The results of the census carried out in the spring of 2010 in this area revealed that the number of mountain gorillas had increased by more than 26 per cent over the past seven years — an average growth rate of 3.7 per cent per year. Of the 480 mountain gorillas living in greater Virunga region, 14 were solitary silverback males, and the other animals were living in one of the 36 identified family groups. Adding to this the 306 gorillas known to be living in the Bwindi Impenetrable Forest in 2006, with those living in greater Virunga, and four orphans living in the Senkwekwe Centre, the total population for the critically endangered species adds up to 790.

Although the number is so small, it is seen as something of a success and challenge. The region that the gorillas inhabit is one of human society's most active 'fault lines' that has brought spectacular violence to Uganda and the Democratic Republic of the Congo. That there are 100 more gorillas now living in the forests of the Virunga mountains than there were in 2003 was seen as 'astonishing' by many researchers.

And researchers are also encouraged by the fact that the population estimate may be conservative. Many of the individuals are habituated to the presence of conservationists which makes them very easy to count. But contact also provides insights into the traces left by other gorillas that are still beyond human contact.

And, in spite of the political turmoil for many local human inhabitants, outside conservationists have paid tribute to the local people who conducted the census and have worked over the past seven years to help protect the mountain gorilla. Also, even the troubled governments have backed the efforts; the Ugandan Wildlife Authority, the Institute for the Conservation of Nature in Congo and the Rwanda Development Board all provided support.

Nigel Williams

Q & A

Kevin Foster

Kevin Foster was born in Paris and grew up in southern England. A first degree in Zoology from Cambridge was followed with a thesis on the evolution of social wasps with Francis Ratnieks at the University of Sheffield. From there, Kevin studied a variety of social species ranging from humans to slime moulds before setting up his own lab as a Bauer Fellow at Harvard. The lab has recently moved to Oxford and the current focus is the evolution and molecular biology of social interactions in bacteria.

What turned you on to biology in the first place? I have always felt a religious sense of wonder in the natural world, although this wonder has driven me to seek scientific explanations as opposed to divine ones. Growing up, it was the insects and their stunning diversity of forms that particularly appealed to me. An English meadow on a summer's day is still one of my favourite places, packed as it is with buzzing insects. As a child, I saw each one as a shiny little machine, shaped for a particular task. As a teenager, I read *The Selfish Gene* and this gave me sight of the power of evolutionary logic for understanding what I was seeing. It is easy to see how I ended up at my thesis project, which was on the evolution of cooperation in social insects.

What advice would you give to someone starting in research? A lot of clichés have truth in them, like finding your passion and striking out on your own. But perhaps a more useful piece of advice that I don't hear enough is to spread risk. Working on a single long-term project that may not bear fruit is a bad idea at the start of your career when career-defining assessments are relatively frequent. Biology projects often go wrong through little fault of the researcher and this can kill your prospects. It is all too easy to see why many students end up on one high-risk project. PIs naturally spread their risk by having more than one person in their group so they are not exposing themselves by putting a student on a high-risk project. There is a conflict of interest here between students and PIs that could be formally studied by a social evolutionist. Intuitively though, for the student or postdoc, probably the best strategy is to engage a few projects in parallel, some with almost guaranteed success and others with more risk and perhaps more potential reward.

One final piece of advice I would offer is to always try to see ideas, interests and experimental designs from the perspective of others. Social evolution is plagued with unproductive debates that are too often caused by an unacknowledged disagreement over what are the most interesting questions, rather than one group being right and the other being wrong. Only by carefully breaking down what questions other researchers are really going after, and their associated axioms, is one fit to objectively assess what is correct and what incorrect.

If you knew what you know earlier on, would you still pursue the same research path? More or less. I feel lucky to have stumbled into social behaviour as I did when I decided as an undergraduate to work on social wasps, rather than something like flies or butterflies. While unplanned, social evolution has proved to be a subject that provides a great variety of interesting questions. It is also a subject that tends to capture people's imagination, although this can also be a bad thing when too much is made of the comparison with our own sociality. Others of my career decisions were more planned. For example, I actively decided to become increasingly quantitative and focus more on molecular mechanism within social evolution. So far, this seems to be an interesting way to go and one that has brought increasing rigour to my work.

What has been your biggest mistake in research? I thought that I could learn microbiology from protocols and a few conversations. The result was a significant stretch of postdoc time where all I learned was a list of cruel and unusual ways to kill *Dictyostelium* cells. Luckily I was rescued from this by *bona fide* cell biologists, particularly Chris Thompson, who showed me how to do things properly. It still took time. I remember one phone conversation where Chris was reporting on the result of my first electroporation of

Dictyostelium cells the day before. The idea is to shock the cells and encourage them to take up DNA. I remember asking Chris: "What, are they dead?" He replied, with his usual patience, "No…well, I know what dead cells should look like down the microscope. Yours are not dead. They are *really* dead". Somehow I had managed to explode the whole lot into tiny pieces.

What is your greatest ambition in research? To integrate social evolution into molecular biology. It is easy to see ways that these subjects can complement and learn from one another, but there are historically very few connections from traditional evolutionary biology to the molecular sciences. This has to change, and is changing, but it is a slow process. From one side, many evolutionary biologists find tiring the complications and idiosyncrasies that can come with molecular mechanism. From the other side, there is a natural resistance to the use of behavioural terms like 'cooperation' in microbiology and cell biology. I am very sympathetic with both perspectives. Hybrid subjects like mine get a lot of hype and can just as easily turn into a monster as something useful. But I don't think we have a monster on our hands. There are important ways that social evolution can contribute to molecular biology, and *vice versa*. This is particularly clear in the application to bacteria.

But are bacteria even social? Obviously not in the sense of having conscious intentions and thinking through the way that actions will affect others. In a basic evolutionary sense, however, microbes are highly social. The currencies of natural selection are survival and reproduction, and social traits are simply those that affect the survival and reproduction of others. These traits abound in microbes which often rely on secreted products to grow or poison other strains and species.

Aren't you just stretching the terminology in order to make microbes seem like humans? In a certain sense, yes. But the idea that one can usefully generalise among different forms of sociality is as old as the study of natural selection itself. Herbert Spencer, the contemporary of Darwin who came up with the phrase "survival of the fittest", used the word "altruism" to describe single cells. And this was only a few years after the word was first used.

Ok, so the desire to generalise among social organisms is an old one — but is it really useful? Yes, but there are obvious caveats. Conclusions made about microbes will not necessarily transfer to other social organisms, especially humans. Nevertheless, this should not stop us seeking out general principles that apply to the evolution of all social behaviours. The secret is to be very careful to define terminology, and not wander from the specific evolutionary meanings to words like cooperation, altruism and selfishness. The meanings we use as evolutionary biologists are not arbitrary, as is often thought. They are rooted in the logic of natural selection. Take altruistic traits, these reduce the average reproductive success of a carrier over its lifetime, while increasing the reproductive success of others. Such traits can occur in any organism from microbes to mongoose to man. Accordingly, one can find commonalities for altruistic traits across all systems, such as the importance of ecology and genetic relatedness among individuals. But, again, I am not saying that this makes all altruistic traits identical in form, clearly, when humans help one another the underlying mechanisms are vastly different to when a microbe helps another cell. Nevertheless, the evolutionary logic may be quite similar.

This is all quite abstract — can you give a concrete example of where social evolution can help our understanding of cells? Certainly. The general idea is that the theories of social evolution, such as inclusive fitness and multilevel selection theory, help to explain the nature of bacterial phenotypes and the genetics that underpin them. Take maximum growth rate. It is easy to see why some species divide very quickly, but why do other species evolve to divide slowly? Part of the answer is that some species typically grow surrounded by clonemates. Because these cells are genetically identical, there is no evolutionary incentive to outgrow one another. Instead, slow and efficient growth can evolve that promotes the productivity of all cells. Of course, where species grow and what they feed on is also very important. The claim is not that social evolution will replace our current understanding of microbes, but that it complements existing ideas.

OK, final question, getting much broader, what do you see as the biggest challenge to the scientific community in the coming years? The biggest challenge for the social evolution community is to stop our bickering and recognize the value in using multiple frameworks. But a much more interesting, and grand, challenge facing biologists is that of complexity. More and more physicists, engineers and mathematicians are entering biology and seeking the same standards of proof that they expect in their own field. This is admirable and much progress is being made in systems biology and evolutionary biology in modelling large scale systems like gene regulatory networks or, in my case, interacting groups of cells. But like the systems that they are designed to emulate, these models are often themselves rather complex. And, as any theorist knows, the risk with building bigger and bigger models is that they become unwieldy and so reliant on unknown parameters as to be useless.

The increasing use of theory in biology is a very good thing, but keeping this theory elegant and intuitive is increasingly difficult and is something that will need new techniques and maybe even new paradigms to deal with the current glut of data. There is a great allegory about this from Lewis Carroll that someone once told me about. It is a story in which two individuals discuss the best scale of a map. One favours a typical scale of a few centimetres to the mile. The other chap boasts that he has been making more and more detailed maps, ending up the ultimate map at 1:1 scale. This map has never been used because it would block out the sunlight and upset the farmers. But don't worry, we are told, it turns out the real world is a very good approximation. I don't think it will come to this in biology, but there is wisdom in the absurdity of the tale.

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