communities. Many communities and tribal governments have established research and ethics review boards to evaluate proposed projects in their communities, stemming from a growing awareness and sophistication of issues surrounding genetic and biomedical research, including individual versus community (or cultural) risk, adequacy of individual versus community consent issues, confidentiality, results reporting, etc.," says O'Rourke.

Some communities may ultimately opt out of genetic research projects, but, says O'Rourke, "my own view is that the increasing interest and sophistication of communities with respect to genetic research is ultimately a benefit to both the community and geneticists. It has already facilitated effective communication between the community and researchers in a number of cases."

Hope for Africa and the world

Mutual benefit is also what the funders of the H3Africa project hope for. As NIH director Francis Collins explained in a recent comment in the *Huffington Post*, "Not only will this [H3Africa project] help people living in Africa, but, since Africa is the cradle of humanity, what is learned about genetic variation and disease likely will have an impact on the health of populations around the globe. […] Rather than seeing biomedical innovation as something that flows from developed nations to low-income nations, we need to start viewing innovation as a two-way street from which the entire world stands to benefit."

The quest for medical benefits and a better understanding of human origins may turn out to be closely intertwined and both may lead back to Africa, as Michael Pepper observes: "As the origin of man moves from eastern to southern Africa, the latter is likely to represent the region on the planet that houses the greatest number of genomic variants. We may be witnessing the wheel turning full circle as the key to the pathogenesis of many complex multigenic disorders may prove to be in the cradle which nurtured the origin of humankind." We're all Africans, after all.

Michael Gross is a science writer based at Oxford. He can be contacted via his web page at www.michaelgross.co.uk

Q & A

Bruce Lyon

Bruce Lyon grew up in Canada but is now a Professor at the University of California at Santa Cruz. He studies the evolution of social behavior, mainly in birds. His recent projects have included studies of brood parasitism, sexual selection and mating systems, and signal evolution.

How did you become interested in biology? I have been interested in birds for so long that I cannot recall a specific starting point. My mother remembers me watching barn swallows as a toddler — a pair of these birds nested in our carport where I spent time each day in my playpen, and I suspect this may have triggered my interest. In junior high school, I worked for a nature photographer in Quebec, helping him to find nests to photograph, and taking photographs seemed pretty straightforward. So I became a bird photographer. At 18 I had my first photographs published in an article I wrote about red-shouldered hawks for a Canadian nature magazine. For the hawk project, we built a blind 20 meters up in a tree and watched the nest round the clock. We kept detailed notes of everything the birds did, including the types of prey brought to the chicks, so this was my first attempt at collecting ornithological data. Two of my other photographic projects — studies of the nesting biology of ornate hawk-eagles in Guatemala and sunbitterns in Costa Rica — yielded scientific papers in addition to photographic articles, because virtually nothing was known about the reproductive behavior of these species at the time.

How did you go from being a nature photographer to becoming a behavioral ecologist? My photographic and academic interests initially competed, because most of my photography involved trips abroad. I didn't really enjoy the first couple of years of university. It was confusing because I loved natural history, but I found the course work unsatisfying. I now realize that what was lacking was a conceptual framework with which to make sense of the natural history patterns I had absorbed over the years — an evolutionary approach and selectionist thinking. I changed universities, and one course in particular had a huge impact on me: Fred Cooke, known for his long-term ecological genetics study of snow geese, taught a course on population genetics, with an evolutionary ecology approach. It was an epiphany for me. I had found a way to integrate my passion for natural history with academic concepts and research. Later, I spent the summer assisting Bob Montgomerie with various projects on behavioral ecology of arctic birds. Every night around the dinner table our research crew batted around ideas and hypotheses. I was hooked and stayed at Queen's to do a master's with Montgomerie. For my PhD, I then went to Princeton to work with Peter and Rosemary Grant. Instead of the Grant's favourite model, the Darwin's finches, I decided to work on a completely different system. I ended up studying within-species brood parasitism in American coots, something I had stumbled on by accident during my first field season: females were laying eggs in each others nests with reckless abandon and — even more surprisingly — many birds were able to detect and reject some of the parasitic eggs laid in their nests. This simple natural history observation changed the focus of my thesis work and, in many ways, my career trajectory.

Was your nature photography ever a serious career option? During a year I spent in Kenya, initially helping with a research project on cooperative breeding in bee-eaters, I spent a few months doing nothing but photography. Being able to spend so much time on photography in such a great place was a dream come true, but it began to dawn on me that I really missed the excitement of thinking about biological questions. So, an academic job was always my first choice, but I always kept photography as a back-up career option in case an academic position didn't come through. Over the years, I have sold enough photos to partially cover travel and photography expenses, but I have also come to realize that it would be pretty tough to make a living as a photographer.

Are you able to combine your nature photography interests with your teaching or research? Nature photography and behavioral ecology research both involve detailed observations and paying close

attention to interesting aspects of natural history. In most of my research projects I try to reserve a little bit of time for taking photographs. Our projects on waterbirds are ideal for combining data collection with a bit of photography — we observe our focal broods from floating, mobile blinds, in wetlands teeming with waterbirds. With a really good blind, it's like being invisible — we often get ridiculously close to all sorts of wildlife. In some cases we actually collect data with a camera: as coot chicks are virtually impossible to recapture within a day of hatching, I worked out a technique for obtaining accurate size measurements from photographs. I also use my photographs liberally in my teaching. The right type of photo can be used as a virtual laboratory, where students have to search for interesting patterns and come up with ecological hypotheses that can explain the patterns. As a result, I am often on the search for photographic subjects to illustrate some of the case histories I cover in class.

Do you have a favorite paper? Arnon Lotem's 1993 theory paper in Nature ('Learning to recognize nestlings is maladaptive for cuckoo *Cuculus canorus* host') is certainly one of my favorites. Cuckoo hosts can recognize non-mimetic eggs in exquisite detail but are completely clueless when it comes to recognizing foreign chicks, something that has puzzled naturalists for centuries. Lotem made the key realization that recognition cues would likely be learned through imprinting at the first breeding. As parasitized hosts raise only a cuckoo chick (the cuckoo chick evicts the host chicks), parents that are parasitized at their first breeding would imprint on the cuckoo chick and in subsequent breeding events reject their own offspring. Lotem showed that the risk of imprinting on the cuckoo chick would make learned recognition maladaptive. Lotem's paper made me realize the insights gained from thinking about proximate mechanisms, rather than focusing exclusively on the potential adaptive basis of traits.

What was your biggest mistake or surprise? Completely ruling out an implausible phenomenon that in the end turned out to be true. Although I discovered that coots were really good at recognizing eggs laid by other females, I did not seriously consider that coots might be able to recognize foreign chicks. If songbirds can't recognise cuckoo chicks that differ comically from their own, how on earth should coot parents be able to discriminate between chicks of their own species? Then, a few years ago, my student Dai Shizuka swapped coot chicks among nests to synchronize hatching, and some birds appeared to recognize and reject the foreign chicks. After several unsuccessful experiments, Dai was finally able to show that coots can recognize and reject brood parasitic chicks, and he also figured out their learning mechanism: the adults imprint on the chicks that hatch on the first day of hatching, which are typically their own chicks. This project was the most enjoyable and exciting research I have ever been involved with, so I was quite happy to be proven wrong about chick recognition in coots. The work also connected back to my favorite paper by Lotem, as our research showed that learned chick recognition can evolve when learning is associated with a low risk of error, as is the case for coots.

Any advice for someone starting a career in biology? Natural history and science are not mutually exclusive. Natural history can be a starting point that leads you to interesting questions and experiments, but of course there are many other entry points to understanding nature as well. Notice and think about odd field observations, or failed experiments — they sometimes lead to your most exciting discoveries. And, get a camera — great for illustrating talks and for sharing your research experiences with friends and family.

Department of Ecology and Evolutionary Biology, University of California at Santa Cruz, Santa Cruz, CA 95064, USA.
E-mail: lyon@biology.ucsc.edu

Quick guide

Houses made by protists

Mike Hansell

What kind of structures are we talking about? Portable protective cases, known as tests, made by single-celled organisms out of collected building materials.

What are the organisms that can do this? There are two distinct types of single-celled eukaryotes with this ability. One group are amoebozoans with generally lobe-shaped pseudopodia; the other are the foraminifera (or forams) which are characterised by long, thread-like pseudopodia.

Does the building behaviour of the two groups have a common evolutionary origin? It seems not. The Protista are not a monophyletic group. The current taxonomy of them is rather fluid; however, it seems that the two case-building groups are separable at least at the Phylum level, or even at the Kingdom level in some classifications. The amoebozoans are placed in the Phylum (or Class) Lobosea, while the forams have their own Phylum (orClass), Foraminifera.

What does one of these portable cases look like? That of the amoeba *Difflugia corona* is made of several hundred sand grains (Figure 1). It is almost spherical, with a single circular aperture out of which the organism can project its pseudopodia as it glides through the soil water film or across damp vegetation. The aperture itself is edged with a finely pleated collar of very tiny sand grains and from the top of the case project five or so spikes, also constructed of sand grains. The size of the case is around 200 μm across.

How does a single-celled organism achieve this? *Difflugia* multiplies by binary fission, and a new protective case is built before cell division occurs. As the amoeba moves around