



## EVOLUTION IN THE GRUNEWALD MIKE BOOTS

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My year at the Wissenschaftskolleg has been remarkably productive and liberating.

My intention for my year in Wiko was to write some large grant proposals, to finish many old papers, to learn evolutionary wisdom from Janis, Dieter, Rich and Curt, to develop a general theory of the role of epidemiological feedbacks on the evolution of diversity in hosts and parasites and to read more. I found that I read more, developed a

general theory on the role of epidemiological feedbacks on the evolution of diversity (more of this later), learnt so much from my conversations with Janis, Dieter, Rich, Curt, Ben, Lynda, Mary, Iruka, Paul, Andy and Olivia, finished most of my papers (see the reference list) and am pleased to say I wrote no grants. Once I had realized that it would be sacrilege to write grants at Wiko, I was very productive.

One major part of my activity has been three group projects aimed at big problems. Many of us at the Wiko feel that evolution should play a bigger role in medical practice, as along with explaining well-known evolutionary problems such as drug resistance, evolution has the potential to play an important role in rational treatment design. Led by Janis, in the first few months at the Kolleg we had many stimulating meetings that will lead to an article arguing how and when evolutionary thinking can help in medicine. Coming out of this, we also developed an interest as a group in understanding the evolution of specificity in hosts and parasites. My final group project came about via Internet conference call most weeks, where a group of researchers asked how predictable the virulence of an emerging disease would be (probably not) and when we might be able to predict what will happen to virulence after the emergence (we may have some useful things to say). The Kolleg provided us the time to really think and explore new directions and ideas, and I believe these three papers will make important contributions to the field.

The other major part of my new work was a journey with my collaborators to try to develop a general theory of how ecological feedbacks can generate and maintain diversity in host-parasite interactions. It is very common to find that some parasites infect very well and that some hosts are very resistant. This variation is important because it affects the evolution of virulence and immunity, alters the spread of disease and may have important implications for disease control. However, we don't yet have a good idea of what processes maintain this variation. I've been publishing models of the evolution of host defence for most of my career. In the last year, thanks to Wiko-sponsored visits by my key collaborators, we have brought all of this together and now have a good idea of what processes are likely to lead to diversity: (i) infection within families and (ii) particular combinations of parasite and hosts not infecting one another. The theoretical results have now been written up in two papers. Without my time at the Kolleg this work would have been much more piecemeal and I doubt we would have gained such an integrated overview of the problem. I would like to thank the Rector for funding my main collaborator Andy White's two visits. We are both so very proud of this work. I now feel that I can move on

from this problem that has consumed most of my research career. Time for something new and I thank the Kolleg for that liberation.

During my time in Berlin I gave lectures at five international meetings: the EEID meeting at the University of California Santa Barbara, USA; the NESCent Catalysis Meeting on “Evolution of Infectious Diseases: Integrating Empirical and Modelling Approaches” at Duke; the Fogarty International Center RAPIDD Workshop on Virulence Evolution in Fort Collins; the Instituto Gulbenkian de Ciência Workshop “Resistance and Tolerance to Infection” in Lisbon; and the remarkable Darwin Meets Nobel Symposium “The evolution of infectious agents in relation to sex” in Sweden. All of these meetings were stimulating and I have no doubt that the presentations were improved by their preparation in the Grunewald, but I regretted leaving the Kolleg to present them. That said, I resented much more the time spent away on unavoidable committee meetings in the UK.

Then there were the things that I had not planned: the development of an interest in the role of disease in human history, inspired by Bruce. The development and solidification of my views on the role of the developed world’s scientific approach in health care in the developing world, inspired by Iruka. The relationship between medical intervention and economics, inspired by Andy, and a number of other wonderful distractions in history and philosophy. In the end, the time to think, talk and read in an environment of broadened horizons improved the quality of everything I did this year and will, I have no doubt, have an even bigger impact in the future. It was a year of academia as I imagined academia to be when I started out trying to be an academic.

#### Papers published during the year

- Boots, M. and K. Roberts (2011). “Indirect Maternal Effects in Disease Resistance: Poor Maternal Environment Increases Offspring Resistance to an Insect Virus.” *Proceedings of the Royal Society B* (in revision).
- Boots, M. (2011). “The evolution of host defence is determined by resource dependent costs.” *The American Naturalist* 178, 214–220.
- Long, G. H. and M. Boots (2011). “How Can Immune Attack Shape the Evolution of Parasite Virulence?” *Trends in Parasitology* 27, 300–305.
- Best, A., S. Webb, A. White and M. Boots (2011). “Host Resistance and Co-evolution in Spatially Structured Populations.” *Proceedings of the Royal Society B* 278, 2216–2222.

- Tidbury, H., A. B. Pedersen and M. Boots (2011). "Within and Transgenerational Immune Priming in an Insect to a DNA Virus." *Proceedings of the Royal Society, B* 278, 871–876.
- Jones, E. O., A. White and M. Boots (2011). "The evolution of host protection by vertically transmitted parasites." *Proceedings of the Royal Society B* 278, 863–870.
- Best, A., S. Webb, J. Antonovics and M. Boots (2011). "Local Transmission Processes and Disease Driven Host Extinctions." *Theoretical Ecology* (in press).
- Reynolds, J. H., A. White, J. A. Sherratt and M. Boots (2011). "The population dynamical consequences of density-dependent prophylaxis." *Journal of Theoretical Biology* 288, 1–8.
- Bacelar, F. S., A. White and M. Boots (2011). "Life history and mating systems select for male biased parasitism mediated through natural selection and ecological feedbacks." *Journal of Theoretical Biology* 269, 131–137.
- Saejeng, A., M. T. Siva-Jothy and M. Boots (2011). "Low cost antiviral activity of *Plodia interpunctella* haemolymph in vivo demonstrated by dose dependent infection and haemolymph inoculation." *Journal of Insect Physiology* 57, 246–250.
- Leggett, H. C., E. O. Jones, T. Burke, R. S. Hails, S. M. Sait and M. Boots (2011). "Population genetic structure of the winter moth, *Operophtera brumata*, in the Orkney Isles suggests long distance dispersal." *Ecological Entomology* 36, 318–325.
- Vale, P. F., A. Best, M. Boots and T. J. Little (2011). "Context-dependent parasitism and the tragedy of tolerance." *The American Naturalist* 177, 510–521.
- Antonovics, J., M. Boots, J. Abbate, C. Baker, Q. McFrederick and V. Panjeti (2011). "Biology and evolution of sexual transmission." *Annals of the New York Academy of Sciences*.