



THREE MONTHS
JUDITH L. BRONSTEIN

Judith L. Bronstein is University Distinguished Professor of Ecology and Evolutionary Biology at the University of Arizona. Her career-long research goal, pursued through field observations, experiments and theory, has been to develop a conceptual foundation for our understanding of mutualism, cooperative interactions among different species. Specific conceptual issues that intrigue her and her students include conflicts of interest between mutualists and their consequences for the maintenance of beneficial outcomes; the causes and consequences of “cheating”; context-dependency; and anthropogenic threats to mutualisms. At the Wissenschaftskolleg, she and her colleagues focused on developing new theory for mutualism evolution. An award-winning instructor, she teaches on both the undergraduate and graduate levels. She has served in a variety of leadership positions at the University of Arizona, the National Science Foundation, and major professional societies. She has been Editor-in-Chief of *The American Naturalist*, a leading international journal in ecology and evolution, and is a Fellow of the Ecological Society of America. – Address: Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, Arizona 85721, USA. E-mail: judieb@email.arizona.edu.

What I learned during my three months at the Wissenschaftskolleg is that three months is too short to spend at Wiko – but that three months is enough to change one’s intellectual life.

My presence at Wiko was due entirely to Mike Wade. My long-term research focus has been to establish a conceptual foundation for understanding mutualisms, cooperative interactions between different species. In 2015, I edited an Oxford University Press volume on this subject, the first full treatment in several decades. Mike reviewed it for one of

our major journals. He tells me that, in the course of perusing the book, he became inspired to investigate these interactions using the powerful intellectual framework and theoretical tools in evolutionary genetics whose development has occupied his own career. Mike applied for and was accepted as a Wiko Fellow for the 2018/2019 academic year. He then invited me, as well as his past students and collaborators Tim Linksvayer and Jason Wolf, to form a working group on mutualism evolution. He did this before he ever met me in person. He made a shrewd guess that an ecologically focused, somewhat mathematically incompetent empiricist who really knew the literature (me) was going to be able to mesh well with theoretically-minded evolutionary geneticists (them) to produce something new and interesting.

How could I say no? The single drawback of this extraordinary invitation, for which I will be eternally grateful to Mike, is that it did not correspond to a sabbatical opportunity. Luckily, University of Arizona cheerfully allowed me to leave campus for part of the winter semester. So, three months it had to be.

Arriving in the iciest week of January, I allowed myself minimal time to get acquainted with my surroundings. I was the last working group member to show up, and time was short; once I was present, we dove directly into work. It was many days before I looked up and realized that I had not even begun to explore Berlin. Perhaps a little oddly, my first trip out of Grunewald was not to a museum or historical site or concert hall, but to an ice hockey match. The evening was raucous and alcoholically well-lubricated, as Jason, Tim, and I saw Berlin's Eisbären crushed by Mannheim.

Mike's vision was that our working group would work closely together with concrete products in mind. We had a biological phenomenon that interested all of us (mutualism), and we had a conceptual and theoretical toolbox. But we didn't really start out with a set of orienting problems that we wanted to solve. Articulating them consumed my first weeks at Wiko. Ultimately, we focused upon an observation about mutualism that has intrigued me for many years. Biologists tend to assume that a given interaction (say, between a flower and a bee) is more or less the same in any setting in which it occurs. In fact, a small change in context can produce a big change in how interactions work. We haven't, though, given much thought to what such "context-dependency" means for where they occur in space or how they change over time. The working group set out to model species interactions in a way that would allow us to explore the consequences of this kind of ecologically realistic variation. Our "grand model" is almost finished. It is a massive and complex tool with many working parts. But analysis is already suggesting to us explanations

of how well-known ecological phenomena might have arisen over evolutionary time. Most exciting of all, it's generating entirely new questions about mutualism. This is a model that should keep us busy for years.

Our working group discussions, as well as the three papers we are currently writing from them, came to center on symbiotic mutualisms – those involving one species, often a microbe, that lives inside its partner. This is probably the single form of multispecies interaction of greatest interest to biologists today. I'd fallen uncomfortably out of date with the fast-moving literature on symbiosis, though. I saw this as a serious problem, since I'm supposed to be the expert on mutualism as a whole, and my research community often looks to me for conceptual direction and synthesis. For this reason, in my solitary work hours at Wiko, I set myself the challenge of updating my knowledge of symbiosis. It was unexpected and a huge advantage that many of the world's leading experts on symbiosis were among this year's class of Fellows. Conversations with Joan Strassmann, Dave Queller, Koos Boomsma, Hassan Salem, and Thomas Bosch in particular strongly influenced my thinking – and lengthened my reading lists considerably.

I left Wiko, then, with a set of manuscripts directed toward a fundamental problem in my focal search area; a deeper understanding of both evolutionary genetics and symbiosis ecology; and a newfound bravery to engage with devilishly complex theory. Beyond that, my working group became my family (joined with gusto by our spouses, at least when we weren't talking science). Mike, Tim, and Jason introduced me to odd corners of Berlin, Brazilian cooking, Neanderthal genetics, bad puns, and, of course, German-league ice hockey. I in turn did my best to educate them about whisky and fine teas. Our joint research will persist, and our friendships will, as well.

Three months is a short time. But, at Wiko, that's a full 90 days of exposure to new ideas and ways of thinking, in a setting serene and collegial enough to foster prolonged discussions about them. At Wiko, I found common intellectual ground in some of the most unexpected places. These serendipitous moments, extended into dialogues lasting many days, will remain some of my strongest memories.

One of these was stimulated by a Science-Humanities Forum soon after I arrived. Led by Karin Kukkonen and Thomas Lewinsohn, we argued intensely about the functions of narrative in fiction versus science. I found myself disturbed that some of the arguments, not only from the humanists but from many of the scientists as well, caricatured scientific writing as, by definition, dry and lacking in a narrative arc. Meanwhile, I had the sense that the scientists in the room, myself included, were pronouncing judgments based on

only the most superficial understanding of how literary theorists define and study narrative. Over the following weeks, I pursued these issues with Karin, particularly with regard to the role of narrative arcs in natural history writing. On a large university campus like hers or mine, a literary theorist and a field biologist would be fairly unlikely to cross paths and then to find common intellectual ground (at least, outside of shared sentiments regarding university politics ...).

A second set of conversations was sparked by a short workshop on community ecology organized by Thomas Lewinsohn. We participants spent over a day pulling together a single conceptual figure that could capture the complex set of patterns and processes we were discussing. This got me thinking hard about conceptual figures in general. What purpose do they serve? What makes a conceptual figure useful or useless, enlightening or downright deceptive? There were a few weeks when I seemed to be bringing up conceptual figures with my tablemates at every meal. I found this to be a topic on which every Fellow has experience and firm opinions. I particularly valued Thomas' thoughts, along with the insights of Richard Swedberg, Michela Betta, and Peter Keller, three colleagues in fields distant from my own.

The final set of conversations were stimulated by three talks that I myself presented. I gave a presentation to the Theology Department of the University of Potsdam in January, then a Wiko colloquium talk rather late in my stay. I was then offered the extraordinary opportunity to return to Wiko ten weeks after I had left, to present the final Abendkolloquium of the year. (For this opportunity I am deeply grateful to Barbara Stollberg-Rilinger and Daniel Schönplflug; not only was it wonderful to have the chance to share my work with a broader audience, it also gave my working group one more critical week of work on our joint project.) General audiences are clearly fascinated by all forms of cooperation in nature, and conversations went on for hours after each of my lectures. However, it became clear that many listeners were deeply unsettled by the language that I and other scientists were using to describe cooperation, either in humans or in other species. One core issue involved metaphor – what biologists really mean by certain of our catchphrases (for instance, when we speak of what organisms are “trying to maximize” by cooperating). A second involves value judgment – whether our word choices imply that we consider cooperation to be “good” and the failure to cooperate (which happens quite frequently in nature and that we unfortunately term “cheating”) to be “bad”. Spirited discussions with my listeners have forced me to critique my own explanatory language. Their challenges have led me to ask myself the hard question whether my choice of

language has, over the years, come to bias how I think about the phenomena I study. As a direct consequence, I am not talking about mutualism in exactly the same way anymore. In fact, I am not thinking about mutualism the same way anymore. Let me be clear: this is because of my attempts to explain what I do to highly educated individuals whose expertise and training are at the furthest possible remove from my own. This is how Wiko can change you as a scholar. Among many other reasons, this is why I hope to return, if at all possible, for my next sabbatical year.

When I left Berlin at the end of three months, I could not help lamenting all the things I didn't have (or didn't take) the opportunity to do. I'll read with envy the other entries in this yearbook, and I'll be taking notes on what I should do next time. I went to two great restaurants and too few cultural and historical venues (although, thanks to Peter Keller and Thomas Lewinsohn, I did attend some incredible early-music concerts). I did make some quick progress in German, thanks to Ursula Kohler and to my partner-in-crime Debbie Rush-Wade, but not nearly enough to be of practical use. Perhaps most disappointingly, I didn't get to know the other Fellows nearly as well as I wanted. Arriving in January and departing in March, I missed many colloquium talks. More significantly, though, my arrival coincided with the moment when many Fellows realize that they must screen out all distractions if they are to achieve their own ambitious research goals by year's end. Many intriguing conversations were started but never finished. Other, potentially promising ones were never begun.

But the conversations I had ... oh, what conversations they were!