Q & A

Karl Sigmund

Karl Sigmund is professor at the faculty of mathematics of the University of Vienna, and also works at the Institute for Applied Systems Analysis in Laxenburg. He studied mathematics and worked on dynamical systems before turning to population genetics, theoretical ecology and evolutionary game theory. He wrote a popular book on 'Games of Life' *(Penguin, 1994) and, jointly with Josef Hofbauer, a textbook on* 'Evolutionary Games and Population Dynamics' *(CUP, 1998).*

What turned you on to biology in the first place? I hit upon a German version of Darwin's '*Descent of Man*' at the tender age of twelve. I cannot possibly have understood much of it, but was immediately fascinated, first by a photo of old Darwin, whose piercing eyes haunted me, and then by the idea of having apes among my forebears: it explained why I felt so happy in the tree-tops. Besides, I liked the fact that not a few of my elder family members — catholics all — were distressed to see the book in my hands. Much later, I noticed that a thoughtful editor had removed the parts on sexual selection. What would my relatives have said to that!

So why did you turn to mathematics later? I was turned off from biology at school — it seemed such a senseless accumulation of complicated words and boring trivia. My teachers acted as if they had never heard of Darwin. Mathematics, by contrast, was so orderly and beautiful, and I was better at it than the other boys at school, another way of climbing tree-tops. I forgot all about biology and became a professor of mathematics before I came across '*The Selfish Gene*'. That was a turning point for me. Dawkins' very first sentence thrilled me: "This book should be read almost as though it were science fiction." There were not just facts in biology; there was a place for the 'what if', a basic question for any mathematician.

If that is your favourite book, what is your favorite paper? The 1981 paper by Axelrod and Hamilton: '*The evolution of cooperation*' (Science *211*, 1390-1396). It brought me back to the descent of man. Later, I came across a few lines by Darwin, to the effect that the small strength and speed of man was more than offset by his social qualities. What moulded these social qualities? My former student Martin Nowak and I became obsessed by the Prisoner's Dilemma, which encapsulated so much of the tension between selfish and social behavior.

What is the best advice you have been given? 'Embrace the obstacle'. My kayak trainer told me so when he explained that I should always lean towards the boulder, not away from it, when the river carries me against a rock. I do not spend much time in white water, alas, but I heed the advice almost every day.

Do you have a scientific hero? Lots, of course, including all the usual suspects, like Ronald Fisher, Robert May, John Maynard Smith... I even tend to hero-worship some my own students, Martin Nowak, Josef Hofbauer — it is such a pleasure to follow them. But the most stellar minds, to me, are those of John von Neumann and Andrej Kolmogoroff, mathematicians both. Each turned, almost in passing, to biology, and left his mark, and both contributed decisively to many other fields. This is, in my view, the greatest advantage offered by their abstract training to mathematicians: everything is open to them.

What is your view on the importance of interdisciplinary work? It comes naturally. There must be thousands of disciplines, and most scientific progress comes from using methods and results from other fields. People do it all the time, often without realizing that they are engaged in interdisciplinary work: paleontologists use bio-informatics, clinicians use tomography... Of course mathematicians are privileged in scientific border-crossings: it has been rightly said that mathematical abstraction is the ultimate in technology transfer. There are some culture shocks waiting for you — each discipline has its own scientific community — but I found always great willingness in accepting new-comers, as long as they accept the current standards and do not act condescendingly. If there is any tension, it is with the community you leave, not with the one you move to.

What do you see as the biggest challenge in evolutionary games? Game theory, so far, has proved very useful in reducing social phenomena to the actions and feelings of individuals. It is the perfect tool for methodological individualism. What I would like to see is a kind of converse: how an individual's decisions are shaped by conflicts and coalitions within that individual, far below the radar of consciousness — how modules in the brain interact, and cooperate, in guiding an individuals' feelings and wishes. A fascinating recent experiment (Sanfey *et al.* (2003). Science *300*, 1755-1758) combined magnetic frequency resonance imaging and economics games: two regions in the brain were found to light up when a person is confronted with an unfair offer, one corresponding to the rational answer — to accept the offer even if it is small — and the other, to the emotional response — to reject the insult. Such a form of neuro-economics — or, better, physio-economics, because hormone levels play a great role too — may eventually tell us more about human nature than anything since Darwin studied expressions of emotions in man and animals. And if I feel foolish when I re-read this sentence ten years from now, I will tell myself that it was pretty good science fiction.

Faculty of Mathematics, University of Vienna and Institute for Applied Systems Analysis, Laxenburg, Austria.