CHAPTER 5

THE DEVELOPMENT OF THE SCIENTIFIC WRITER

> I think you become savvier about not just being a good writer but at writing to an audience. . . . And I think that's where I'm at. I know who these people are who will keep writing the same papers to the day they die, the same sort of formulaic kind of stuff. I want to get savvy and become more proactive than reactive.
>
> — Lizzie

One of the questions of this book, as outlined in Chapter 1, is whether the writing of scientists changes over time post-Ph.D. Do scientists' writing activities change and broaden, and do their beliefs and attitudes to writing change with them—or, perhaps, do their beliefs and attitudes cause them to engage with new writing tasks?

The findings of this study in relation to these questions were somewhat equivocal: while almost all scientists experienced a change in writing activity post-Ph.D. (from a primary focus on writing their own research to supporting the writing of others—see Chapter 7), the extent to which the audience for their work broadened, and their attitudes and beliefs changed over time, was more variable. Some defined a narrow field, addressed by a specific hierarchy of journals and discipline-specific organisations, which they wrote for and engaged with. One of the participants who worked in this way, when asked about whether he thought about his audience when he was writing, commented that he did indeed, since he knew all of them personally. They were 8–12 scientists in his field who met together regularly at conferences around the world, wrote together, engaged in lab rivalries, and reviewed each other's work. These are the routine expert science writers, who define a field and work narrowly and extremely competently within it. One of these scientists submitted his work primarily to three specific journals (for one of which he was co-editor), commenting that he had never had a paper rejected "because I know my stuff." Retaining this highly specialised focus was an individual decision, not driven by field (one participant, for example, explained how his work could be adapted to a more interdisciplinary context or have been appropriate to public interest) or outside pressures—indeed, could be seen as being maintained *despite* external pressures to engage with what one participant referred to as "big science" and its associated funding.

On the whole, those scientists who engaged with broader, more diverse activities as they developed seniority, tended to be critical of these narrowly focused scientists—this was certainly not a path they wished to take. And yet this group of narrowly focused, highly specialised scientists included individuals who were extremely successful, even award-laden. Not engaging with "big science" did not seem necessarily to inhibit their careers or, perhaps more importantly, the way *they* wanted to grow their careers. I heard no regrets.

The scientists whose writing activities changed over time tended to express different beliefs about the purpose of science and more complex motivations about writing science, which led to individuals seeking out interdisciplinary research partners or opportunities to engage with the media or social media. While these individuals maintained a strong interest in moving their field forward, and most were engaged in writing their own research, they saw and pursued opportunities to broaden their focus.

In this chapter, I have chosen four interviews that illustrate the progression from narrowly to broadly focused writing, and the beliefs and attitudes associated with this shift. Grace, a young post-doc, is engaged in writing in a narrow field. At the time of the interview, she lacks confidence as a writer, sees writing and science as separate activities, doesn't see writing as persuasive, struggles with issues of audience, and relies on imitating her advisors' writing style to develop her writing. Yet I have chosen her narrative because it contains the seeds of a growing understanding: she enjoys writing, is developing resilience, sees the value of adapting to feedback, and is taking steps to broaden the audience she engages with.

Lizzie and Paddy are at a different stage in their careers, and both show an understanding of where to go next to develop themselves as scientists and writers of science. Neither is content with a narrow field. Paddy is about to begin a research project with a group of writing researchers, and is considering how to engage with a public audience. Lizzie describes herself as being on the cusp of the next big step. These two narratives demonstrate more sophisticated approaches to science and science writing: they talk in complex ways about audience, persuasion, process and style, and they enjoy writing in a range of contexts.

The final narrative in this chapter comes from Lemrol, someone who has reached the last stage of his career, and who exemplifies the adaptive scientific writer. Like Richard and James in Chapter 2, and Catalizador in Chapter 6, his interests generally, and more specifically in writing, stretch well beyond a narrow discipline. He is the master of his craft—highly resilient, strongly innovative, endlessly curious. His research, and his writing, is now influential in a range of contexts, and he has a significant role in shaping the next generation of scientists. He is the model of the adaptive end-of-career science writer.

GRACE

Grace was the only person I interviewed in a lab, in her white lab coat, surrounded by equipment. She's somewhat distracted, not quite sure why she agreed to this interview. Perhaps in keeping with her status—she is early in her first postdoc (a three-year project) in the field of marine science—she has the simplest attitude to scientific writing. In her view, writing is not part of science, it doesn't have to be persuasive, and her approach to style focuses on mimicking the style of her advisors. She has yet to develop her own style or a sense of ownership of her field. But one thing of interest is her description of writing a paper as an organic process of writing all the sections almost simultaneously.

I Don't Think Writing Is Part of Science

Oh goodness. Shall I describe my project? OK, well I did some preliminary experiments—this is before starting to write it up—and found that I had discrepancies with other papers, and then we decided to take it forward and do it as a project in itself. So I think then you, or we (it's hard to describe how it goes) start with the introduction.

But also at the same time we're looking at the results, so I find that I tend to do both of those things at the same time: you know which direction you're going in and also you don't want to tread on other people's toes, so if someone's done the work before you, you don't want to repeat what they've done. I'd say definitely the introduction and the results at the same time, but the results are ever-going until you've finished your experiments. And then probably the methods as well, you're starting to write those up as you're doing them so you don't forget them. And then as you're getting your results, you're formulating an idea of where you want to take the discussion. So I would say the discussion would be next, and then finally the abstract.

I'm not very good at seeing a big picture. I get very bogged down in details, so it's good to have the different paragraph headings. I try to keep to those headings and then you can formulate the plan and see how the paper flows or how your write-up is flowing. I do my processing on paper. I print out many, many copies and keep going through it. Even after a day's editing or changing, I'll take it home to read on the train and sometimes I can't quite believe what I've written because it doesn't make sense. So it's obviously been a brain dump from my brain to the paper.

When I've got it to a stage where it's all written up, I pass it on to my advisor. He's very good at making things concise. So what I say in two sentences he will say in one sentence, and I don't know whether that's because of his experience, or

just that he's very good at writing. But you learn from that. Recently we've come to an agreement where he'll say "that paragraph needs reducing by half" or "that section needs to be reduced, and the lists that you've done there are too long so take out some of the detail and put them in the paragraph afterwards." So he'll send me away to do that myself which is really good—rather than him doing it and then me learning it parrot fashion. I think I'm quite quick to learn, so once I've seen how a section has been corrected, I would then absorb that correction and apply it to the rest of my writing.

We do have other authors but generally, within this post-doc, it's mainly my main advisor here that would do any editing; the other one lives elsewhere. While he might pick up spelling mistakes, he doesn't really change that much, and I don't know whether that's because he thinks it's fine or because he hasn't got time to go through and change all these things. Sometimes I pass on my papers to family members just to read through—I know that some of the science is probably a bit gobble-de-gook for them, but as long as they can get the general gist, I see that as a positive thing. My grandmother loves reading through the papers because then she gets to understand what I'm doing.

Whether I think about my audience depends what I'm writing. If I'm writing a scientific paper then I don't really think about other scientists—you just sort of write—I never think about them. Whereas if I have the public in mind, then I would definitely think about the audience; and that's probably also when I would pass it to a family member and say "do you understand this?" because essentially they are a lay person and the kind of person that would read it.

I find writing for the public more enjoyable than writing for scientists and possibly easiest as well. I find scientific writing more of a challenge. But I want to get better. Self-improvement is what motivates me. And I do enjoy writing, even though it's a challenge sometimes.

I don't think scientific writing should be persuasive. I think sometimes it can be; it depends on the writer. I think if you're clever and you're good at writing then you can probably be very persuasive. But I don't think I'm that good at writing—I'm bad enough at just writing up my results to get published, let alone to publish it with an intent to persuade people.

I think if you are able to adapt then you can survive. Like we've had one paper—the one that I'm working on now—rejected by one journal and we've had to go back, rewrite it, do some more experiments and submit to a different journal. We've had to change our stance and the way that we've written it. I think the first draft that we submitted to the journal, was too . . . well, it's criticising entrenched methods. I think that upset some of the reviewers. So with the second submission, it's a lot looser; we showed that there are discrepancies

with the method, but we're not so forthright in saying that another scientists' methods were wrong.

Writing is very important. You've got to keep writing. It's an avenue to show the world what you're doing, what you're working on, what you've found out. But I don't think writing is part of the science. I think you do the science and then you write it up—I can't see how writing is part of the science.

PADDY MCCARTHY

I interview Paddy, a postdoctoral researcher in experimental freshwater ecology, outside on a cold day in an icy wind. He has no office of his own—just a lab shared with other young scientists who have chosen this day to be at work. The various places we've tried around the university have been too noisy for my recorder, so we sit outside the library, our hands turning slightly blue, and talk. What is significant about his discussion, from my perspective, is his determination to see writing not as a thing in itself, but as an integral, inseparable part of the research process. He can't really tell me how he learnt to write or how he teaches writing. Instead, his focus is on the entirety of the research process. He's not a writer, "just a scientist," but for him writing is part of being a scientist.

I'm Not a Writer. I'm Just a Scientist

When I was a child, I used to write short stories and little books. I write poetry now, so I still write for pleasure. I really enjoy scientific writing as well, so I guess that is writing for pleasure too. Most of the time. Writing is something I really enjoy. But I don't have enough time anymore and most of the reading that I do is journals and papers. There are so many books that I want to read and they're all sitting there half read.

I work primarily on my own, but there are quite a few people in my research group; there's one Ph.D. student who is directly linked to my project, so we've worked quite closely together. And my boss is very involved, hands-on in the project too. It's a lot of solo work but with a team around me when I need it as well.

The project I'm currently on is for a grant that my boss won. So in terms of designing a lot of the core ideas, that's already in place and certain boxes have to be checked over the course of a three-year project. But then there's a lot of leeway within that as well, so you can put your own stamp on it and contribute your own ideas. To give you an example, my most recent field trip involved setting up an experiment that I had designed with my leader's help. So a lot of it *is* coming up with your own research or getting involved with the rest of the group and

helping them with their data analysis or writing. I've come into a project that has been going on for years, so I'm also contributing to, or writing papers for, work that I haven't actually carried out.

The way I usually start to write a paper, if it's a paper based on data, would be to start with the results section and get the story clear. So I'd look for the key patterns in the data, weave them together into a story that makes sense and that you can engage a scientific audience with, and then work backwards from there. I would write an introduction to that story next, which obviously has to make sense in the context of the results. So the various introductory paragraphs should talk about the background area to each element of the story. The methodology's obviously fairly set anyway because that's what you've done. And then in terms of discussion, I guess it's starting very narrow by summarising the key results that you've found and then going through each of those results in detail, putting them in the context of the wider field and then broadening it out more and more so that you can relate it to the work of others; highlighting how it's advancing the field, or what the new questions are, new gaps that we realise based on these results and what the next steps need to be. I guess that's pretty much the paper written.

A lot of the processing is done in my head. I'm not one of these people who actually writes down a plan and draws a nice schematic; but to me the story is very important, so I plan it in terms of a story. So I would need to identify what the key elements of the story are; these are the themes that I have to address in the introduction; these are the themes that will have to reappear in the methodology so that you can see how each of them was carried out, and then they are the themes that I need to discuss and interpret and develop in the discussion. It is very structured, there is a plan, but nothing really formal.

There's always room for improvement I think, no matter how good you get at writing. I really benefit from talking to people, or showing my writing to someone who will look at it from a different perspective. In my most recent paper, there were a lot of co-authors who took on that role. Some of those co-authors didn't even have a big involvement in the paper, so it was almost like getting an outside person to look at it. But normally I would send it to the next most leading author in the paper, get their big input on it, and they would probably be involved in a lot of the writing as it develops anyway. If it's a high profile paper, you'd want to send it to a couple of people—maybe outside your university—just to get their feedback. Sometimes I'd go to a colleague down the corridor and say "look I have this paper, do you mind perhaps taking a look at it?"

Since most of my writing is scientific, I find it quite difficult to communicate complex ideas to an audience that is probably going to get bored by the details but excited by the key themes and topics. Sometimes you've got to write a press

release for a paper and that's challenging too, writing in a very succinct way, selling the story to a general audience. And sometimes you almost start bashing yourself as well, because you get so caught up in your little bubble world of scientific journals and other researchers that you forget the more hands-on applicability of your research in terms of conservation or management perspectives. And it can sometimes be an eye-opener when you have to say what the real importance of your research is in one of those journals.

On this recent field trip I did very little desk work; you get into research mode and it's long days in the field. In experimental freshwater ecology you could be out most of the day, and it's very intensive work that tires you out, so the last thing you'd want to be doing is writing at the end of it. You make all the plans before you go there so you know what it is that you're doing; but at that stage you just want to set up experiments, carry out your survey work, collect your data. You're not worried about how it's going to fit into writing these different papers. You almost have to be a little bit distant from the end product because it might influence how you carry out your research. You just really have to do it in your logical, scientific fashion, collect it all as best you can, and then just trust that, later on in the lab, when you're processing samples, the story will start to emerge and then you can start writing things down.

I guess scientific writing is persuasive. You have your questions that you want to test; you probably have your idea of what the answer's going to be, and it is exciting when the results confirm your expectations. Then you want to persuade the reader that this nice piece of work that you've done was well thought out, was well executed; that the results that you're presenting to them are believable, full of integrity. You want to persuade them that the results, which you're saying have all these characteristics, are going to be really interesting to them and will forward our understanding of some particular topic.

In terms of the writing I like best, it's definitely forming the story, trying to see the pattern in the data. I don't know if that really counts as writing because a lot of that is storytelling or analysing or interpreting. I guess what's very rewarding is when you can start trawling through the literature of those buried studies that you haven't ever read before or that you didn't know about, and then you start saying "oh, somebody else had done something that proves an element of what I'm showing here" or "well that was a surprising thing but I can see why mine might differ to that." That's an exciting part of writing, still a kind of a learning process, seeing these other studies that relate to your work, even if it's slightly tangential.

I always find starting to write is the hardest part of it and it's the bit that takes me the longest; I can literally be sat for weeks just staring at a blank screen or just thinking "no" and going off and doing some other task. I think subconsciously

you need that time to be able to process the story, the patterns that are there; and even though you're not actively thinking about it all the time, having that long lead-in period to writing somehow gets things gestating within you. It becomes a lot easier then, once you get into the flow, to really start, and everything kind of runs together. But getting it going, that's frustrating at times.

What motivates me with my writing? I guess it's a couple of things. One of the more facile ones is, you know, the same way as when you're a kid trying to collect stamps or whatever, and you want all the stamps or you want the best collection. And in one sense when you start getting into this publishing thing, you want to publish in better journals, you want to publish more papers, you want to collaborate with more people—so it's kind of "I want to do more" and you're going to get greedy. But from a more practical standpoint, I'm really interested in being the best I can be and having the best career I can, and a very important part of that, I realise, is building your CV. What you write is almost like your portfolio, and I guess the more research you do and the more varied the topics, and the more people that you do that with, shows that your research is valuable and of general interest. It's not just being a first author on the papers but also showing that you'd make a good mentor, that students you've done projects with can write really good papers as well. And I'm starting to like that process of not being the key person that's driving the writing but being there to offer a helping hand and seeing somebody else get to that end product stage. I'd say that's probably one of my main driving goals.

I think writing is part of science. It's not just there to communicate—of course it *is* there to communicate what you've done—but I think like what I was saying about when you're writing the discussion, there's an element of discovery to the writing as well. So just through the writing process—and I think every author will have their own unique way of doing this—you make connections between findings or the data that you've collected, the interpretation of that, and the work other people have done. I think only through writing do you make those discoveries and connections. And then reviewers might say "oh my God! How did you miss this?" or "you should have done that" or "have you read this paper?" It's all that process that makes the study not just the actual collecting of the data. It is this really nice integrated process of collection and then communication, but with feedback loops in between.

There definitely are different styles in different disciplines. Within the ecological sciences we don't have these definitive laws like they have in chemistry or in physics—but we're almost a little bit too hard on ourselves at times because of that. We take this really hard line on trying to be sure that everything is completely above board and as unbiased as possible. And we're very—I don't know what the word is—third-person voice, very cold and logical like "this was done"

and "this is how it was done," but we won't tell you who it was done by because it needs to sound like a robotic process without any room for personal error. And I think that is because there is so much natural variability and confounding factors in ecology and, as a result, a lot of the elements around our research are kind of soft and open to criticism. There's no room for flowery language or anything like that—it all has to follow a highly logical scientific code.

Something that drives me is not just being pigeonholed into one particular field where you become the all-conquering knowledge master of that field—I don't think I could ever be one of those people. I'd rather be like the jack of all trades, you know, and have my finger in 10 different pies. I've changed my focal research area through different ecosystems throughout my career so far, and I've had collaborations with lots of people in different fields, whether it be empirical or theoretical, and I don't think I ever will be an expert in any of those. But I'd rather try and take the core set of skills I have and apply it to lots of different areas so that you're doing something that's new to a particular field and advancing that a little bit of the way, and then other people can go on and do with that what they will. So I'm trying to adapt what I've learned from one particular area to lots of other areas, and that's exciting, even though I'm never going to know everything there is to know about that new area. At least you've contributed to some sort of advancement of that field.

I thought I wanted to be a biochemist or a microbiologist when I started college, but on a second-year undergraduate field course we were taught by two people who were really passionate about ecology. I came back from that course going "that's it—I want to be an ecologist." And then a professor in my final year undergrad showed an interest in me and persuaded me that I could write a proposal to get Ph.D. funding. He was like a good friend as much as an advisor throughout the Ph.D., and very driven by wanting papers and success to make his research group bigger, so you wanted to do well for him. But no one ever really influenced or inspired me specifically for writing—I think that's very much something that's just a product of all the other steps in the research process.

I don't know how I learned to write science. It's definitely through the Ph.D.—I don't think I had any proper clue about it before that. I guess it's very much self-discovery and getting to know what will disappoint your advisor. My advisor would give me a lot of comments on my writing; he was not just one of these people who would say "mmm, that's no good. Rewrite it." He would give very constructive, detailed criticism and then I'd try to develop my writing style so that when I handed something in there wouldn't be much correction or criticism or commenting required on it. And I guess you read other people's work, and you have a research group around you where other people are at the same stage or maybe just a year down the line, and you can see how they're writing

so much better than you, and you think "how can I get to that stage?" I find it very hard, thinking about it now, to put a finger on how I learned to write. How much of it was my advisor, how much of it was just learning, or all those other things around me, in my environment? But, I think they probably all came together in some small way to improve my writing.

I would like to have the opportunity to write with a little more freedom. It would be exciting to write in a style that you're not familiar with for an audience that you're not familiar with. It might be challenging to try and adapt and broaden your horizons a little bit. Being able to adapt to certain situations and convey your message to different audiences would be a really good thing to be able to do.

I'm not a writer. I'm just a scientist, a researcher. I always just see writing as part of all the things I do. Writing isn't the prime focus. I would never describe myself as a writer, but I guess I do a lot more writing than most people do in their day-to-day lives.

LIZZIE

Lizzie's office is light and colourful, and she is too. Her energy and passion for her topic are palpable, and she draws you into her experience of writing. She describes herself, after some deliberation, as an evolutionary conservation geneticist, and one of the challenges she has faced, as an emerging scientist and a scientific writer, is establishing and managing relationships—with colleagues, with students, with conservation officials, and with the amateur bird watchers who have watched "her" birds for decades. She wants, more than anything, for people to notice what her community is saying through her writing. When I interviewed her, she was sitting on the cusp between emerging scientist and established scientist—moving away from her previous advisors and establishing her own ground. She's transitioning into a new phase, beyond just writing up research, to commenting and contributing to her research community in a broader way.

It's Time to Stop Just Writing Up Research. It's Time to Start Commenting

Almost all the research that I do is collaborative—I'd say there is very, very little that I would do just on my own, and the nature of those collaborations really depends on the project. For example, I did my Ph.D. about six years ago, and that research now has two prongs to it: one is following up on some of the research I did in my Ph.D. in a collaborative role with a current Ph.D. student

of my former advisor. And then also the project I did for my Ph.D. was very global and now I'm focusing it more locally. That research now is sort of mine and part of my research programme, so I no longer collaborate with my Ph.D. advisor, but I collaborate with other people here and internationally. I also do a fair bit of conservation genetics work, and I do that in collaboration with a government body. And I'm just wrapping up the post-doctoral collaboration with my post-doctoral advisor and now again launching that off into more of my own research programme. But that's through students and other collaborators.

So you could say I'm emerging into a new phase where I'm no longer the person working with somebody else's ideas and concepts and becoming one where I'm taking more of a leadership role. That's what I'm gunning for. It's not an ego thing, but if you want to establish your research programme, that is what it's about. I mean, in terms of authorship issues and things like that—at what point do you cut the cord with that previous advisor?

I'm also moving into the stage of my career where it's not me doing the work; it's the students doing the work, so I get to spend less time in the field. The vast majority of my work is actually done in the lab, but I haven't held a pipette in quite some time. Because I'm building on things I've already been working on, the samples are already in the lab. So a student can come in to do a project without ever seeing the species that they worked on. And I don't like that at all. There's a huge disconnect if you don't know your study species. I currently only have one master's student right now, but she's working with a recovery group for a critically endangered native bird, and so I've got her spending time with the conservation folks in the field and then also there are birds in captivity so she's spending time with the managers of those captive facilities as well. It's really important for students to get that interaction. Even though she doesn't need to go for her project, I think it's really important for her to know what she's eventually going to be writing about.

When you are a young scientist, you are usually species driven—you're interested in whales or you're interested in birds, and you generate your questions around your species. But as you grow up in science, you start generating your questions first and then looking for model systems in which to address those questions. I was the classic example of that. I was like "I like whales, all cool, there's these new genetic tools—I'm going to use these tools to answer these questions about whales." And I started thinking "well actually these are the questions I'm interested in. Seabirds are the great model species." So my doctoral project started with some ideas that my advisor had been thinking about and she was the one that pointed me in that direction, but then ultimately where the thesis went was generated by me. In my field that's usually how it goes. There will be some research proposal that says I want a Ph.D. student on this project,

but then ultimately you're handing that over—the Ph.D. student's going to sort the details.

Let me walk you through my writing process. It's a long story. I work with a critically endangered bird, and one of the questions around them is that they occasionally hybridise with a self-introduced species. So part of the question with these guys is that, because they occasionally hybridise, there are people who think that they are not worth anything. That, from a conservation perspective, there is no reason why we should put any energy into these birds. And so for me the question was "Well are they or aren't they?" When I went into the project, I thought there would be some evidence of what we call introgression because what happens is, if you've got the two species and they mate and form a hybrid offspring, that's all well and good. But if that hybrid offspring then goes back and mates with one of the original species, that's how you get the DNA of one species into the other. So what I figured I would be doing is I would be talking about the conservation value of what we call a cryptic hybrid, which is a bird that looks like one species but has the other species' DNA. And I thought, okay this would be a really challenging project because it is not cut and dry. And in order to do that, we needed to develop some genetic markers to be able to correctly assess that because a little bit of work had been done previously but the sample sizes were low and the marker was inappropriate. But I insisted that we needed at least to see that data out, we didn't want to just jump blindly into a new type of data. And also I initiated a relationship with people in conservation management. To me, relationships are really, really important, especially in conservation. As a conservation geneticist you can publish a gazillion papers, but if a conservation manager wasn't part of the process or wasn't involved in the development of the conservation management recommendations, you might as well have not even done it.

I said "okay who do we talk to?" So then I went down and met with him, got to see the birds—really just had a conversation. And then shortly thereafter there were two students who came over on a summer exchange from overseas, so I took them down there. The same sort of thing: "you've got to go see these birds." And for me a lot of understanding whether this introgression is occurring is about the behaviour and about the management that has happened with these species, and all of that information is in the grey literature. It's in conservation management reports and things like that, and so the only way you're going to access that is through those people. There is a whole lot that isn't written down which you can read between the lines when you are in the know, but unless you are in the know, you have no idea.

For example, with a species that has a recovery plan, theoretically the recovery plans are meant to be published. They may or may not be accessible through

the conservation management department. For example the '98 plan is available but the 2001 plan isn't, unless you go and talk to them. And every year the recovery group meets and there's an annual report. Those annual reports you could only access through the recovery groups. That's where the nuts and the bolts of everything are; the people writing the reports have this knowledge in their heads. And so in addition to going down and meeting with the local expert and then bringing the students down, at the next recovery group meeting I was invited as an observer, because I really wanted to see how this recovery group worked. Then I was invited to present, and now I'm occasionally brought down when they've got questions. So I'm communicating with some key people in conservation management, but I'm also communicating with people in the local community. And to me it's one of my proudest achievements, to be honest—and this paper that we've been writing is such a rich paper because I understand this system very, very well. And it's because of the relationships that I've built. I was a bit nervous about giving the studies species summary to the guy from conservation management, because he is very pedantic and very particular and will correct you if you say one word wrong about the history of this species. And he barely touched it. And I was like "Hooray!"

I mentioned what I thought would be happening, which was that I would end up debating the conservation value of these cryptic hybrids. Turns out these birds are genetically pure, as far as we can tell. What we thought was occurring isn't occurring. Which is why it's so interesting because it's like: How come? Because it is the "why" that's really meaty. And answering that why is what's required all this knowledge that I've purposefully gathered, but not really knowing why. And that then led to a collaboration with another colleague who's a statistician. I said "okay we need to analyse some of this data that's been kicking around in spreadsheets for twenty, thirty years." That's why I also like working with recovery groups, because if they're a good recovery group, they've got amazing databases. And it's all well and good to say I'm going to work on this species and go and collect data on them for a field season or two and try to infer something about the evolutionary history of that group. But when you've got three decades worth of data—you know? It took me a year to vet that data. I don't think I'd ever do it again, it would be a post-doc or a Ph.D. who would do that for me now. But at first it was just me. And I'm really, really proud of this particular piece of work. And the species in itself, it's a critically endangered bird, but nobody knows anything about it. And there's a lot of misconception about their genetic status. So I'm really, really keen to get some national coverage. I'll be really frustrated if it doesn't get picked up by the media.

Vetting the data is a huge deal because it's very subjective and that's when I knocked on the statistician's door and went "hey, what do you think?" And

I said "if this is of interest to you then I would like to invite you to be on the paper. If you're not interested, that's fine." Sometimes co-authors can get ornery if a statistician comes in at the end and gets put on as an author. So I had to talk to each of the authors, and I was first author so it was ultimately my decision, but I said "you know, as far as I'm concerned he's an author. If he's going to do something for me that I can handle, then you know we could maybe debate it. But I cannot explain what he's done and not sound like a complete moron." And so that was something we had to talk about. I'm a really open, honest person, I don't do anything remotely sinister. I go "this is how it is" or "this is what I think" and everyone who is involved in this paper is the same way. So it was a really painless process.

So then I wrote up. I stayed home for a week in my pajamas and wrote this thing and just said this is like my Ph.D. all over again, this is crazy. And it was as dry as straw. It was so dry. I've talked about this research a lot, I've presented it at conferences, I've presented it at invited talks. And so I had, certainly, the abstracts and outlines from the talks that I had given. So I certainly had a very good idea of the structure of the paper, but mostly it was in my head. I said to a friend, "it's all in here. I just have to get it down." And that really is why it was a week, in my pajamas, writing. Because I just had to leave all this crap here and just write it. And it was—yeah, it was a painful process.

Almost always I'll start with figures and tables. So I was doing figures and tables, and then while you're doing figures and tables, you're drafting your methods and your results, and because we were going to a high impact journal I wanted really pretty figures. So I worked really closely with our graphics guy on figures. I spent a lot more time on that than I would for just an ordinary journal.

And then of course when you're writing up your results you're like "oh, okay, why did I do that? What was that about?" So that was all written over, probably like a month, in along with everything else I was doing. And then it was time to sit down and really get serious and write it, and so that was when I stayed home.

But I was a bit funny with writing this one because usually I've embraced the shitty first draft better (you've read *Bird by Bird,*[9] right? Everyone should read it) and gone "yep, yep, yep, okay I'm going to say something about this," and I'll literally type that: "I'm going to talk about this." And then write go "Now I'm going to talk about this." And that will help me with my structure. If I can't think of a word I need I just write **word** in the sentence and keep going and come back to it later. But with this one, because I knew that I really just had this week and if it didn't happen I was going to rip my hair out, I was a little more pedantic—more like "I'm going to fight with this sentence because I need to get it right." When I said it was painful, that's why: because I was so determined just to get the damn thing done. And then when I gave it to my colleague I said "you

will fall asleep when you read this. It is so incredibly true and factual and bang on, but it is boring." And she came back and went "yeah, it is."

And she goes "It's all good, but you need all this, you need this information" and I said "I know, so I don't really know what to do with it." But I also wasn't worried about it because both my co-authors are flashy kind of writers, and I thought now I have other people who are going to help me flash this up. And that's certainly what happened. So then it went to the co-authors and they said "Oh yeah, put this over here" and, "ah, you need to spin this a little better, maybe just change this paragraph to change the emphasis so you're focusing on this aspect of it." And that was a really excellent process. And that was really a three-way between us to jazz it up a bit. And a lot of it too, I really enjoyed—I really had a lot of fun with that process because they would say "okay, try this" but I was the one who actually did it. So I don't feel like I wrote a boring paper and they made my paper sound good. I feel like I wrote the boring bits and then *we* made it sound good. It was a real team effort.

Sometimes you just need to get the damn thing out. I think I learned that during my Ph.D. I was doing this particular project, my advisor wasn't super helpful, and I looked at what we had and went "okay, there's enough data here for a paper. I think I should write up this data, and we'll submit it to this particular journal." My advisor actually discouraged me from doing this. She said "I don't think you have enough here, I think you should hold off," and I said "no, I'm going to do this." And it became my first first-authored work from my Ph.D., and everything that I have done since then (and also all her current students are doing) stems from that paper. Just get it out.

To go back to this recent paper, I was writing for politicians who make management decisions about money, I was writing for the conservation managers, I was writing for the faculty who often say "these birds are a waste of space and this is a really good example of what we call a hybrid swarm," and they're not. And I was writing for conservation biologists who were interested in hybridisation. There's a whole field that's interested in hybridisation and conservation and I was writing for that community. And then also there are spin-offs, which is just evolutionary biology in general, so there's a whole layer of people that that paper was written for. For example, there's a section in there that I wrote as a response to communications that I've had with academics in a particular country. And I wouldn't be surprised if the journal tells me to take it out. And a couple of co-authors said, "Do you want this in here?" I said, "Well I'm going to try. If they take it out, I'll write it somewhere else, but let's just give it a go."

The politicians won't read the journal but I'm hopeful the media will pick it up. The conservation managers will read it because the academics they work with will read it. And the evolutionary biologists and conservation geneticists

and those hybridisation types will all read this journal. Evolution biology is a massive field, but that little subsection that are interested in this sort of stuff, they'd already be reading that journal anyway. It might get completely lost in another journal. And we want people to read this one. It's not just to put on my bloody CV, this is one I want to be read. So I was really going for the broadest possible audience.

I'm doing an assignment with some juniors right now and there's a paper called "How to Read a Paper" and—have you ever come across it? It describes this first pass, second pass, third pass approach, and we've started introducing it at second year here. We have built it into either lab exercises in one of our sort of lab-y kind of courses, and into a lab report exercise on the ecology side of things. Every student we have in the department ends up in one of those two courses, and we wanted to capture as many students as we could, really embracing that idea that you have to teach writing within your field. So what I'm now doing in third year with students who got introduced to that idea last year is we're building on it, and I'm saying that in order to figure out if you understand a paper you need to be able explain it to someone. And so I had them going through the first pass and the second pass in a tutorial yesterday. And part of the first pass is "is it well written?" You see, I think they're your audience too. It's not just your post-grads and the academics, it's also the undergrads.

One of the things that we said to our students is that writing is a skill. It is a skill you hone and you develop and the only way to get better is to practice it. And I used that book (*Bird by Bird*) as an example and said you've got to start somewhere. And I was really, really lucky in that when I was writing up my master's I had a mentor, a very, very good writer, and he held my hand through that process and I learned a lot about good writing from him. And I got really, really lucky during my Ph.D., again. My advisor wasn't very helpful—she would correct things but not tell me why—but I had a close collaborator and he would tell me why. He would edit and he would tell me why. And my writing improved so much during my Ph.D. because of him.

I got the kick in the pants that I needed during my master's, but I was still really slow and really pedantic. It would take three days to write an abstract and people would be like "oh yeah, you know, a few more years from now and it'll take you 20 minutes." And I'm like "no, that cannot possibly be true!" And now I'm popping them off. And I think communicating clearly is really important to me and I'm also a pedantic kind of person and quite literal. So writing well is important to me. It is a skill I've purposefully worked hard on. And I think, also, when I was at elementary school it was during a phase in the 70s when they didn't think they had to teach grammar, you know, and all that nonsense. So actually I can write you a nice looking sentence but I can't tell you what the noun

is, what the adjective is, I don't know. And I remember taking an English class at university and I was lost. I was like, "I don't know what any of this stuff is." I just did not come from a really strong place, and it's literally just been practice and good advice. And lots and lots of support.

Now I think I'm pretty good. I don't mean it in an egotistical kind of way, I think it's just this a skill that I really value having. And I think also it's not just that I want my students to publish, I want my students to be good writers. Because I don't care if they become academics, or managers, or moms, I don't really care what they do, but I want them to be able to communicate, you know? And it doesn't really matter what you're communicating; if you're a good writer and you know how to tell a good story, it doesn't matter what the story is.

I'd probably say the intro is the hardest thing for me to write—not so much the discussion. Because there's so much and you've gotta cut through all the crap. If it's something you've been working on for a while, you've spent a lot of time thinking about it, you're really aware of the literature. But then when you go down to write the paper—especially if you don't have a good idea of what journal it's going to, how you start it can be so key.

I think it's framing the paper . . . I mean it's so obvious. The intro is "this is why we need to do this, this is what we're going to do." You know it's really, really basic, but actually snipping out the extraneous stuff and getting it down into "well, what is the relevant background information—what is it that I am actually trying to do here?" can be a struggle. All this other stuff is interesting, but what am I trying to say? And for my big paper it was about capturing the audience right away, because I want to make the biggest possible impact in these first two sentences. And actually the first two sentences weren't too bad.

The easiest kind of writing is writing out a research proposal. It's so easy. "I'm going to do all this great stuff!" Coming up with the idea is easy and is definitely a lot easier than writing what you found!

The relationship between writing and science? That's a pretty open question, isn't it? It's co-dependent really. If you don't write it, it didn't happen. And if you don't communicate it well it doesn't get passed along the chain. And from a teaching perspective, that's what we're telling our students more and more. You have to embrace this skill because you need to be able to communicate what you're thinking or what other people have found or why you're doing what you're doing. Even with this example of the work I have been talking about, I need to get that paper out so the recovery group can go "it's *this* paper, it's not just what Lizzie said."

So the status of what I'm saying changes. I'm going to be really pissed if this paper doesn't get accepted, because I'm really fascinated to see how it goes. I'm

curious about how attitudes might change when it's not just me saying this, it's my colleagues and it's been peer reviewed.

I had a paper come out in *Biology Letters* last year and it got pretty good media pickup. It was about the rediscovery of this bird, merging ancient and modern DNA. And again that was written with a very specific audience in mind, very punchy. It went to *Biology Letters* because I needed it for my research rating; I needed to be able to say "there's my letters, here's my international coverage, here's my national coverage. I've got some experience with media interviews, tick, tick, tick. Done." M, my collaborator, also worked on that paper. She doesn't work on birds, she's like "oh, no-one's going to care about this" and I said "It's birds. People love birds!" And they did; the media here really responded. I'd presented very similar data at a conference in Barcelona, and no one really cared. And that's what I think I found so interesting, that among my peers, they're like "oh yeah, that makes sense, that this presumably extinct thing and this living thing are one in the same. Well, yeah, okay." I did find that kind of interesting, that my peers didn't give a shit.

But this paper I've been working on should be interesting to both communities. It's interesting to the conservation community because it's a really nice, good news story, but to the academic community it's a, "well how the heck did that happen?" kind of story. Like a puzzle, a mystery. And we gave this paper a very jazzy title—that was very intentional as well. We had a lot of discussion around this. Apparently, with those high-end journals, if there's a species name mentioned in the title, they won't even look at it. That's what I've been told by the people that publish in these journals, and that's good to know. Whereas a related one that went to *Conservation Genetics,* I was loud and proud about writing the species name in there.

I'd say that I was definitely learning how to write science during my master's and Ph.D. I already sort of knew how to write, but in my master's and my Ph.D. I was learning how to write science. I think particularly because I was writing papers. Now in science it is very rare that anyone will actually write a standard thesis; usually it is two to five data chapters sandwiched in between a general intro and a general discussion. And so I think the scientific writing skills that we're getting now at graduate level are probably different to what scientists would have gotten in the past. I think I'm honing the skills, learning how jazz it up. It's about learning those little things, the tricks of the trade. You've got this rejection letter from one journal, how do you turn it around to be something positive? Like with the recent submission, the one I've been sweating over, in my letter I incorporated the fact that I got feedback from the senior editor of another journal. I wouldn't have had that savvy during my Ph.D. I remember I did some stupid things, like I submitted an article to a

journal and didn't even write a cover letter for it. Now I wouldn't even think of doing that.

So I'd say that this next stage is just getting savvy and honing your skills and picking your battles and being really strategic. That's not just the way I approach my research, but the way I approach my early academic career. It's all about strategy. And it's all about not just ticking boxes but using your time and your energy efficiently, so you can have a life outside of academia.

I'm getting to the end of that stage now. Right now with M and another friend of mine (who I've yet to publish with, but we've always known that we would eventually), we're ready to write a reply to an article that is absolutely pissing us off. It's time. And I know it. I go "yup, it's time to stop just writing up research. It's time to start commenting." I guess you just feel you've got the expertise to see something and go "that's just wrong." With this one particular paper, all of us are reviewing articles where people are citing this guy and it's just a pile of horseshit really. It's pissing me off. I feel bad that I'm reviewing this Ph.D. student's paper, and they don't know any better, so I'm just this nasty reviewer that goes "well I know you cited so and so, but so and so's on crack." Well, of course I don't say it like that—it's much more professional, trust me. But that's what I'm thinking. I said, "look you guys, we need to write something because I want to give those students something else to cite." Hopefully someday someone will invite me to do a review, though I've heard it's horrible so I don't think I really want to do it.

I think you become savvier about not just being a good writer but at writing to an audience, that you're picking your audience and you're writing to that audience. And I think that's where I'm at. I know who these people are who will keep writing the same papers to the day they die, the same sort of formulaic kind of stuff. I want to get savvy and become more proactive than reactive.

LEMROL DARNEL-GAN

Lemrol is a senior academic, past retirement age, but still working full time and taking an active research leadership role. It is hard to pin down his discipline: his overarching interest (and the discipline in which he began his career) is applied physiology, though his current primary interests are animal welfare science and bioethics. He speaks with authority, in long paragraphs and with precision. He somehow finds time for me to interview him three times (for a total of three hours), because there is so much to discuss. I chose this small part of his narrative as the final narrative in this section on the development of the scientific writer because, in a sense, he picks up where Lizzie left off. She is just realising that she has to think bigger, start engaging with and challenging the central

questions of her field. Lemrol's end-of-career narrative shows what the career of someone who's done that, who's looked broadly and creatively at their discipline, can become.

Everything I Write, I Still Learn Something New

By the luck of the draw, by the accidents of circumstance, I've done a lot of writing. I did my final year at high school twice. I went back to repeat the year, not because I had failed, but because I didn't do particularly well. I had great learning problems at school. I'm mildly dyslexic, and in those days, the 1940s and 50s, they thought you were intellectually handicapped. It also gave me an opportunity to do the same subjects again, but I elected not to do English, which was really stupid, although I didn't know it at the time. At university I started an agricultural degree, changed to science at the end of second year, and majored in physiology. So I had a BSc, and that was followed by a final full year of research at honours level. That was when I had my first introduction to the contingencies and the difficulties of writing about scientific subjects. I was extremely lucky, in that it was a small, fully residential university and so you virtually knew everyone. And I had very nice friends, some of whom were in the humanities. One in particular, very kindly, when I was writing my honours thesis, took me under her wing, and helped me with English expression, because I was struggling with that.

What I found difficult was the focus, the precision, the use of language, how to express what I was trying to express. I mean, you thought you had it, and you'd write it down, and someone would look at it and say "I don't know what you mean." The way I say it to my students now is that "I was not born writing the way I write today, I had to struggle and learn exactly what you have to learn." And this is where I usually quote T.S. Elliot's poem "Four Quartets: East Coker" to them:

> To arrive where you are, to get from where you are not
> You must go by a way wherein there is no ecstasy."

I say to them, when they're writing theses and assignments, that there are two processes going on, unless they're exceptionally lucky and they have done humanities and actually have a facility with English already (and even then, they still have to learn the precision of scientific writing). They are working out what their ideas are, and, at the same time, they're learning the careful use of English so that they don't overstate or understate the situation; also, so readers who don't know really what their ideas are can understand them from the very beginning to the very end of what they have written. Those two processes are so overlaid that you can't really separate them.

It's a long and painful process. And you have to learn from ground zero, which is what I had to do too. You must go by a way in which you don't know. This is why you have to trust that your advisors know what they're doing on your behalf, because you can't get someone to understand what they will understand at the end of the process when they have not yet gained that understanding. And I still learn. Everything I write, I still learn something new. There is always another way of putting an idea, or a fresher way.

In the early stages as well, you do not have a vision of the subject. You've been gobbling up all these references, which you're reading to get facts. Then you come to know the facts, and you become burdened with facts. And those advisors who are not that experienced in scientific writing and in scientific research say to their students, "you've got to write your literature review first. You've got to do your historical review of the literature." And I tell these students that it should be called an "hysterical review" of the literature, because, if you write a historical review of the literature reporting only facts, you will bore your examiners to the edge of insanity before they even get to read about the research you've done. So, you do all the reading, but the last thing you write is the introduction to a thesis. That is unless we can get them involved in developing their wisdom of the subject early, developing a vision of the subject that's publishable. If the introduction is not publishable, we don't think our students have done as well as they might. I've had several Ph.D. students who have co-written three to six review articles with me as part of their introduction.

I was extremely fortunate that I lucked into a productive area for my Ph.D. My first advisor was unwell and he died 18 months after I arrived. So, I ranged around to find something that I could do. I was fortunate to find a very productive and interesting area which included human beings. By the time I finished my Ph.D. and landed my first job, I was much better at writing. But oh boy! I was still raw—my style was very verbose and repetitive. There was a guy there who was head of the biochemistry department who was brilliant at science but often inept with people. I learned a lot from him! He was a more senior staff member than I was, and I was a pretty young head of department, so the director of the institute, who was not a physiologist, said I had to show my papers to this biochemist before sending them to scientific journals. And he would take a sentence that was maybe 25 words long and he'd reduce it to 10. And it would be much clearer. But as he wasn't a physiologist either, he didn't understand how it should be written for physiology journals, creating other challenges for me. But that's another story.

So I'd written my thesis, and six papers that came from that work. Everything you did, you had to publish. I mean, you *have* to, because this shows its value. If you can't publish it, it hasn't been worthwhile doing. So everything

you'd done should lead to a paper. Being inexperienced, you'd just write it the best way you could. It would then go out to referees, and the referees would come back and say "well I don't understand this," "it's not clear what you mean here" and so on. You can learn a huge amount from referees, even if they misunderstand. Because, if they have not understood what you've said, and they come back and say "oh, this is rubbish," you have to ask yourself "why?" So, every time you get a paper back from a referee, it's a learning experience—as long as you're not someone who reaches for the irate button.

Sometimes reviewers talk about writing style. Editors occasionally do as well. I published quite a few articles in one particular journal, and there was a period there where I'd get every manuscript back after it had been accepted for publication with red writing all over it. About 30% of the comments were helpful in making the writing clearer. But 70% didn't make it any clearer; all it was doing was putting my writing into the editor's style. He clearly didn't have enough work to do, despite being a full-time scientist as well! So eventually, after about eight or nine papers where he had done this, I wrote to him and said "I know you're trying to be helpful; I really appreciate the effort you're putting in; but to be perfectly honest, I think you're going over the top, because I believe you are now trying to convert my writing into your style. I'm very happy to accept the things that really do make it clearer, but I frankly want to retain my style." He got back and he said "yeah, yeah, fine. No problems. Take or leave what I say as you see fit." This was about five years after the Ph.D.—I was confident about my style by then.

But if you'd said "what is your style?" I wouldn't have been able to tell you. It was still evolving. If I looked back at some of my early papers, I would say "oh, I could say that much better now." And, so, you keep on learning, as you get more involved, more experienced, and as the breadth of your vision of the subject widens or deepens. Then you have the confidence of that experience behind you, and you are actually putting your writing in that context. In the early stages, the writing is part of working out the ideas. That hasn't been the case with me for many years now.

Once you get enough into the subject, you get to the stage where you have thought a lot about it, so when you're sorting out the results you are also looking at the interpretation. And so at an earlier stage you'd get all the results, and then you'd say "oh god, what the hell does this mean?" But then you get to the stage where you've worked out what it means before you start writing. You've discussed it with your colleagues, you're saying "oh this fits in here, and what that's showing is this," and so on, so that, in a sense, you have a much earlier idea of where you're heading. But it sometimes happens that in the process of writing, and then pulling in the references to give the embellishments and the support,

or the caveats, you suddenly have a fresher idea than you've had to that point. The writing might take a different direction. So once you know your field well, you often work from a base of ideas that you put together at the very beginning.

I think a way of seeing it is to look at the different sorts of articles. When you first start, you're writing original scientific articles, where you've done the research, you've evaluated the results, you've looked at them in context, and you've written the paper which explains the significance of the results. At this very early stage, you're learning how to use English, and you are working out your ideas as well. So you learn something new about English expression every time you write. You learn less and less about English expression as you get more and more experience, but you still learn something every time.

And, as you get further on, having written many original scientific articles—and this may be peculiar to me—you start asking "how does this fit into a review article I could write, to carry the subject forward?," rather than, "this is where we've got, and it stops here." You think "What do we know and how does that take us forward?" I advise junior faculty to think "what review am I going to write?" because that helps them crystallise their vision. Now, you have to be very careful that your vision is open, that it isn't closed and you're not disregarding anything that disagrees with what you want to put forward. So yes, you develop that vision. And that vision is built on original research and, we hope, is also pointing to fresh ways of thinking about the subject.

So, reviews at their best provide a solid foundation together with fresh conceptual frameworks to help the subject move forward. As you get more and more experience with writing papers, you get invited to present longer articles where you actually begin to tell a story. And that tends to involve drawing information together, and putting it out as important ideas for people to have in their minds to stimulate other research. So, I started writing reviews, or at least thinking about writing reviews, many years ago and now review-writing is my major activity.

After 28 years as a head of department and researcher, I became a full-time scholar and academic. This was 11 years ago, and it has just been absolutely wonderful. What I've noticed, and this is something I've heard other people comment on, is that I began to say: "well, part of my obligation now, as someone who has the time to reflect on the wider background to the subject, is to draw on my professional lifetime of experience, to see how that can be brought forward into the present, to give a basis for going forward; not as a strait jacket which rigidly holds onto particular ideas, but a launching pad for originality." And that's where it's been real fun. I've really enjoyed writing reviews and books, and co-editing other publications for international organisations.

Physiology, to me, is just fascinating. And what I really like to do is to get across the fascination of it. And it's not just fascinating. It's really useful.

The ideas that engage the imagination and lead to fresh directions in research are the ones that fascinate. I'm saying "have you thought of this this way?" For example, take the question of fetal consciousness. I presented the evidence for it, some of which is quite controversial, at a scientific conference and someone said "but isn't this relatively well known?" And I make no pretence about it: "Yes. It's been in the literature for many years. Fetal physiologists have known this for 25 to 30 years." But one of my colleagues said "yes, this is very well known, except for this new synthesis. What Lemrol has done is completely fresh; no one had ever drawn it together that way. And he's the first one who's dared to say it." And it's led to all sorts of things, like special global guidelines for the slaughter of pregnant animals, to make sure their fetuses are managed in such a way that they can't suffer. This kind of writing can lead to all sorts of fascinating new directions.

So, at the beginning, when you start writing science, first of all, you're learning to write. Then you go through a phase where you are writing to discern what your ideas are as well as to understand your field and learn to write about science more effectively. And from there, you go on to writing reviews, where, in a way, you know what the ideas are at the outset. You know the field so well that you write and your ideas are already formed. It's simply a matter of putting them out there. And then finally you get to a stage—or maybe not finally, maybe there is another stage after that—where you are providing a platform for something that has huge implications in lots of different ways.

I learn something new every time I write. That is what the enjoyment is. For example, I have another review that I have in mind, where I'm not absolutely clear what the outcome will be. Well, I am clear what the outcome is going to be, but I'm unclear as to how I'm going to express it, if you see what I mean. The question is "do you need to be conscious in order to learn something?" People say "well the fetus must be conscious because it recognises its mother's voice after birth." Well actually there's no physiological reason why it needs to be conscious for that to occur. But I need to explain it physiologically. And that's what I've set myself the task to do.

But there's another project, this time on animal welfare, which has a rather different focus. This reminds me, that maybe we need now to think about the breadth of subjects, how my interest in broad issues arose, and the impact of that on even wider issues. Much of this has come from other activities that I've been involved in.

So fetal and neo-natal physiology were my major areas when I worked in Scotland, when the context was the causes and prevention of lamb mortality. Also, the fetal/neo-natal area gave me a link between agricultural and veterinary sciences, science, and medicine. Now, part of my neo-natal work led me to look into stress physiology and pain. And so, when I came to my current university,

I had also published in the area of the impact of routine husbandry practices on animals, looking at behaviour, pain and stress responses. As a busy head of department, I couldn't manage fetal and neo-natal physiology projects, because they're pretty much full time, but I could do focused projects with masterate students. These were on different aspects of assessing how much pain was caused by these husbandry procedures, and finding methods that were practically usable and not costly on farms for relieving that pain. So that got me into the animal welfare area.

Now this is where opportunity can lead you to different writing styles, different writing areas. So I'm just telling you the history here. If you'd said to me 21 years ago "this is going to happen," I wouldn't have believed you. Once here, I became involved on behalf of the Royal Society in establishing a council for the care of animals in research and teaching. I was its executive vice-chairman for many years. So that put me into the area of bioethics applied to animals used for science and for other things. One of the ideas I really pushed was that scientists should become ethically literate. Previously I started a bio-ethics discussion group and afterwards I had a lot of work setting up conferences and so on. Now, that involved a completely different sort of writing. Getting ethical ideas across. My inaugural address at the university was a different sort of writing as well, as it was the first time I had nailed my colours to the mast, where I was saying that scientists have to embrace the ethical dimensions of science.

This path I've taken is, perhaps, unusual. But it is usual in the sense that there are always a few unusual individuals who have such broad interests. This doesn't make me wonderful or special. It just means I have a different orientation to knowledge and thinking that takes a wide compass. Other people can't cope with that. Now that's not a negative thing. Other people prefer, or are more satisfied with, a more precise focus. It may be because they are a bit nervous about stepping outside their comfort zone, or it may be because they just really like the pursuit of that very detailed knowledge. And I'm not judging them one way or another. Both approaches have a legitimate place in science.

My interests have always been extremely wide, and include religion, culture, history, economics, philosophy and politics. So, as chairman of an animal welfare advisory committee, I found myself writing for lay people. The areas of writing sometimes really surprised me. At one stage we had a challenge from one of the industry boards when we were preparing a code of welfare which was a major part of the remit—and still is—of that committee. They sent in this challenge from one of the leading lawyers in the country, about the fact that we had interpreted the Animal Welfare Act the wrong way. And I said "well, I don't think we have, actually." But I couldn't say why. I found myself writing a 20-page analysis of the Act demonstrating that we had done exactly what the Act intended in its

spirit, and in its detail. So I found myself then writing on legal matters. That was fascinating. Incidentally, no response came back from the lawyer!

My late first wife, who was from India, wrote a book which was an analysis of crossing cultural and religious barriers. It was an analysis of why it was that something we found so easy, everyone else seemed to find so difficult. We didn't see it as a barrier, really. But you don't realise how difficult that can be until you look back at the journey you've actually travelled yourselves. It was a delightful thing to do. It has been immensely helpful in all the other things I've done, and is very important in my writing. What I learned through her writing of that book was the importance of finding ways of really truly putting yourself in the position of someone who doesn't have your primary assumptions. And the point there is that you start from a position of respect. You don't start from a position of "I'm better than you and everything that you think makes me feel good, because I'm right and you're wrong." And so that has given me a facility of actually taking what people have written, or what they say, and finding out where they're coming from.

As an example, when we were looking at religious aspects of slaughter, we sent out a discussion paper asking for input on particular aspects of religious slaughter, before the national organisation came to a view on how religious slaughter should be managed from a welfare point of view. We had a significant number of submissions from all sorts of groups, including the Jewish community. So I analysed all of the submissions, not just the submissions from the Jewish community, and presented them from the point of view of the people who had made those submissions. Again, this is the business of writing. After I had written the part for the Jewish community, I phoned one of the rabbis who we'd been in discussion with, and who had made a submission, and I said "look, this is what I've prepared on your behalf to present as a statement of your position." And I read it to him. And he said "are you Jewish?," which I took to be a very great compliment. And I said "no, but I've spent virtually all my adult life trying to put myself in a position of other people who have other views from my own." That undoubtedly has influenced my writing style.

If you're only interested in the science, that is all you will do. And you will feel really uncomfortable stepping outside what you know. But as I said, I'm an integrative holist person with eclectic interests. And so, it wasn't that hard for me to do, because even at school I had a personal interest in studying world religions. And then, of course, these interests grew stronger when I met my late first wife, as she opened up a whole world of completely different orientations to spiritual expression and human existence. So what I am able to say is, I'm an ethically literate scientist who feels completely comfortable operating in the humanities and other wider areas; not claiming to be an expert in them, but completely comfortable to operate in them, and draw out of people what it is that interests them.