also be difficult to deal with – you interact personally with a lot of pain and tragedy. I had a mass casualty call involving a family of nine ejected on the highway. But, I got to catch 11 babies, which was thrilling. The last call I had was on Christmas Eve. A gentleman had had a full cardiac arrest in his living room but by the time we got him to the hospital he was talking and it was amazing.

I was also able to develop a fantastic set of skills, which, at the time, I didn't realise would be very useful later during my nonlinear career path. When I started my PhD at Harvard after finishing my Master's degree, I sat down with my mentor, George Lauder, to learn how to do electromyograms, where we insert fine wire electrodes into muscles to record the electrical activity. I had never done this procedure before, so I had a pickled fish and about 10 little catheters set up with the electrodes. He told me which muscles to put them in and then I had to dissect them out to make sure that they were placed correctly. He told me not to worry if I didn't get them in

the right place, because it's a hard skill, but I got every single one on the first try. He was surprised and asked how I did it and I explained that if I can get an IV in a squirming 2-year-old, I can hit a muscle in a dead fish.

How did you eventually convince a Master's program to accept you?

While I was working and applying to programs, I met many people at the ASIH conferences that I had attended, including students at the Moss Landing Marine Labs (MLML) in the Monterey Bay area who spoke very highly of California State University's Master's program. They introduced me to Greg Cailliet, whom I ended up working with. I realized that I could enrol in classes without being in the program, so I transferred with my company, American Medical Response, to California, and I just showed up and started taking classes. At the same time, another professor, David Ebert, had just started and set up the Pacific Shark Research Centre at MLML. They were getting specimens that hadn't been assigned to projects, including a lot of deep-sea catsharks, so I started looking at their morphology and ecology. I applied again the next semester and they realised I wasn't going to go away and accepted me. The catshark work ended up becoming my Master's thesis.

For the 2 years I was a Master's student, I was in the lab 40-plus hours a week and I was working 12-hour night shifts as a paramedic. My thesis was written in an ambulance. Most days I was only getting 4 hours sleep, but it never seemed too challenging because it never occurred to me that there was any other way. It is not a strategy I would recommend for everyone, but it worked for me.

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Why did you decide to shift focus from morphology to biomechanics?

When I was at MLML I had the fortunate experience of meeting Lara Ferry, who was an Adjunct Professor there at the time. She taught a class on fish biomechanics and my mind was blown. I realised that my passion was in biomechanics; the interaction of physics and biology was the approach that could answer so many questions that I had about the world. Lara strongly suggested that I take the Friday Harbor Labs' (FHL) Fish Course with Adam Summers, which was tremendous and one of the best classes that I have ever taken.

At the beginning of the course we went out fishing and collected dogfish sharks, which are a running theme through my life, and we dissected them. I had done this hundreds of times. We started dissecting the muscles of the head and then we looked at the muscles of the side of the body. I had completed the dissection early and was bored so I dissected the rest of the shark. When I got to the tail I realised there was this bright red muscle that wasn't listed in the dissection manual. Three of the greatest comparative morphologists that I know were in the room – Adam Summers, Beth Brainerd and Karel Liem – and they had never seen it before either. I had accidentally discovered a new muscle, which became the focus of my project.

How did you get accepted into Harvard?

I have no idea how I was accepted into Harvard. When I was finishing my Master's I planned to visit Harvard to look at the catshark specimens in the Museum of Comparative Zoology. Lara got wind of this, emailed George and told him that I was coming. Then she told me that he was expecting me. I was completely intimidated, but he was amazing. He introduced me to

his lab and explained what they did. I hadn't actually applied at that point and I had never been on an interview before so I did not realise that this was one. Lara had told him about the muscle that I discovered. He asked about the work and I happened to have my laptop with me, which had a short presentation that I had put together for FHL. I started to show him a couple of slides but then he asked if I would give a talk to his lab during lunch, which was in 10 minutes. I did and then went and hid in the museum for the rest of the day, because I was sure that it had been awful. But I guess it went well, because I got in and then stayed at Harvard for my postdoc too.

When did you begin applying for faculty positions?

During the second year of my postdoc. The grant was also running down during the last year of my postdoc. I ended up taking a one-year position teaching anatomy at a local liberal arts college a few miles from Cambridge, so that I could still work in the lab and do research. Then I got my current position at the New Jersey Institute of Technology.

What advice would you give to early-career researchers that are beginning to teach for the first time?

The first class I taught was when I was a graduate student. Karel Liem asked me to take over his comparative anatomy course when he fell ill before he passed away. I had been his teaching assistant and I taught that class throughout my postdoc. The first lesson that I learned about teaching is that you have to step back from your excitement about the material and ask, what do I need to teach the students within the confines of the time I have available and how much is a digestible quantity of material, while still challenging the students? I also learned that you never know something as well as you thought you did until you explain it out loud. Suddenly, it may not make as much sense to you as you thought! You can have the same experience when new information comes out and you include it in your teaching, so you must be adaptable and willing to learn.

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How do you put a course together?

I start with the syllabus and I try to make an outline; I think about how much information I expect them to know when they leave this class. I don't use PowerPoint for something like comparative anatomy, because it becomes a television show that students just watch; they think they know it but they remember nothing. I draw on the board, 'a la' Karel Liem and Farish Jenkins. I have a bunch of different coloured pens and I draw structures in one colour through all of the organisms of interest so that they can see the changes through evolution. This approach slows you down, so it reduces the amount of material that you can throw at them, but I can't think of any other way to do it where they would learn the material as well.

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I use interactive strategies for the other class that I teach, where I alternate between comparative biomechanics and a bioinspired

robotics class. We read and discuss peer-reviewed literature and talk about current science during the first part of the course, and then the students do a project. I bring them into my research lab and they do hands-on research. If they are not getting personally involved I don't feel that they are learning as much.

In your experience, what is the best way to go about building collaborations?

I usually just ask someone if they would like to collaborate, mostly when I have an idea in my head and I come across research by a person that makes me think, 'If I could do something like that with this project that would be really cool'. If I see them at a conference or I send them an email, I say, 'Here is my idea, this is what I am studying, I saw your information on this. Is this something that you would be interested in collaborating on?', and 90–95% of the time I get a favourable response. The only person that said no was already overwhelmed with collaborations and they recommended someone else to talk to.

Collaboration is massively important for me. There is no way of knowing everything in the field of integrative biology. By the time you get to your PhD, you are broadly trained as a biologist, but a lot of the stuff that I do involves fluid mechanics and engineering. Sometimes it is fun to fly by the seat of your pants and figure it out, but you can't get as far as you would with somebody who has worked in that area before. I think you have to be open to collaborating and working with people who have complementary skill sets in order to answer the really big questions.

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What is your preferred funding organisation and why?

I enjoy applying to the National Science Foundation (NSF) because they have a strong interest in basic science and I think that is fundamentally important to a lot of research addressing broad questions. All of my greatest discoveries have been completely curiosity driven: the shark tail muscle, the fish that walks like a tetrapod, the blood vessels in the head of remoras that work in really cool ways as part of their adhesive mechanism. I would never have been able to write a grant application to another organisation to understand how these things work unless I had already known part of the answer. Once you have answered some preliminary questions you might have a treasure trove of new findings of incredibly broad importance, but you have to do the basic science first.

There is a recipe for writing grants, whether they are from the NSF or Department of Defense, in which you need to identify a need or problem and describe how the work will be done to demonstrate that you are the person who should be funded for it. I think a lot of novice grant writers don't sell their expertise strongly enough. I like to follow Heilmeyer's Catechism, a set of eight questions crafted by a former Defense Advanced Research Projects Agency director that should be addressed in any research proposal, which also helps to place your work in a broader context.

How did you develop your approach to writing grants?

Sitting on grant proposal panels was a huge advantage. This allowed me to go over other proposals and to hear the opinions of

experienced panel members about where things fell through and why applications didn't make the cut. I would never have learned this by just reading a bunch of proposals. I was invited to join, but you can contact your program officer and say that you are interested in serving on a panel and ask them to keep you in mind.

I would absolutely recommend postdocs and early-career researchers in their first couple of years of a tenure track position to serve on a panel. When you get into a tenure track position everyone thinks that they need to start writing grants right away, but I would say that if you got on a panel in your first year, the experience would improve your chances of writing a successful proposal in year two or three, more so than if you just started writing and hoped to get lucky.

What is your experience of working with the media?

It has been really great. I have had a lot of exciting outcomes from some of my research. We had an article in the New York Times about the fish that walks like a salamander, and I did a 2:00 am live radio interview with BBC 5Live in the UK. I have never seen such an outpouring of interest in a fish before.

What tips do you have when talking to journalists?

You need to be able to talk conversationally about your work. That doesn't mean that you need to dumb everything down, but you definitely have to be able to talk as if you were chatting to someone on a bus. Explain a little bit about what you do, but you don't need to give all the information at once, and then summarise things briefly and thoughtfully. If you expand on specifics, give details in a way that is digestible, clear, concise and factual.

Whenever I am interviewed I make sure to read it afterwards, to see what the reporters put into the article and which parts they thought were interesting or important to the general public. Also, my experiences of talking to people as part of the outreach activities that I have been involved in have helped me to understand how to talk to people about what I do.

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Is there any aspect of your research that has changed your home life?

I don't know if research changed my home life or home life changed my research life, but in some ways they have both grown around each other. My daughter's second word was 'fish' because she started coming to the lab with me when I was a new postdoc and she was 6 weeks old. One of the things I enjoy about academia is the fact that it has a fair amount of flexibility built in. Bringing my daughter to the lab for the last 7 years helped expose her to many wonderful things about science, and my twins that are arriving soon will have the same opportunity. My experience of academia is that it has been incredibly supportive for family life: George was amazing during my postdoc. I make sure that I have time every day that is only for the family and I make sure that I spend time that is only for my research. This way I can make sure that both sides get what they need from me and I don't feel like I am missing anything.

Brooke Flammang was interviewed by Kathryn Knight. The interview has been edited and condensed with the interviewee's approval.