

CONVERSATION

Early-career researchers: an interview with Heath MacMillan

Heath MacMillan is an Assistant Professor at Carleton University, Canada, where he studies the physiological mechanisms limiting ectotherm performance. He received his Bachelor's degree in biology from the University of Western Ontario, Canada, in 2008 before completing his PhD in 2013 with Brent Sinclair and Jim Staples at the same institution. After undertaking a postdoc with Johannes Overgaard at Aarhus University, Denmark, MacMillan was awarded a Banting Fellowship, which he took in the laboratory of Andrew Donini at York University, Canada.

Where did you grow up and how did you become interested in science?

I was born and grew up in the Toronto (Canada) area. When I was a kid, my father was interested in camping, so we went on canoe trips in Algonquin Park, which is a massive provincial park in Ontario. We would see wildlife, the natural world. Then, as I started to go through school, I learned more about the scientific process and those two things came together in a passion for biology. I had a great physics teacher, Mr Wellman, in Grade 12 (when I was 17) who had a really solid approach to the scientific method. He got us involved in an engineering competition, the kind of thing where we went to a university and built robots that needed to do certain things such as going down a ramp and stopping at a certain point. I think that kind of experience got me thinking seriously about pursuing science as a career, because it was fun and exciting and challenging. However, I was also interested in art. My mother is a ceramic artist, so I grew up around artists and art materials and in my last year of high school I re-took the art class, despite having got an A in it the year before, just to get access to the room, to use the materials and keep exploring. So, I had two sides to my life and when I applied for university, I applied for both visual arts and science programmes.

So how did science win out?

I applied for visual arts at one of the universities in Ontario, which based its decisions entirely on grades and not on an applicant's portfolio. My grades were good, but I was in Grade 13 when Ontario got rid of the final year of high school, so there were two cohorts of students going into university at the same time; it was a competitive year. I applied to a few different places for biology, but I only applied to one university for visual arts and ended up not getting accepted. However, I did get in for biology at Carleton and that was the choice made.

When I started at Carleton I was interested in physics, but it turned out that I was inspired by my high school teacher and not by the subject itself. After one term, I switched to business, because a totally different career caught my eye. But I quickly learned that I didn't like business either, so I transferred back to biology.

At the time, my girlfriend, Christine – who is now my wife – ended up going to Western University in London, Ontario, which is about 8 hours from Ottawa. We did 2 years of living apart, but then we decided that one of us needed to move. I drew the short straw, because her programme only existed at Western and biology existed in both places, so I transferred and did the second half of my undergraduate degree there.

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How did you acquire research experience while you were an undergraduate?

I was taking environmental animal physiology with Jim Staples in my third year at Western and he had a guest speaker in one of his lectures, a young new faculty member named Brent Sinclair, who came in to tell us about insects and their physiology for surviving winter. I was keen to find someone to work with for my fourth year honours thesis, and I thought that Brent was doing really interesting science, so I approached him. He was just getting started at Western, so he invited me to start working in his lab on a summer project on *Drosophila*. It went well and ended up getting published in Insect Science. Then, my honours thesis on another project got published in the Journal of Insect Physiology; so, under Brent's guidance, I had two first-author publications out of my undergraduate work. After my undergraduate degree, I decided to continue in Brent's lab doing a 2 year Master's degree focusing on insect chill coma and ion balance. About a year into that I began thinking about doing a PhD and I had to decide whether I wanted to stay in Brent's lab or go somewhere else. There's this idea floating around academia that you shouldn't do your undergraduate degree and postgraduate work in the same place, so I was trying to find ways to do my PhD elsewhere.

But the other options that were available didn't excite me as much, and Brent is a phenomenal mentor, so I decided to stay and turned my Master's degree into a PhD.

What were the most important lessons that you learned during your PhD?

Doing a PhD is one of those experiences where you don't really know what you've learned until after you have finished and can reflect on it. The things that I try to emphasise now to students are that failure is always an option in science. Experiments tend not to work the first time you do them. Being successful in science is not so much about avoiding failure but about being able to learn from it, being observant enough to turn failure into learning or an opportunity. In addition, I learned that publishing throughout your PhD can lead to further opportunities. Lastly, I learned to ignore that nagging little voice of doubt in my head and just to try things. For example, I think that techniques in the lab that we're not familiar with can be intimidating, so sometimes you really have to force yourself to just get in there and try it out.

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How did you manage your postdoc transition with two careers to consider?

In 2010, half-way through my PhD, I was at an American Physiological Society meeting and I met Johannes Overgaard; our posters were across from each other and we ended up talking. I was presenting the first work from my PhD about the loss of ion balance in crickets, he was presenting work on thermal limits across a bunch of *Drosophila* species, and our interests were very much aligned. At that time, he was putting together a grant following up from the stuff that I was presenting, which we had published already. He asked me to help frame some ideas and told me that maybe there would be a postdoc opportunity in his lab in the next few years.

Christine had gone to do a Master's at the University of British Columbia (Canada), on the other side of the country, and returned to London to start working as a physiotherapist during the last year of my PhD. The possibility of going to Denmark for a postdoc was hanging in the air and I was a bit reluctant to move there, but Christine was extremely supportive, and Brent and Jim, who were co-supervising me, were very much in favour of me going too. At the time, Christine and I were also starting to think about having kids and it ended up that our first baby was due 2 months before we flew to Denmark. I think we were quite naive about how challenging that would be, we just figured it would all work out – which it did, but I wouldn't necessarily recommend moving across the ocean at the same time as becoming new parents!

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What was your experience of doing a postdoc in Denmark?

Being in Denmark was absolutely fantastic. The Zoophysiology Department at the University of Aarhus is incredible. It's a very welcoming and collegiate place. I got tons of work done, despite taking more vacations than I ever have at any other time in my career. And it gave me great opportunities for collaboration and establishing relationships that are continuing and, I expect, will carry on for quite a long time. From a family perspective, it was

more challenging. I think it is isolating being in a different place. Immigrating to Denmark as an English speaker is relatively easy – everyone speaks the language fluently and we didn't feel that there was much of a communication barrier – but we couldn't help but have a sense of not really belonging. It was a window into the experience of people who have immigrated to Canada. It was a really healthy experience to have.

When did you begin applying for jobs?

Half-way through our time in Denmark, I started applying for jobs and further postdoc funding. I wanted to branch out and start getting a little more experience in molecular biology. During my PhD, I had collaborated with Andrew Donini at York University, Canada. He is an expert in insect epithelia and molecular biology. I applied for the Banting Fellowship, which was a long-shot, and the regular NSERC fellowship to join his lab. I also ended up getting an interview invitation from a university in the United States, so I was all set to fly over for that when I found out that I had been offered the Banting Fellowship. I was forced to choose between going to the interview, which could have turned into a permanent job, or taking the Banting Fellowship, which meant doing another postdoc and hoping that another job would come up later. I decided to go with the Banting Fellowship, because that provided us with the opportunity to come back to Canada, it was prestigious and would hopefully lead to other opportunities later.

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I never came off the faculty job market. I continued applying for jobs and the one at Carleton, which I ended up taking, came up soon after I arrived in York. It was a perfect fit for me. I was very careful with the application; I did so much preparation for the interview that it was like having another part-time job. You need a lot of planning, preparation and attention to detail to really perform your best at a faculty interview. I gave a talk on my research, so I prepared a PowerPoint with as many additional slides that would help me to answer questions as there were real ones. I looked into the details of every course that was being offered and I read papers written by every faculty member in the department to get a better sense of their research. Someone advised me to prepare draft syllabi, so I put together three that I would offer if I got the job and then I worked them into the conversation. 'If you worked here, what would you teach?', is a common question that comes up during interviews, so that gave me the chance to demonstrate how I would be a creative and innovative teacher. Two other questions that come up a lot in interviews are: 'Where will your funding come from?' and 'What kinds of projects will you be working on?' So I had a whole PowerPoint prepared for that, even though I didn't end up showing it. There is no such thing as being too prepared for interviews.

Can you tell me about preLights and how you contribute to it?

preLights is a preprint highlighting service that's run by the biological community and supported by The Company of

Biologists. Contributors to the service provide short summaries of preprints to draw attention to the article and explain why they think the science is important. I was invited to join because I had an existing interest in preprints and it's something that I think is important. One of the things that comes out of writing these short articles is that you end up reading papers and speaking to people who you may not otherwise have interacted with. preLights writers often get in touch with the author of the preprint to notify them of the highlight and to ask them to respond on the website to any questions raised. I hope to use preLights as a training opportunity for my group. We have a journal club as part of our lab meetings. One of us presents a paper and we discuss it. My eventual aim is for individual students to write preLights highlights for us to edit and publish together as a group so that we can get something else tangible from our journal club.

How do you think we can encourage comparative physiologists to interact more with preprints?

I think the only way is to lead by example and show the benefits of using these services. I think it's really helpful when the journals that are relevant to comparative physiologists make it easy to submit to preprint servers. For example, JEB switched a few years ago to allow you to automatically submit your paper to a preprint server when you submit it for publication. That saves time and takes a lot of the effort out of submission because you don't have to enter all the meta-information about the paper again. I think that comparative physiologists are reluctant to post papers on preprint servers because they are worried about being scooped, which is confusing to me, because I think of it as a way of protecting yourself by staking a claim to those results.

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What is your opinion of the current peer-review system and how do you think it can be improved?

I think peer review is absolutely essential to science and I think for the most part it works well. I'm an Editor for two different journals, Functional Ecology and Conservation Physiology, but I find that I do have to say no to some review requests these days, because I handle a lot more papers as an Editor and simply don't have the time to review as much as I did before. I think part of the problem is that there's little incentive to review, because of the way that the peer review system is set up. I think that was less of a problem in the past, but now people's time is being pulled in so many different directions and their productivity is being evaluated in so many different ways, so it is easy to push aside something that lacks a direct incentive. As an editor, I often find that I send papers out for review and go through a dozen or more prospective reviewers before I get two to say yes; I think that is a common experience. In fact, I think a lot of editors have even more difficulty finding reviewers than I do. I think that it might be helpful to have some form of reviewer metric to incentivise participation in peer review, but I also question whether more metrics is really the answer.

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How much teaching do you do?

I teach two undergraduate courses: a second-year course called Animals: Form and Function and a fourth-year course called Adaptation to Extreme Environments. I also teach a new graduate course with Jenny Bruin called Research Communication. I have put a lot of effort into developing all three courses to try to keep the students engaged. I think it's really critical to be aware of the pedagogical literature and the evidence that supports different teaching practices. In a second-year class of 230 students, it's hard to get away from a didactic lecturing system, but there are ways of creating engagement through group activities and questions; I've been trying as much as possible to introduce new ways of teaching into that course. I have a little more freedom in the fourth-year class to be creative because it is smaller (10–20 students) and the students have developed a keen interest in specific topics by that point in their degree. That course is far more student driven; beyond a couple of lectures at the start of the term, the students really direct where we go. They choose topics, make presentations and host journal clubs on those topics as they build toward a final assignment, collecting feedback all along the way. It's really up to them to choose what they think is interesting and where our discussions go. The graduate course I teach along with Jenny Bruin is designed to help practising scientists become effective communicators in every way possible. Students in that class are trained in things like graphic design, oral presentation, writing to a diverse audience and speaking to the media. The idea is to teach graduate students the soft skills they are expected to get along the way in their degree, but are rarely formally trained in.

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How do you assess a course that the students have essentially developed themselves?

The students in the fourth-year Adaptation and Extreme Environments course are obliged to give a presentation on a topic of their choosing. The whole class assesses how they frame and present the material, their knowledge, how prepared they are, and how they engage with the rest of the group and answer the questions raised. I do teach some material and I teach them how to clearly impart information to others. They also have to write a paper at the end of the course on a topic that they choose and I provide very specific guidelines. A lot of their mark is based on that paper and the process that they have gone through to produce it. They write an outline with the key references that they're going to use and I give them feedback. Then they write a draft, which they submit to their peers for review. They're marked on how they respond to the feedback that they receive, as well as on the feedback that they in turn provide to their class mates. Then they submit a final draft at the end. The process forces them to make an early start and to think about their paper throughout the term, instead of writing it the night before. When I started to run the class, I was concerned that it wouldn't work, but I was really impressed with the feedback that the students gave, how constructive, meaningful and well put it was. I think it is a really good exercise. Initially, they didn't like the idea of submitting their work to a peer, it made them uncomfortable, but my attitude was 'that's too bad'. That's what collaboration is about, isn't it? You have to be willing to put yourself out there and send something to someone for their input, for their feedback; that's how we grow.

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