Q & A

Christophe Boesch

Born in St. Gall, Switzerland, Christophe Boesch spent his early childhood in that city and moved to Paris at the age of 8 to finish his primary and secondary school. He moved to Geneva in 1968 where he completed his diploma of biology. He began working on chimpanzees in the Taï forest in Côte d'Ivoire in 1979. Since 1998, he is a director at the Max Planck Institute of Evolutionary Anthropology in Leipzig, Germany. His work on the evolution of chimpanzee culture has been synthesised in his recent book Wild Cultures: A Comparison between Chimpanzee and Human Cultures*.*

What turned you on to biology in the first place? The *Jungle Book* by Rudyard Kipling was probably the very first awakening. Later, as a teenager, I lived in the center of Paris, a huge megapole that offers little space for outdoor activities. Therefore, I spent all my weekends with the scouts exploring the limited forest patches around Paris — my best memories of city life. When I read *King Solomon's Ring* by Konrad Lorenz, I wanted to understand more of the behavior of the animals in nature. Later, at 18, I discovered *The Year of the Gorilla* by George Schaller and immediately knew what I wanted to do. I did my diploma work on the mountain gorillas in the Virunga Mountains in Rwanda and DRC, under the late Diane Fossey and, incredible but true, spent some weeks staying in the same hut and studying the very same group of gorillas George Schaller had studied many years ago.

Sounds like every biologists' dream... Fieldwork turned out to be the ideal way to combine my youthful passion for nature with a profession oriented towards answering so many of the questions about our planet's wilderness. I never regretted this decision: even during the most frustrating periods of the chimpanzee habituation process, I was constantly discovering all kinds of other animals, for instance exploring all the different termite species that live in the forest or admiring the constructs of fig trees that germinate high up in the branches of large trees. I was overwhelmed by the wealth of the tropical forest.

How did you start working with chimpanzees? When I returned home from the Virunga Mountains, though totally fascinated by gorillas, I was looking for a new field site where I could develop a new project. As I was inquiring about different possibilities, I heard from the late François Bourlière in Paris that the chimpanzees in the Taï forest in Côte d'Ivoire were suspected to use hammers to crack wild nuts, although nobody in the scientific community had seen them doing it. Hammers, hard nuts, a large pristine forest, a new window into the evolution of tool use that all seemed too attractive to be left neglected! But some student colleagues told me I was crazy and should rather obtain my Ph.D. quickly on fruitflies or something, and then I could still go to see the Taï chimpanzees.

You obviously didn't listen! No, I went anyway and I was lucky, as within the first few months, I saw a female chimpanzee holding a stone in her hand while sitting at a nut-cracking site. I also saw a group of chimpanzees eating a red colobus monkey, while common wisdom at the time suggested chimpanzees in West Africa did not hunt for meat. These two observations decided my future and luck remained with me and my wife Hedwige: nut-cracking is very noisy, and as wild chimpanzees are extremely shy of humans, who hunt them for meat, this was a decisive advantage. We could use the nut-cracking sound to help find the chimpanzees in the dense forest and succeeded in observing their unique behaviour. What's more, female chimpanzees were more efficient at using hammers and used more complex techniques than males. This opened a set of fascinating questions about the evolution of tool use and the role of sex differences. This turned out to be a decisive help for getting funding for a long-term research project. After the 5-year long habituation, we were also able to concentrate on the chimpanzees' outstanding hunting behavior.

Do you have a 'favourite' paper? My favorite paper is from Jane Goodall in 1963, where she revealed that wild chimpanzees were hunting

small monkeys for meat and thereby convincingly showed the importance of going into the field to observe what animals really do. Before this paper, humans were thought to be the only primates that hunt. Hunting was thought of as a distinct feature that shaped humans as they are today ('Man the Hunter' theory). Jane Goodall's observations also highlighted the importance of natural observations rather than preconceptions or observations on animals in captivity to uncover their species-specific nature.

Do you have a 'scientific hero'? Yes, Charles Darwin, who far ahead of his time confronted the accepted consensus of his social environment, his family, and science to propose a revolutionary theory. The belief that humans are a uniquely special species remains very strong in many domains of science. Too often, results suggesting a clear-cut difference between humans and other primates are published readily in high-profile journals, are widely cited and popularised by the media. By contrast, publications suggesting a continuity between humans and animals or contradicting such a clear-cut dichotomy are too often relegated to specialized journals that attract much less attention and are much less cited. Charles Darwin's openness towards conclusions resulting from natural observations remains an important inspiration in a period where competition for finances and jobs perhaps favor mainstream thinking at the expense of originality and innovation.

How should science position itself with respect to issues faced by society? The persistence of the 'Ivory Tower', where scientists tend to hide behind their expert status to evade their responsibility towards society as a whole is intriguing. Especially for those of us who collect data in the field, societal issues cannot be ignored. Just two examples: as I was tracking mountain gorillas in Congo, I encountered a man-made track where snare traps were placed to capture whichever animal would be unlucky enough to place its foot or hand in the trap. Such snares were also used to trap gorillas, leading to very bad, even fatal, injuries. Could I close my eyes and let gorillas be trapped in them? Or should I remove the snares with the risk of entering a conflict with the snare owners and the habits of the local people? Later, in Taï forest, a poacher entered our research area and killed one of our habituated chimpanzees for meat. Should I refrain from intervening, because I was a researcher working in a foreign country?

So, what did you do? In both cases, I intervened. I removed the snares and had the poacher brought to court. By doing so, I became a party in the conservation landscape. I had to explain to the local population the reason for my reaction, and most villagers understood why I should act to protect our study subjects and the justifications for having the national park rules effectively enforced. Then the next question is whether we should only care about our study animals or whether we don't also have a responsibility towards all of the members of that species that face the same problem. As scientists working on them, we are the ones who know best what such threats can mean to the survival of the species, so, we are also the ones that could make the best case to protect them. For me, a logical consequence of all of this was, besides my studies, to create the Wild Chimpanzee Foundation (www.wildchimps.org), a non-government organisation working at the grass-roots level in West Africa to help conserve chimpanzees and their forested habitat.

What are your next projects? I am fascinated by what technological progress allows us to do. Ten years ago, the adaptation of genetic techniques to degraded DNA allowed us to undertake for the first time a genetic study of wild apes, determining paternity and reproductive success. Five years ago, we could implement for the first time projects about hormones in wild apes and uncover some of the effects of dominance and stress. Now, we are starting to measure the contribution of meat to the diet in chimpanzees and bonobos using stable isotope measurements. What will be possible tomorrow is not clear, but we will probably be able to measure things that cannot be measured in wild apes today. We have, therefore, launched the Pan African Chimpanzee project to collect data and samples from as many different chimpanzee populations as possible, before they go extinct due to human impact. This database will allow us to answer many questions about the factors promoting culture, hunting, tool use and other aspects in our closest living relatives. We may even uncover new facets about chimpanzees, whose future is so badly threatened. It is motivating to see how much more there is to learn.

What have the chimpanzees taught us? Humans have for as long as they could think and talk wondered about what makes us so special and distinguishes us from other animals. Here, chimpanzees, as our closest living relative, act as a direct testimony to our past. For the first time in history, we are in the fortunate situation that we can learn from observations on chimpanzees about our similarities and differences to them and we, therefore, are finally in a position to specify and define human nature. What is puzzling to my scientific eyes is that too often scientists seem to have a hard time to accept or consider what chimpanzees tell us about ourselves. Furthermore, we are still far from knowing the full extent of chimpanzee nature. I remember vividly the day a few years ago in Loango National Park in Gabon when I saw for the first time chimpanzees using tools to extract honey from deep underground. This was an ability chimpanzees had not been thought to have, and even I, having worked for 30 years with them, was not expecting to see this. How much more will chimpanzees teach us in the future?

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Quick guide

Monopolin

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What is monopolin and how did it get its name? Monopolin is a protein complex that organizes chromosomal architecture at the centromere and the ribosomal DNA (rDNA) repeats. Monopolin was identified in *Saccharomyces cerevisiae* as a core complex (Csm1 and Lrs4) and two accessory proteins (Mam1 and Hrr25) that is required for reductional division of chromosomes during meiosis I. Unlike mitosis, during meiosis I, sister chromatid pairs align at the metaphase plate with their homologous chromosome pair, and then each sister pair segregates together to opposite poles. Then, in meiosis II the sister chromatid pairs separate from each other as in mitosis. A key question has been why do sister chromatids segregate as a single unit during meiosis I. Because monopolin mutants attempt a mitotic-type division in meiosis I, it was proposed that monopolin acts to crosslink/clamp the microtubule binding sites on sister chromatids together during meiosis I so that they segregate like a single chromosome.

The idea that monopolin bundles together microtubule binding sites on kinetochores gained further support from studies on the function of monopolin in the fission yeast *Schizosaccharomyces pombe.* Unlike budding yeast, where each kinetochore binds a single microtubule ('point centromere'), in *S. pombe*, each kinetochore binds 2–4 microtubules. Although Mam1 is not conserved in *S. pombe*, Csm1 and Lrs4 (Pcs1 and Mde4 in *S. pombe*) are conserved. Monopolin mutants in *S. pombe* do not have defects in meiosis I chromosome segregation but do display frequent lagging chromosomes during meiosis II and mitosis that are caused by merotelic attachments. Merotelic attachments occur when microtubules from opposite spindle poles attach to the same kinetochore, creating a tug of war that causes the chromosome to lag behind the other chromosomes in anaphase and often mis-segregate. Thus, in *S. pombe* monopolin could act to clamp together microtubule-binding sites on each kinetochore to ensure that they all attach to microtubules from the same pole. It is unknown why monopolin is not required for mono-orientation of sister