



BRILLIANT
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One does not normally associate Berlin in mid-winter with colour, but this year for a small (but perfectly formed) group of Wiko scholars, colour was everything. Are the shimmering blue, gold and green eyespots of a peacock an evolutionary response to a sense of beauty in peahens? How do some birds of paradise create a black that is blacker than the blackest pigment? Do the patterns on a bird's eggs help it distinguish its own from that of a cuckoo? What are the consequences of being brown or white (if you are a barn owl, that is)? And why do zebras have stripes? Answering that last question has

been the personal quest of our Focus Group leader, Tim Caro, for some decades but I'm not going to give the game away; for an answer you had better read his report.

I am extremely grateful to Tim for including me in the Focus Group on *Animal Colouration*, and for putting together such an exceptional mix of scientists. Only Tim was present throughout the year, the rest of the group coming and going as academic and family commitments allowed. I was part of the first wave, staying from the beginning of November to the end of February, overlapping Rick Prum and Alex Roulin before Christmas, Daniel Osorio, Devi Stuart-Fox and, for a brief visit, Cassie Stoddard after the New Year. Although I was very familiar with all of their work, the only one I knew as a person was Daniel; now we are all friends, with research collaborations established. Do I regret not staying the whole year? Of course; indeed my wife and daughters, visiting before Christmas and again in February half term, announced that I really should have come for the whole year. They'd have happily traded in, respectively, job, school commitments and friends for a year in Berlin. A shame that they didn't realise this when I was planning my sabbatical! However, I have a sneaking suspicion that if I'd come for the whole year, the trauma of returning from Wiko's pampered intellectual freedom to the normal routine and pressures of academic life in the UK would have been too hard to bear.

So, why was my Wiko time so stimulating? First, having time to think and think widely. Second, being surrounded by clever people. And not just in the "colour group". I feel very fortunate that, by chance, two of the other Focus Groups at Wiko were on topics that have always fascinated me: the evolution of human language, and animal sentience and the perception of pain. In particular, Peter Gärdenfors and Dorit Bar-On from the "language group" were very generous with their time (and very patient, given my naivety about deep issues in philosophy, linguistics and cognitive science). I consider my discussions with them among the highlights of my stay and it was mind- and horizon-expanding to sit in on the workshops they organised with Luc Steels and Holger Diessel. It was also wonderful to catch up with a trio from "deep time": Dan Weary and Victoria Braithwaite, both graduate students in John Krebs' research group in Oxford when I was a post-doc, and Dan's wife Johanne Mongrain. Very clever, very nice, people whom I should never have let slip out of contact. These were my immediate intellectual and social companions, but these were just the closest stars in the wider firmament of scholars that I met at Wiko. I cannot overstate the privilege of not merely being exposed to topics that I would never encounter in the intellectual silo of biology, but also to different approaches

to scholarship. Last, but not least, Wiko was (and is) special because of the support the institution offers. Everything from the friendly, efficient, bureaucracy-light administration to the varied delicious meals from Dunia Najjar and her team, to the hugely patient and inspiring Ursula Kohler in German classes. It is this attention to detail across the board that is the recipe for Wiko's success: a happy scholar is a productive scholar.

Did I achieve my goals for the four months? All of them and more. My main research area is camouflage, in particular how it evolves in response to the eye and brain of the species being fooled. Wiko gave me time and facilities to explore a new and somewhat counterintuitive possibility: that iridescent colours, those that change hue with viewing or illumination angle, could function as defences rather than conspicuous signals. There can be no doubt that a peacock's tail and a hummingbird's throat patch are designed to attract attention (although not necessarily always: in shade or at many angles, the colours can be subdued). However, there are many shimmering iridescent insects in which both sexes are the same colour, and even caterpillars and pupae with metallic, changing hues, so the possibility exists that these act as camouflage: the changing colour boundaries and intensities fooling object recognition, distracting attention or misdirecting attack. While at Wiko, I educated myself in the mechanisms of structural colouration, the perceptual mechanisms involved in object recognition and target tracking, and the natural history of iridescent insects. This literature spans modern applied physics and 19th-century German natural history, so great library facilities and mental space are essential! Now, thanks to Wiko, I have a £760,000 research grant to test my ideas.

The primary aim achieved, I had the chance to chase up new objectives, unthought-of until arriving in Berlin. First was, with Tim and the rest of the colour group, organising a workshop for May to bring together not only the various people who had joined Tim at Wiko for various periods, but also a selection of the world's best biologists studying colouration. Twenty-four talks in a day was an intense experience, but nothing like that of the second day, when Tim tasked us to write a review paper in one day! Now I am editing the result, for submission to a top journal. The workshop also resulted in a special edition of *Philosophical Transactions of the Royal Society*, in which will appear two papers that I am a co-author of. Many thanks to Wiko for funding a visit by two of my co-authors, Sami Merilaita from Åbo Akademi University, Finland, and Nick Scott-Samuel from Experimental Psychology in Bristol. From that two-day visit, we think we have come up with a new framework for studying camouflage. Other papers completed while in Berlin included ones in *Current Biology* ["3D camouflage in an ornithischian dinosaur." 26, 18 (2016)],

Biology Letters ["Aposematism: Balancing salience and camouflage." 12, 8 (2016)], *Royal Society Open Science* ["Contrast, contours, and the confusion effect in dazzle camouflage." 3, 7 (2016)], *Behavioral Ecology* ["Dazzle camouflage, target tracking and the confusion effect." 123 (2017)], *PLoS ONE* ["Dynamic dazzle distorts speed perception." 11, 5 (2016)], *Proceedings of the Royal Society B* ["Background complexity and the detectability of camouflaged targets by birds and humans." 20161527 (2016)], *Proceedings of the National Academy of Sciences, USA* ["Optimizing countershading camouflage." 113, 46 (2016)], *Behavioral Ecology* ["Stripes for warning and stripes for hiding: spatial frequency and detection distance." doi: 10.1093/beheco/arw168 (2016)], *Animal Behaviour* ["Dazzle camouflage and the confusion effect: The influence of varying speed on target tracking." 123 (2017)], *Royal Society Open Science* ["The confusion effect when attacking simulated 3D starling flocks." doi/10.1098/rsos.160564 (2017)], *Philosophical Transactions of the Royal Society, London B* ("How camouflage works." In press) and *Philosophical Transactions of the Royal Society, London B* ("Cultural evolution of military camouflage." In press). Twelve papers represent a remarkably productive four months; in my field, four in a year is considered good going.

There is one final new direction to report. In February, I visited the University of Ghent to meet an architecture and design student whom I had contacted on a whim at the end of 2015. Willem Beckers is interested in "dazzle camouflage", the bold geometric designs used by both sides on ships in WWI to (allegedly) interfere with targeting by enemy gunners or submarine commanders. Willem is interested in using computer-aided design to apply the historical patterns to accurate, computer-generated ship models and then apply Deep Learning algorithms (the Artificial Intelligence method that hit the news this year for defeating a "Go" master four times in five games) to see whether the colour patterns have the effects on identification, speed and trajectory judgement that were claimed at the time. I work on "dazzle colouration" in terms of how perceptual mechanisms are fooled, and I know how to tease apart the different effects with experiments. We met, we talked, we realised that we had complementary skills, and now we have a grant in submission to the Flanders Research Council.

It was an unforgettable four months, both intense and liberating. I also fell in love with Berlin itself, grateful for the opportunity to explore it as a resident rather than as a fleeting tourist. Will I return? Definitely. *Bis später!*