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ACCEPTANCE OF THE EMINENT PARASITOLOGIST AWARD

MY JOURNEY THROUGH PARASITE LAND: EIGHT SIMPLE TIPS FOR SUCCESS FOR EARLY-CAREER RESEARCHERS

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ABSTRACT: My journey from mediocre undergraduate with zero interest in parasitology to this year's recipient of the American Society of Parasitologists' Eminent Parasitologist Award has been shaped by serendipity, lucky breaks, and near misses. It is a story beginning with great mentors and then supported for 3 decades by a wonderful cast of students, postdoctoral researchers, research assistants, and collaborators. In this essay, I share that journey to date (it is not quite finished yet!) and some of the research directions I followed along the way. I then present 8 simple tips for early-career parasitologists, distilled from my years of experience in the field, in the hope that they may help others achieve success in research.

Admission to an exclusive club is always an occasion for joy and pride, but also one for great humility at the prospect of joining an elite group. The latter is certainly how I feel when considering the list of previous recipients of the Eminent Parasitologist Awards. I am deeply grateful to the American Society of Parasitologists for this honor, which tops every other accolade I have ever received. Nothing beats recognition from one's peers. More important, although only my name appears on the plaque, I accept it on behalf of the numerous students, postdoctoral researchers, and colleagues with whom I have worked and who have made invaluable contributions to my research.

If you had told the young me, growing up in a totally French-speaking environment in the lower-middle-class suburb of Saint-Hubert, outside of Montreal, Canada, that he would end up having a reasonably successful academic career in parasitology spent mostly in southern New Zealand, he would have laughed at you. In what follows, I revisit my journey in science, with an acknowledgment of key mentors and role models, and a focus on some of the moves I made and directions I took that brought me to where I am today. Hopefully, my story can be a source of inspiration to other researchers. More importantly, I want to share with all early-career parasitologists some advice in the form of 8 simple tips. These are things I have done throughout my career, not consciously but obvious in hindsight, that I believe have helped me achieve some measure of success. This seems like the perfect forum to share these thoughts; I may not get another chance. If these tips prove useful to some readers of this essay, then writing this article was time well spent.

UNEXPECTEDLY BECOMING A PARASITOLOGIST

After completing all my schooling in French only, I enrolled at McGill University in downtown Montreal for a B.Sc. in Biology and what proved to be a much-needed crash course in English. My first couple of years at university are best remembered not for the mediocre grades I obtained, but because that's when and where I met my future wife. That alone was well worth suffering through first-year biometry and genetics! When selecting courses for the final year of my undergraduate degree, I had the option of taking a parasitology course. However, I chose not to after one quick look at the syllabus: it seemed like the most boring course on offer! Instead, I took further courses in ecology, animal behavior, and evolutionary biology, then and now my main scientific interests. The turning point in that senior year was when Donald Kramer, now retired but then a leading behavioral ecologist, agreed to supervise my independent studies project. This gave me my first taste of biological research, and also my first paper (Poulin et al., 1987) on the predator–prey interaction between cichlid fishes and guppies. I learned much about conducting research from Don; however, I am especially grateful to him for the strong reference he wrote for me that compensated for my underwhelming grades and got me into graduate school at Laval University in Quebec City.

There, I worked with Gerry FitzGerald, another prominent behavioral ecologist whose life was tragically cut short by an aggressive brain tumor. Gerry was an interesting character. On one hand, his short temper and abrasive personality, which were barely acceptable at the time, would surely get him sacked in today's academic environment. I have stories, many stories about Gerry, but I simply cannot share these in print. On the other hand, there are things he did as a thesis advisor that I have myself later adopted in that role. For example, he would return feedback on any draft manuscript or thesis chapter we gave him within 24 hours. He was also very supportive of our ideas. I put that to the test when, returning from my first 3 months at a remote field location, I told him I wanted to change my thesis topic from the one we had agreed on (the roles of competition and abiotic factors in shaping the growth and survival of young sticklebacks). Indeed, on my first sampling day, I found ectoparasites on the sticklebacks I collected, and then spent the rest of my summer conducting preliminary experiments and further sampling to explore a possible connection between fish behavior and parasitism. Gerry was immediately on board, and thus I ended up doing a Ph.D. on the impact of ectoparasitism on fish behavior. At the beginning of my studies, I had no idea what these parasites were. There was no parasitologist at the university, no parasitology book or journal in our library, and of course no internet at the time. I was advised to contact Dr. Zbigniew "Bob" Kabata, a leading fish parasitologist working in Canada. Bob had been a decorated hero of the Polish resistance during World War II who later studied in the U.K. before joining the Pacific Biological Station in British Columbia, Canada. He proved to be very generous with his time, helping me identify my 2 ectoparasites (a copepod and a branchiuran) and sharing useful information with me. Bob is a former recipient of the Eminent Parasitologist Award, and it is quite special for me to share this award with the very first parasitologist I ever interacted with.

After my Ph.D., I returned to McGill University and joined the university's Institute of Parasitology, supported by a Natural Sciences and Engineering Research Council of Canada postdoctoral fellowship. That's when I first thought of myself as a parasitologist. In fact, I was for the first time surrounded by parasitologists; at the Institute, you could casually drop words like metacercaria, acanthella, or cysticercoid, and no one would blink an eye. As a postdoctoral fellow, I continued my research on fish and ectoparasites, but also had my first forays into the world of helminths, which were to become my favorite parasites. My advisors there were Mark Curtis and Manfred Rau, who incidentally had been the teachers of the undergraduate course in parasitology that I carefully avoided a few years earlier. Needless to say, we had some robust discussions about how they could make their syllabus and entire course more attractive for ecology-minded students like me.

This should have been a great time for anyone working on host–parasite interactions from an ecological or evolutionary angle. The previous several years had seen the publication of some landmark papers making strong connections between parasitism and key areas of research in ecology and evolutionary biology. For instance, John Holmes and others had shown that parasites can alter the behavior of individual animals (Holmes and Bethel, 1972); Roy Anderson and Bob May had demonstrated that, in theory at least, parasites could drive the dynamics of entire animal populations (Anderson and May, 1978); Bill Hamilton had argued convincingly that parasites were strong agents of natural selection responsible for the maintenance of sexual reproduction in plants and animals (Hamilton, 1980), and later, teaming up with Marlene Zuk, he showed that parasites were also agents of sexual selection responsible for patterns of mate choice and the expression of secondary sexual characters in animals (Hamilton and Zuk, 1982). Yet my early attempts at publishing my work in journals of ecology or evolutionary biology were often met with rejection, not on scientific grounds but on the basis of prejudice against parasites. The general attitude of ecologists seemed to be that organisms as small as parasites were unlikely to matter for ecological processes, where size is everything. For their part, evolutionary biologists were quick to dismiss studies on parasites because they viewed parasites as evolutionary degenerates, that is, organisms that show reduced morphological complexity and thus run counter to the generally progressive nature of evolution. These frustrating attempts to break into the ecological and evolutionary publishing space gave me a lifelong goal: to become a lobbyist for parasites determined to advocate their importance to anyone willing to listen.

I almost never got to become that champion of parasites. After my postdoctoral work and a couple of back-to-back 1-yr, fixed-term teaching contracts at University of Quebec in Montreal, and about 50 applications for faculty positions, I still had no academic job. I was in the process of negotiating a contract to work as an environmental consultant in the private sector when I got a phone call from far, far away.

PARASITOLOGY IN THE ANTIPODES

Several months earlier, I had faxed an application for a tenure-track lectureship (equivalent to assistant professor) at the University of Otago in Dunedin, New Zealand. The call came from Colin Townsend, an internationally renowned freshwater ecologist; Colin was then the head of the Zoology Department and was soon to become a role model and friend. After a surprisingly brief phone interview, he offered me the position! My wife and I took a few weeks to consider this; in the days before the internet, finding out about life in distant countries was not nearly as simple as it is now. In the end, we accepted the offer, and so in mid-1992 we packed up our belongings and our 6-month-old son and boarded a plane for the South Pacific.

Dunedin is too far south in the Pacific for palm trees and coconuts, and yet it proved to be a wonderful place to live and raise a family. We have been and continue to be very happy in southern New Zealand. The University of Otago generally, and the Zoology

Department in particular, have also proved to be a very collegial and supportive environment founded on traditional academic values. My first decade of research in New Zealand would have discouraged many of my peers, however. Without a national funding scheme for fundamental research and extremely little internal funding, I could support only 1 graduate student at a time, and much of our field or laboratory expenses were paid out of my pocket. Undeterred, I instead saw this period as providing me with time and an opportunity to read, learn, and expand my range of approaches to science. Ever since my Ph.D. I had been scaling up my thinking about host–parasite interactions, from intraspecific to interspecific, from local to global. Were the correlations I had observed among individual sticklebacks between host traits and parasite richness or abundance also seen across different host species? Were the links between parasitism and host behavior that I had demonstrated in local fish populations also present in populations of other species elsewhere around the world? In other words, were there universal and repeatable patterns of host–parasite interactions? Soon after arriving at Otago, I read two publications that equipped me with the tools necessary to answer these questions: the first application of meta-analysis in the field of ecology (Gurevitch et al., 1992) and the first robust framework for comparative analysis of species traits within a phylogenetic context (Harvey and Pagel, 1991). With time on my hands to compile from scratch large databases using Otago's excellent science library, and these novel analytical tools, I could explore large-scale, general patterns of interactions between animals and parasites without spending a dollar. This turned out to be a productive decade, during which I published some of the first (I believe the very first) meta-analyses and phylogenetically grounded comparative analyses connecting parasitic infections to host behavior (e.g., Poulin 1994; Côté and Poulin, 1995) and host traits to parasite richness (e.g., Poulin, 1995). Far from a wasted decade, the 1990s were a crucial period in my development as a parasitologist.

Eventually, the lean years came to an end. The establishment of the Marsden Fund, supported by the national government but overseen by the Royal Society of New Zealand, reinvigorated fundamental scientific research in the country. My first application was a total disaster; however, the second was successful, and I've been continuously supported by the Fund ever since the early 2000s. It finally became possible to build a team of graduate students, hire postdoctoral fellows, and launch field and laboratory research projects broader in scope and greater in cost. From that point forward, my research program could have followed a range of approaches. For example, some researchers adopt a species-driven approach and build a successful research program focused on a single model species, about which they will address multiple questions answered with a range of methods. Others take on a tool-driven approach, mastering a particular analytical method and applying it over their career to a range of questions and taxa. Without really planning this, my program has instead followed a question-driven approach: we typically come up with what are, to us, interesting questions, and then choose the most suitable model species and research tools to answer those questions. As a consequence, we have investigated host–parasite interactions across broad taxonomic and environmental spectra, in hosts ranging from molluscs and arthropods to fish and birds, with parasites ranging from single-celled eukaryotes like microsporidians and haemosporidians to all major helminth groups, and in freshwater, marine, and terrestrial habitats. Throughout it all, I must confess that helminths have remained my favorite parasites.

My team's research has explored numerous ecological, behavioral, evolutionary, and genomic aspects of host–parasite interactions; publications associated with this research are all available from our lab website (https://www.otago.ac.nz/parasitegroup/). Four central themes have provided a semblance of direction and planning to our research. First, continuing from my doctoral work on parasites and behavior, my team has conducted extensive research on parasite-induced changes in host behavior, particularly those changes assumed to benefit the parasite's own transmission. We have not only documented this phenomenon in multiple endemic New Zealand host–parasite combinations but also explored its broader implications for populations and ecosystems, as well as the underlying physiological and genomic mechanisms allowing parasites to take control of their host. Second, we have investigated the determinants of gene flow among parasite populations and how they shape the genetic structuring of parasite populations. This has been done in parallel with research on local adaptation and intraspecific variation in key parasite traits, such as host specificity and life-cycle complexity. Third, like many other parasitological research groups around the world, we have become increasingly interested in (and concerned about) the potential impact of environmental and climate change on host–parasite interactions. Among other rapidly changing abiotic stressors, we have conducted research on the responses of parasites to global warming, ocean acidification, herbicide runoff into freshwater habitats, and, more recently, nanoplastic pollution. We can only hope this work will inform decision-makers as they develop new policies to deal with the huge challenges ahead. Fourth, I have never abandoned the interest in large-scale patterns in parasite biodiversity and biogeography I developed during the funding-free 1990s. With many collaborators, I have continued to seek universal drivers (still hoping to find something!) of variation in parasite diversity across host species or areas, as well as repeatable patterns in the structure of host–parasite communities. Working across multiple host and parasite taxa, some weak and semiconsistent patterns emerge, though idiosyncrasies and contingencies reign supreme.

Research on the last theme usually requires the compilation of large data sets, often from scratch and based on records of parasite occurrence in particular hosts or locations. This work is only possible thanks to the hard work and dedication of parasite taxonomists who are responsible for the discovery, identification, and characterization of new parasite species. I am not a taxonomist myself. However, I take great pride in having supported, logistically and financially, taxonomic research by members of my team. To date, they have found and described many new species of helminths in New Zealand hosts; there is no taxonomic research in New Zealand outside what members of my team are doing. Even if my role in this work is merely a supporting one, I see it as one of the important contributions I have made to parasitology.

Enough about me. I want this essay to be of some use to its readers. On the basis of my career path and experience, what pearls of wisdom can I pass on to those beginning their journey through parasitology specifically and science more generally?

ADVICE FOR EARLY-CAREER PARASITOLOGISTS

Several factors outside your control can affect your career as a scientist. For example, good health and a stable and happy personal and family life certainly make it easier to succeed at work. I will assume here that all readers have (or are in the process of obtaining) a Ph.D. and the basic skills associated with this degree, as well as the

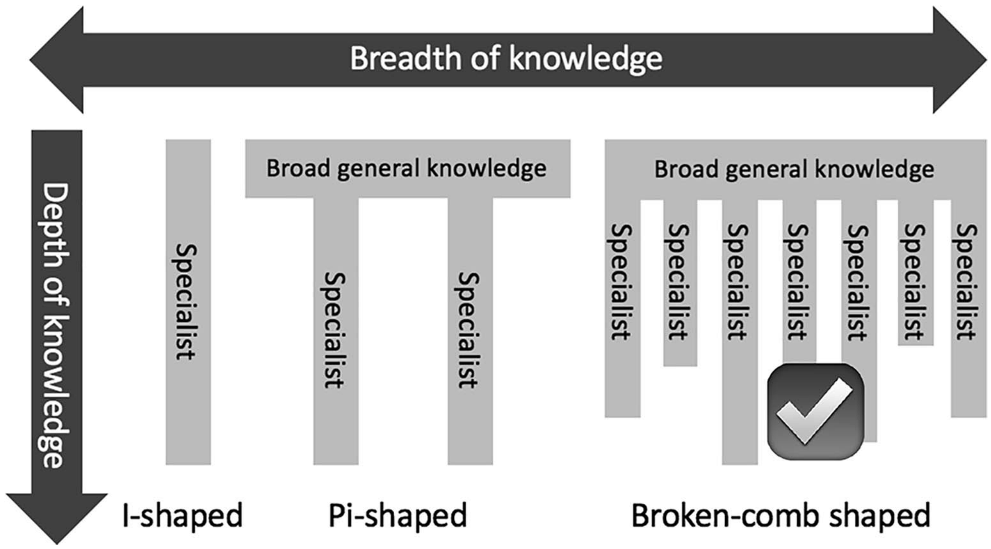

Figure 1. Broaden your scientific horizons.

more general skills necessary for success in any position where responsibilities are many and diverse. These include great time management and the ability to juggle multiple tasks without losing track of each one. I will also ignore the common refrain that substantial and sustained funding is essential for success in science because that is not true of certain disciplines, and also because one can easily argue the other way around: funding follows early success, not vice versa. Instead, I want to focus on strategic decisions that you can make from the start of your career. I do not pretend to have all the answers; others have also offered their views on what leads to success in science (e.g., Goldstein, 2023). I've tried to distill some of the things I've done throughout my career, not always consciously but very apparent in hindsight, and present them as 8 relatively simple, practical tips for early-career parasitologists. They are summarized visually in the figures below and discussed in no particular order.

Broaden your scientific horizons

Knowledge is often considered to involve a trade-off between breadth and depth: you either know a little about many things, or a lot about a few things (Fig. 1). Limited time and brain capacity prevent us from knowing a lot about everything. Scientists today are typically specialists (great depth of knowledge, but lack of breadth) working in a silo of knowledge from which it is hard to escape. They read only journals in their area, attend only conferences in their discipline, and even use a set of keywords for literature searches that restrict what they read to a narrow slice of existing knowledge. A study by Bateman and Hess (2015) indicates that the personalities and individual dispositions of scientists are associated with their tendency to conduct broad vs. deep research. Regardless of one's preferences, there is little doubt that the cross-pollination of concepts and methods among scientific disciplines can promote advancements in each discipline. I encourage you to break out of the narrow silo of knowledge typical of the modern scientific specialist, read broadly across disciplines related to yours, and who knows, you may discover new ideas that you can apply fruitfully to your own research. My earlier story about discovering the (then) novel tools of meta-analysis and comparative analysis is an example of how borrowing ideas from other disciplines has not only helped my career but also in a modest way advanced our understanding of host–parasite interactions.

Take an occasional dive into the truly unknown

What we currently know of the natural world is only the tip of the iceberg of what there is to know (Fig. 2). Most scientific research extends our knowledge only marginally, by adding to the "stuff we know" some of the "stuff we know we don't know." As a parasitological example, a survey of the parasites infecting a previously unstudied fish species living deep in the Amazon would yield information on stuff we knew we didn't know: we knew for certain that the fish were parasitized, we just didn't know exactly by what parasite species. This is routine, safe science, guaranteed to generate results that are novel and important to complete our understanding of nature, but not really revolutionary. There is a deeper layer to our ignorance, however: the "stuff we don't know we don't know." Attempts to extend the boundaries of knowledge into this great unknown are riskier, as they may fail and yield no result since this is the sort of research for which we have no solid a priori expectation. Yet this is where breakthroughs come from, the type of game-changing findings that represent more than an incremental step forward. There is evidence that research of this nature has declined in recent years, in proportion to the increasing volume of research being published

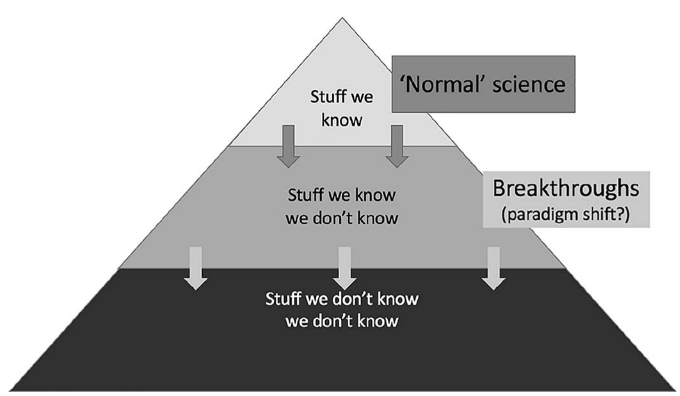

Figure 2. Take an occasional dive into the truly unknown.

(Kozlov, 2023; Park et al., 2023). I cannot boast of having conducted this sort of risky research into the truly unknown very often; however, the few times I did it generally paid off. For example, a few years ago I shifted our externally funded research toward characterizing the microbiome of helminths, its stability through the parasite's life cycle, and its impact on how parasites interact with their hosts including the extent to which parasites alter host behavior. The reviewers of our grant proposals were less than enthusiastic, and yet our early results are extremely promising and suggest to me that the work we and others around the world are doing in this area could lead to a paradigm shift in how we view host–parasite interactions. Therefore, I encourage you, early-career readers, to take the occasional risk, break away from the safety and routine of classical parasitological research, and pursue wild ideas. Expect some failures, but also successes that may define your career.

Beware of impostor syndrome

Did you ever fear that your peers will find out that you don't know what you are talking about, that they might question your competence, that you are not good enough as a scientist, and that everyone will realize it any minute now? Then you know exactly how I felt when I accepted the Eminent Parasitologist Award in front of a large crowd of my peers. That is the typical manifestation of impostor syndrome (Jaremka et al., 2020). Another one is that feeling you get when your manuscript has been rejected, possibly for the second time in a row: are you good enough as a scientist? Stop thinking like that! Everyone feels the same way, it's not just you (Fig. 3). Impostor syndrome can erode the confidence you have in your novel ideas and stifle your creativity. It will creep up on you when you least expect it and make you doubt your abilities. Be aware of it and fight it off; you cannot let it control you.

Maximize conversion rate, minimize conversion time

Scientific results that are not published do not exist: as long as you do not publish your work, it may as well have never been done, as far as the rest of the scientific community is concerned. Uploading a manuscript to a preprint online archive does not really count, as many institutions and funding bodies do not recognize publications that have not been peer reviewed. Neither does talking about it on social media. You will only receive credit for your research once it is published in a journal. Delaying submission not only delays its contribution to scientific progress and the recognition it will bring you, but it also increases the chances that you will be scooped by another researcher publishing a similar study before you and beating you to the punch. Too often I hear colleagues saying they've been sitting on results for a few years awaiting a day when they'll get a chance to write them up. Often, they never do it, an outcome unlikely to please their funders and collaborators. Set yourself a simple goal: converting all completed research projects into a submitted manuscript within 6 month, without exception (Fig. 4). Resources and effort go into every research project, so why not aim to communicate the results promptly and 100% of the time, for the benefit of science and your own?

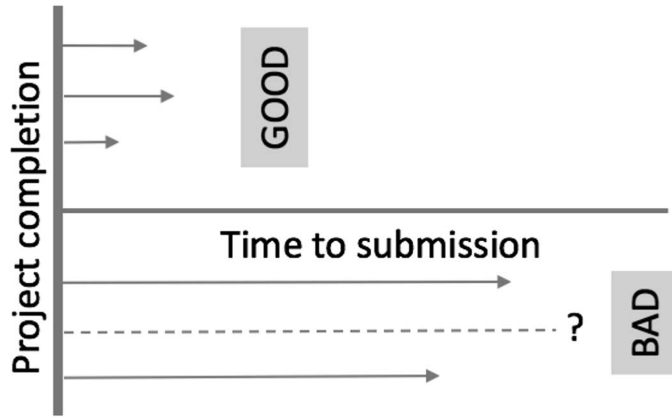

Figure 4. Maximize conversion rate, minimize conversion time.

Be the master of your own time

Some key deadlines mark the lives of scientists, such as those associated with the submission of grant proposals or fellowship applications. How many times have I heard colleagues saying that they really had to start writing that proposal because it was due next week! Ideally, documents as important as those written to seek funding should be ready well before the submission deadline, allowing the applicant

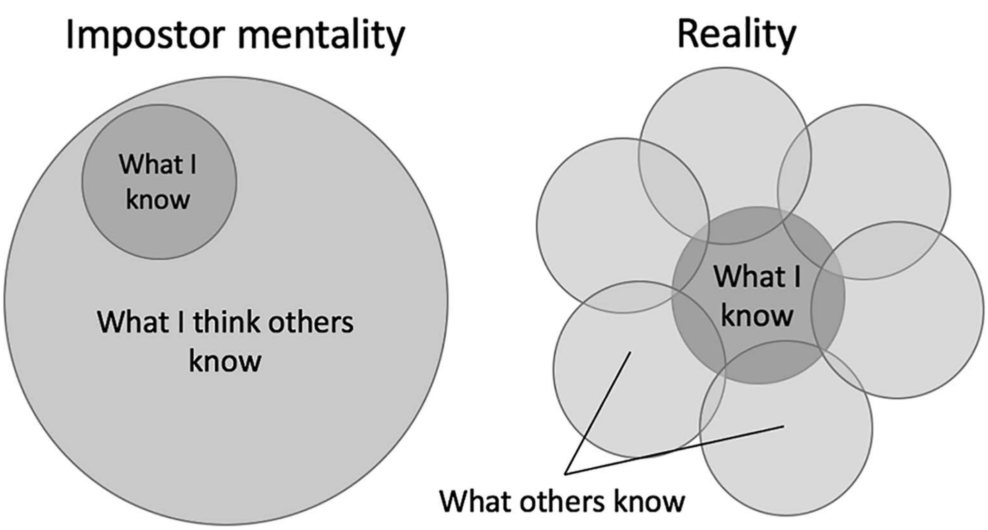

Figure 3. Beware of impostor syndrome.

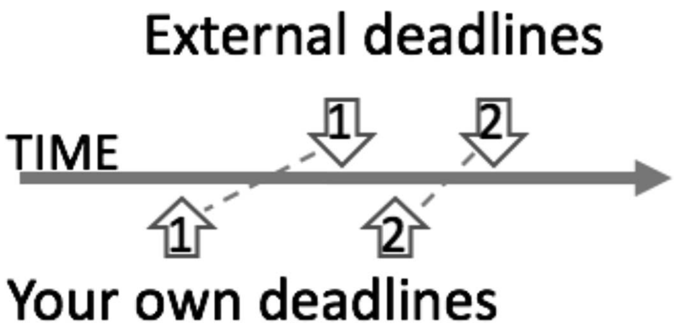

Figure 5. Be the master of your own time.

time to mull them over, have them read by trusted colleagues, and polish them into masterpieces. Some commitments are fixed, such as lectures and meetings; however, what little time we can allocate to research can be structured as we choose. My advice is simple: don't be a slave to external deadlines; set your own schedule and then stay ahead of that schedule (Fig. 5). You will not have to do more work, i.e., this will not increase your workload, it will just shift it forward. In other words, try to do today what the normal schedule says you should do next week. This way, you will not only complete tasks ahead of due time with the possibility to return to them and refine them, but also when unexpected tasks land on your desk, you will not be under pressure to meet looming deadlines.

Be a synthesist once in a while

Writing a review article or a larger work of synthesis yields multiple benefits (Fig. 6). It forces you to bring together somewhat disparate concepts or findings into a coherent whole, connecting dots that may not have seemed related to you earlier. It helps to organize your thinking about a broader research area and provides an excellent catalyst for new ideas for your future research. I cannot emphasize enough how important writing a short book on parasite ecology and evolution in my late 30s, and a later second edition (Poulin, 2007), has been to give me a holistic perspective on my field of research. Of course, writing a review article, whether of the narrative or quantitative variety, and assuming it is original and done to a high standard, will benefit your career in tangible ways. Reviews can establish someone's name in the field and often become a scientist's best-cited publications. That is certainly the case for me: the above-mentioned book and a series of review articles written in the first half of my career have no doubt played a key role in getting me this award. Publishing reviews is not the exclusive domain of senior scientists. I urge early-career researchers to seriously consider writing synthetic articles or shorter opinion pieces; they will sharpen your thinking, give you a clearer understanding of the big picture, and boost your citation statistics.

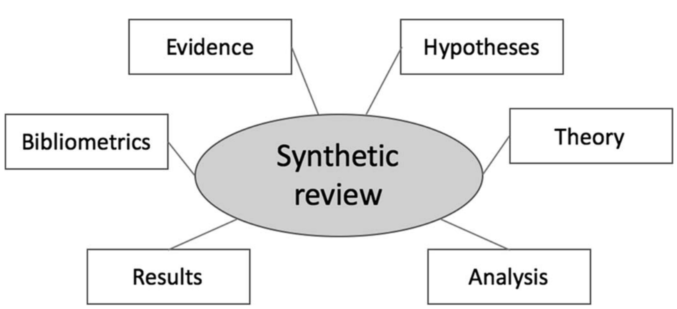

Figure 6. Be a synthesist once in a while.

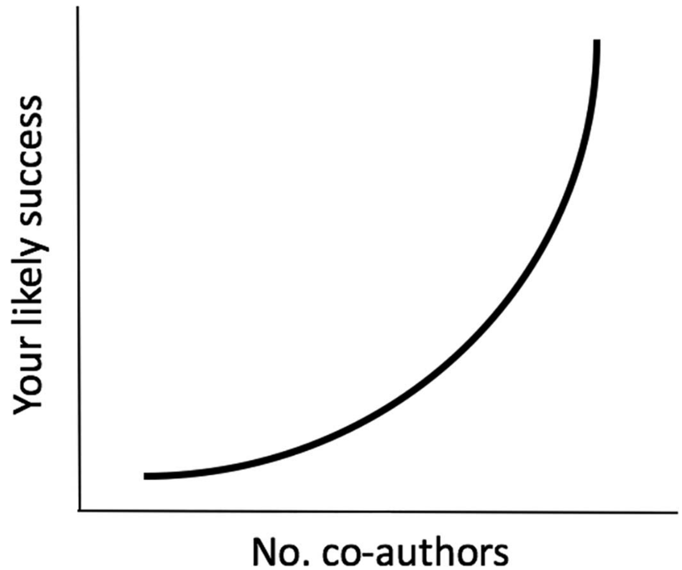

Figure 7. Collaborate, collaborate, collaborate.

Collaborate, collaborate, collaborate!

Science is not an individual endeavor but a team effort. Very little can be accomplished in isolation: the more you work with others, the more you achieve (Fig. 7). By the end of 2023, my publications had included a total of over 500 coauthors. Many of these are graduate students or postdoctoral researchers; however, two-thirds are collaborators, mostly from other institutions and countries, with whom I worked on 1 or a few projects. We have accomplished more and produced more innovative research by combining our respective skills and knowledge than we would have by working separately. Each one of them, from the most junior to the most experienced, has taught me something. You grow as a scientist, and also as a person, by working with others. You can also make lifelong friends. I encourage all of you early-career parasitologists to not only welcome offers to collaborate, but also actively seek opportunities to work with colleagues. You will become a better and more successful scientist as a result.

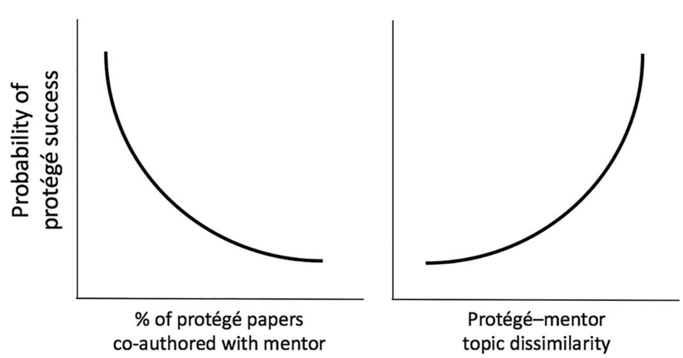

Figure 8. Don't cast a mentor shadow.

Don't cast a mentor shadow

As you approach the end of your career, you will realize that your greatest source of professional satisfaction, the true measure of your own success, is the success of all the people you have mentored over the years. I've always recognized this; however, it is only in the past decade that I have realized I need to do more to ensure that the graduate students I supervise can establish their own identity and carve out a reputation distinct from mine. Being there when they need you, making sure they get their work published, and helping them move on to the next stage of their career may not be enough in the longer term. For the past 10 years or so (and I wish I had started earlier), I have done things a little differently. A recent study by Ma et al. (2020) of the predictors of scientific career success has reassured me that I might be on the right track (Fig. 8). They found that the probability that a mentor's protégés will succeed, on the basis of various metrics, is inversely proportional to the percentage of the protégés' papers coauthored with their mentor by the time their formal association ends. This finding brought me hope because I have encouraged graduate students from my lab in the past 10 years to publish without me, either work from their thesis or other research conducted in parallel. There have now been over 50 papers from members of my lab published without me as a coauthor in the past 10 years. Ma et al. (2020) also found that the probability that a mentor's protégés will succeed is positively correlated with the dissimilarity between their thesis topic and their mentor's main research topic. The reason my team has conducted research on such a wide range of host and parasite phyla is in large part that increasingly I let new students choose what they will study, instead of coaxing them to take on a project that fits within my own long-term program. I advise all of you early-career researchers to value the future success of the students you are mentoring now. To use an analogy from evolutionary biology, think of what they eventually achieve as your "inclusive success:" their success matters more than yours. Go beyond the usual "good supervisor" criteria and take all steps necessary to ensure they go on to successful careers.

There you have it, my take on simple strategies that can lead to a successful career. When I reflect on what I have done, and when I look at what other researchers are doing, from the least to the most accomplished of them, I am convinced I can see a connection between the 8 strategies above and various metrics of career success. I can only hope they work for you, early-career readers, and help you achieve your goals and explore the frontiers of parasitology.

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Providing a complete list of all those who have contributed to my research career in a meaningful way and helped me collect the Eminent Parasitologist Award would blow out the journal's page budget. However, I must single out the following individuals (they would know why): Diane Guévremont, Donald Kramer, the late Gerry FitzGerald, Colin Townsend, and Kristin Herrmann. They each have played a special role in getting this award to end up in my hands.

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