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Cover Printer: Courier Corp.
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On the Cover: Silverback male mountain gorilla, Bwenge, and his son, feeding on the bark of planted eucalyptus trees outside Karisoke National Park, Uganda, in 2010. Photo credit: Martha M. Robbins

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Library of Congress Cataloging-in-Publication Data
Primate ethnographies / editor, Karen B. Strier.—1st ed.
p. cm.
Includes index.
ISBN-13: 978-0-205-21466-2
ISBN-10: 0-205-21466-5
1. Primates—Fieldwork—Anecdotes. 2. Primates—Research—Anecdotes.
I. Strier, Karen B.
QL737.P9P672456 2013
599.8072—dc23

2013023258

10 9 8 7 6 5 4 3 2 1

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ISBN-10: 0-205-21466-5
ISBN-13: 978-0-205-21466-2

20

The Evolution of a Conservation Biologist

By Colin A. Chapman[1]

There is little doubt that the earth's biodiversity and ecological systems are gravely threatened. For example, in 2010 the Food and Agriculture Organization of the United Nations estimated that 16.1 million hectares of forest was lost per year globally in the 1990s, and the majority of this was lost in the tropics (15.2 million ha/year). Such large numbers are hard for me to comprehend, but this is about the size of the state of Florida. The conservation situation with respect to primates is similarly very grim, if not worse. Approximately half of the nearly 600 species and subspecies of primates living today are in danger of going extinct. In fact, one subspecies in West Africa, Miss Waldron's red colobus, may already be extinct. For the last two decades, I have studied what I would argue is the only viable population remaining of another endangered species of red colobus monkey (*Procolobus rufomitratus*) at Kibale National Park, Uganda, where my wife and I work.

Although I have dedicated much of my life to the conservation of primates and the ecosystems in which they live, my commitment has evolved over time as I witnessed the plight of primates and tropical rainforests around the world. My father tells a story about when I was very young and was losing at a game of Scrabble. He spelled out "primate," and I asked what it meant. He told me what primates were and why they were interesting. According to my dad, I then

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Citation: Chapman, C. A. 2014. "The Evolution of a Conservation Biologist." In Strier, K. B. (ed.), *Primate Ethnographies*. Upper Saddle River, NJ: Pearson Education, Inc. (pp. 218–227).

FIGURE 20.1 Red colobus from Kibale National Park, Uganda.
Photo credit: Jessica Rothman.

stated that I wanted to watch monkeys, and I have never seriously deviated from that path. In fact, the only time I ever questioned whether I would conduct research on primates until a nice old age was when I met a male elephant in the forest in Kibale. The bull decided that he did not like all the noise I was making cutting a trail, and I had absent-mindedly gotten about 15 meters from the elephant when he charged. Elephants can run fast, and I think that the only thing that saved me was that I ran into the swamp, where the heavy elephant would have sunk quickly into the mud had he followed me. There might have been a few other close escapes involving poisonous snakes and large cats, but I lived through those, too.

After doing an undergraduate project that paid me to travel from Edmonton, Alberta, to Guatemala by bus (a bus ride with many stops that took months and covered over 6,100 kilometers) and then flying to St. Kitts in the Caribbean in search of primates, I settled on St. Kitts as a study site for my master's research. I focused on how ecological conditions influenced behavior and ranging of the St. Kitts vervet, a species of monkey that was introduced onto the island in the seventeenth century, coming over on slave ships associated with the sugarcane industry. This was a wonderful introduction to the world of primatology. Linda Fedigan, my supervisor from the University of Alberta, had conducted research on a particular group of primates before me, so when I started to work on them, they quickly habituated to my presence, and the juveniles would often come within a couple of meters and "peep" at me as if to ask, "What are you doing here again?". However, if a stranger got within 100 meters, the group faded into the vegetation, becoming invisible to all.

Late one night, I was woken up by a friend who worked as guide taking people on treks up the volcano. He had come to tell me that he had heard that a juvenile vervet from my group had been captured. At this time in St. Kitts' history, a biomedical group was conducting research on vervets in captivity. While I was ethically opposed to this sort of research, as a

master's student I was not in a position to do much about it. But we had come to an agreement that no animals would be taken from the area that our study group inhabited, so at first light, I raced on my motorbike to the facility to ask about the fate of this juvenile. The researchers were very kind and apologetic; they called in the trapper and we learned that he had trapped the juvenile in the home range of our study group. The senior researchers asked me what I wanted to do. I was not entirely sure, but I figured that as the juvenile was still in quarantine and thus had not likely been exposed to any diseases, I wanted to reintroduce him to the group. I literally put the little male into my backpack (yes, he bit me), rushed to my field site, and searched for the group. I found them in one of their favorite resting areas and as I got close, the juvenile started giving calls. A number of animals approached me but were still more than 10 meters away. When I opened my backpack just a little, the juvenile began calling much more intensely, and a female came within 5 meters, calling continuously. Then I opened the bag all the way. The juvenile ran out and was immediately picked up by a female, and they both disappeared into the bush. I had the sense to cut hairs on the side of the captured juvenile so that I would be able to recognize him again, and to my relief, he was still with the group when I left the island a number of months later.

With more experience under my belt, looking back I am not certain I did the right thing, particularly with a present-day understanding of disease transmission. I think luck was with me then, though, and it seemed to have worked out. And it was this experience that likely pushed me towards a life of conservation. Sadly, the home range of my vervet monkey group is now the site of a luxury hotel. Maybe some of you reading this essay have stayed at this resort without knowing the history of the area, or if not the exact one on St. Kitts, then perhaps another one that also led to losses of primate life.

After my experience in St. Kitts, I thought seriously about my academic career. I never doubted my goal was to study primates in the wild, but I wondered how I would do it. Dr. Fedigan had recently started research in a protected area, Santa Rosa National Park, Costa Rica, and it made sense to go there, along with my wife, for our PhD research projects. Santa Rosa is a wonderful place with three species of primates: cebus monkeys that show complex social relationships; howler monkeys with fascinating diet choice; and spider monkeys with an amazing prehensile tail and grouping patterns that change in complex manners over the day.

After the first year of studying the basic ecology of all three of these species, I became fascinated in a side project dealing with what determined the size of primate groups. My ideas were relatively simple. Various researchers had suggested that grouping confers such predictable benefits that differences in group size can be explained by the disadvantages. The most accepted potential cost of grouping is that by being a member of a group, animals experience reduced foraging efficiency. This is either because animals fight over food, or one animal in a group simply beats another to the food; thus, when the second animal comes for the food, there is simply none left. In both of these situations it is thought that competition over food leads to animals having to travel farther.

Animals must forage over an area that can meet their energetic and nutritional requirements. It follows that an increase in group size will increase the area that must be traveled to find adequate food supplies. Thus individuals must travel farther and expend more energy if they are in larger groups, rather than in smaller groups. With an increase in the time spent traveling, a point is approached where the energy spent in travel exceeds that obtained by feeding, and smaller groups become advantageous. The first time I presented these ideas, my lab mates thought it was a silly idea and that I should abandon this line of research. This might have been due to the fact that I explained it poorly or that it was a relatively new and

unusual idea. However, my work over the years and that of others has provided general support for these ideas.

It was while I was trying to wrap my head around what determined the size of primate groups that I again came face to face with conservation issues. Costa Rica is known in tour guides as the "Garden Spot of Central America" because it has such an extensive system of parks and reserves, but outside of those parks the land has often been terribly degraded. When I was in Santa Rosa, a well-known field biologist named Dr. Daniel Janzen was trying to buy land to extend the park. My wife and I surveyed these areas because we thought that if we could demonstrate their potential for supporting primates, he would have a good fund-raising tool. Much of the landscape consisted of badly damaged grasslands that had once been forest 30 meters tall, but there were still some small forest fragments and riverine forests and it was in these areas that we often found all three of the monkey species that were present in Santa Rosa. It was clear that if one could restore the forest, like Dr. Janzen was trying to do, one could help the monkey populations in significant ways.

To the best of my knowledge, the term conservation biology was introduced as the title of a conference organized by biologists Bruce Wilcox and Michael E. Soulé at the University of California, San Diego in La Jolla, California in 1978. This was before I had ever been to the field or seen my first wild primate. Arguably, the field of conservation biology did not become well recognized until after 1987, when the journal *Conservation Biology* was first published. At this time I was completing my doctoral degree and surveying the degraded habitats neighboring Santa Rosa.

I continued to work in Costa Rica for my first postdoctoral study, but in 1989, the opportunity to conduct a second postdoc in Kibale came through. Everyone thinks that my wife and I made the decision to start working in Uganda as the next step of a well-planned research program; however, this could not be farther from the truth. In reality, we had applied for postdoc positions in Panama, South America, South East Asia, and Africa; we were just very lucky that each of our respective proposals to work in Uganda came through. My wife's research and conservation efforts focused on fish and freshwater systems, while mine focused on primates and tropical forests. After working for almost three years with Richard Wrangham on chimpanzees and trying to understand how changing ecological conditions affected group dynamics in chimpanzees, I began to pick up where a long-term researcher, Tom Struhsaker, had left off with his study of the endangered red colobus monkeys. My wife and I have conducted research on these monkeys ever since.

We thought that assessing determinants of red colobus abundance would be valuable in managing this population. To do this we conducted intensive population density surveys to determine primate numbers at six locations in Kibale that were on average 12 kilometers apart. These sites were all connected by continuous forest, so primates could easily disperse between them.

Red colobus were present at all of these locations; however, their lowest density was at an undisturbed and very diverse location in the middle of the park, and they were abundant in disturbed and logged locations where tree density was low. This pattern was not easily interpreted in light of forest structure because we expected that primate biomass would be related to food availability and therefore greater in the least disturbed area. We decided to examine the relationship between monkey density and food supply. This included watching redtail monkeys, a fruit-eating species, as well as the red colobus, a leaf-eating monkey, in these six locations for about 4,000 hours (the equivalent to working at an 8-hour-a-day job for almost two years) to determine their important foods.

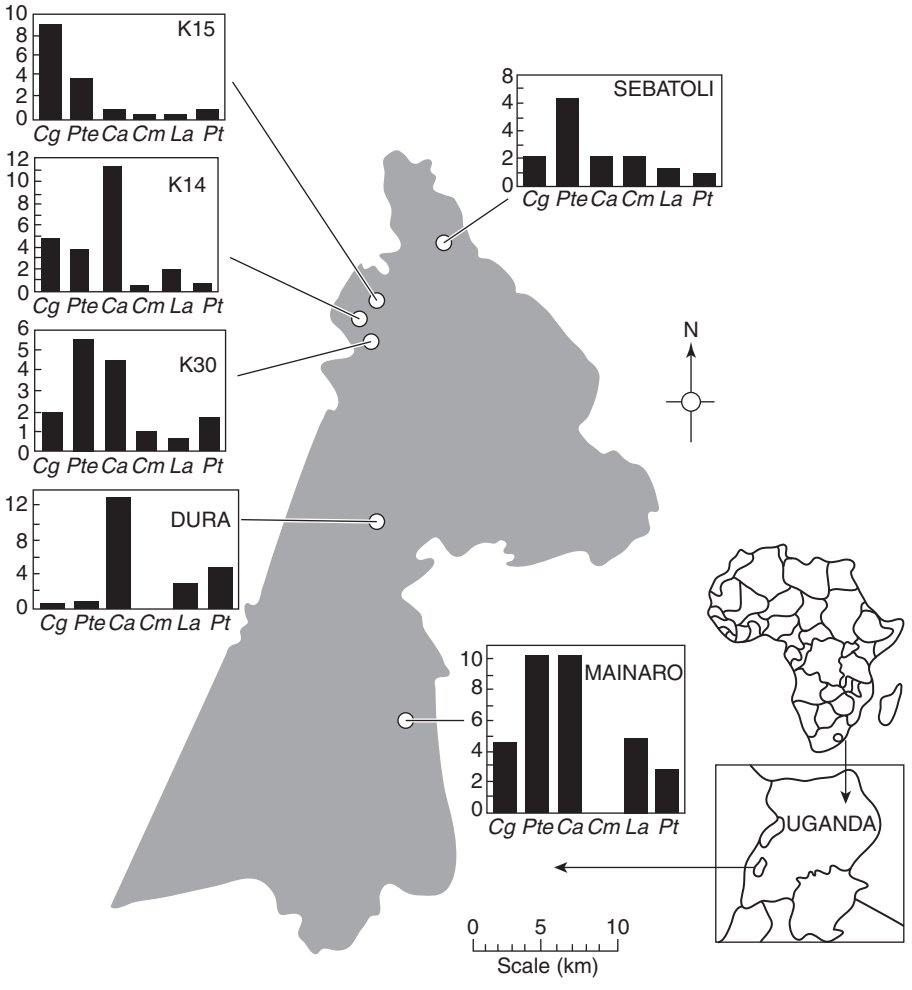

FIGURE 20.2 Map and density of the common primates found in different areas of Kibale National Park, Uganda. (Figure courtesy of Colin A. Chapman.)

We found a fairly strong positive relationship between the abundance of the fruit-eating redtail monkeys and their food, but the relationship for the red colobus held only if one undisturbed and very diverse site in the middle of the park, known as the Dura River site, was excluded. We knew that Tom Struhsaker had seen an epidemic that killed a number of red colobus back in the 1970s and we saw a male die of apparently the same disease in 2013, so it was possible that this population was still recovering from the effects of a past disease. However, it bothered us to not understand an outlier like this. Were we missing something?

We started to consider the possibility that primate abundance might be affected by more than the availability of food, with food quality being a likely candidate. Unlike most primates, colobus monkeys have a specialized alkaline forestomach capable of digesting leaf material. Previously, Katie Milton had proposed that leaf selection in howler monkeys, another leaf-eating monkey, was related to how digestible a leaf was relative to its protein levels. Others extended

MAP 20.1

this idea and suggested that if easily digestible mature leaves (i.e., low in fiber) were plentiful in an area where other, more-preferred foods were lacking, the site could support a relatively large population of colobines. When we quantified the average protein-to-fiber ratio of mature leaves at our sites in Kibale, we found was that it predicted the differences in red colobus abundances. The low abundance of colobines at the Dura River site finally made sense, for although this site had an abundance of food, it was of low quality.

No conservation biologist in his or her right mind should make conservation decisions based on four data points, so over the next 6 years, we examined the generality and predictive power of the relationship between protein-to-fiber ratios and colobine abundance by adding our biomass and leaf chemistry values to five previously published values and to a set of values we collected in five forest fragments. We found that a whopping 87 percent of the variance in colobine biomass could be attributed to the quality of the foods at a site.

It was extremely satisfying to discover that colobus abundance was predicted by the quality of the foods available to them (or a strong correlate of this) because we could use this information to engineer solutions to conservation issues. It does not take a Ph.D. to conclude that primate populations can be protected more efficiently if we decrease logging or bushmeat hunting, but finding subtle, unexpected, or cascading effects of anthropogenic disturbance and using this information to construct informed management plans is a major challenge. That is why it was so rewarding to be able to start applying our findings about the importance of protein-to-fiber ratios in primate conservation. For example, this knowledge of their dietary preferences would allow one to restore an area to make it very suitable for endangered colobus by planting the highest-quality species of trees. Such habitat restoration may soon become a big element of tropical conservation as a result of changing international agreements about how countries can offset carbon emissions that increase global warming by restoring "natural" forest and storing carbon in trees. As many countries have trouble meeting the carbon emission

reductions that they have pledged to make, they can live up to their previous agreement, while not cutting emissions by buying carbon. Basically, a country can pay for the reforestation of areas, and the carbon in those trees is taken off what the country emits so that it achieves its promised reduction levels.

We know almost nothing about how climate change will influence primates—which species will prosper or which will go extinct. We do know that some estimates suggest that the climate could warm by 5.8°C this century. Primates will be affected by either climate-induced loss of particular plant species or changes in flowering and fruiting cycles. It has been estimated that 81 to 97 percent of the 5,197 African plant species studied will have distributions that will decrease in size and/or shift in location, many to higher altitudes, and 25 to 41 percent of plant species will lose all their area by 2085.

A second area in which to apply this understanding about colobus food quality is in logging operations. We would like to influence logging companies by instructing them not to cut down trees that have particularly high protein-to-fiber ratios to reduce the impact of logging on the colobus. Realistically, logging companies will take the trees with the best market value. However, one could hopefully convince them to directionally fell trees that they do cut away from trees with high protein-to-fiber ratios. Often over 50 percent of the trees killed in a logging operation are not cut for timber, but are incidental damage. Directional felling is a large component of what is required for a logging concession to receive certification from groups such as the Forest Stewardship Council, which facilitates the reduction of damage in logging operation, and the certification facilitates logging companies being paid more for the timber they sell.

Logging operations as well as bushmeat hunting and expanding human populations have increased the risks of infectious disease transfers between humans and other primates. The sudden appearance of diseases like SARS and swine flu, the devastating impacts that diseases like Ebola have on both human and wildlife communities, and the immense social and economic costs created by viruses like HIV underscore our need to understand the ecology of infectious diseases. Given that monkeys and apes often share parasites with humans, understanding the ecology of infectious diseases in nonhuman primates is of paramount importance. In the last couple of years, my colleagues (particularly Tony Goldberg), students, and I discovered that red colobus monkeys have three unknown simian retroviruses, including a new form of the SIV virus (the progenitor of HIV). We also found serologic evidence for a novel like poxvirus in red colobus and have shown that anthropogenic disturbance promotes bacterial transmission among humans, livestock, and primates. With primate habitat loss averaging approximately 200 square kilometers a day, humans, domestic animals, and primates are forced into closer contact, which contributes to the emergence of novel infectious diseases. A particularly poignant example comes from Minkebe Forest in the Democratic Republic of Congo, where Ebola caused not only human deaths but also a decrease of at least 90 percent in the gorilla populations. In collaboration with my student, Ria Ghai, and Tony Goldberg, we are now using novel genetic techniques to examine if and potentially how readily *Trichuris* (a very common intestinal parasite) and malaria are transferred among primate species, including humans. To our knowledge this has not been done for a community of primates that includes humans. If transmission is frequent, this will dramatically change concerns over spatially separating nonhuman primates and people and lead to significant modification in both conservation and public health strategies.

Doing good conservation work is not just the application of information on the plant and animal communities; rather success depends on acceptance by the local human community of

the ideas coming out of academic efforts. It is not surprising that we have gotten to know the local community well during the 24-plus years we have worked in Kibale. They welcomed us warmly during the entirety of our research. Several members of the community worked with us from the very beginning of the project; one was born in the backseat of the truck as we were racing the mother to the hospital. One day when we were working far from our base camp, a truck just like ours drove off the road and over a cliff. The driver, a 2-meter-tall, red-haired white man with a beard, was killed along with a passenger. Based on this description, the locals thought that my wife and I had been killed. Once the community found out we were not dead, they threw a party for us to, as they said, "welcome us back from the dead." It was the nicest funeral for ourselves we had ever attended.

We wanted to give something back to these kind people, so we asked our closest friends in the community what they regarded as their most pressing needs; almost universally the request was for jobs. We could not hire the whole community or even a significant part of it (more than 6,000 people are within easy biking distance of the field station), so we went to the second need on their list, health care. After payday or the sale of their crops, the people in this community make essential purchases and then pay for making improvements to their houses or for their children's school fees. Thus, within a week they are often out of readily available cash. If a child gets sick, it costs over a day's labor to go to a clinic. They often do not have the cash on hand, so they wait. It is only when the child is very sick that they ask friends and neighbors for a loan and then go to the clinic. We verified the importance of the local community`s need for health care and the reason it was ranked number two in their list of what they needed the most by studying the health situation in depth. It quickly became clear that medical services were desperately needed in the area. For example, life expectancy in Uganda is only 45 years; 26 percent of children under the age of 5 are malnourished; 30 percent of all deaths among children between the ages of 2 and 4 are caused by malaria that could be easily treated or prevented; and many of the diseases are waterborne, as people typically collect water for drinking, water their cattle, and wash their laundry at the same water source—usually the only water source available. Thus, our objective became to build a medical health center just within the borders of Kibale National Park to provide the communities surrounding the park with reliable health care that is close at hand and affordable and to maintain strong positive park–people relationships.

With the efforts of many undergraduate and graduate students, we raised the funds to work toward our objective. Within two years, the Kibale Health and Conservation Centre was functioning. It is staffed by a full-time nurse and a second nurse who concentrates on outreach to the schools, and it is visited regularly by a medical doctor and AIDS counselors. To make the service affordable, there is no charge to see the nurses or doctor, who are paid with funds raised in North America. Patients pay only for treatment (e.g., malaria drugs), and if they cannot pay at the time, they are asked to come back on payday. We thought that the local people would see the health centre and the benefits coming from it as a benefit of the park and have the cascading effect of decreasing the illegal bushmeat hunting and the collection of firewood that still occurs in the park. In keeping with our academic spirit, we are now testing the impact of the Centre on people's health knowledge, which should improve from the outreach, as well as looking at changes in attitudes toward, and actions related to the park. It is estimated that the Centre provides vital health care and education to more than 6,000 people, so the potential for positive impact is very real.

After a couple of decades of working with tropical primates in the field, I am optimistic about conservation. It is very obvious that human actions endanger many primates and that

FIGURE 20.3 Kibale Health and Conservation Centre. The Centre was established by Drs. Colin and Lauren Chapman as a means of expressing their thanks to the local community that had been so welcoming to them during the time they have spent in Uganda and we are eagerly looking forward to working with this community over the next couple of decades.
Photo credit: Colin A. Chapman.

great effort needs to be made to conserve the forests they inhabit. However, the rate of forest loss is declining, a great deal is now known about primate diseases, and programs to decrease the size of the bushmeat industry are succeeding. These advances should not make us reduce our efforts—rather our knowledge offers great opportunities to make significant contributions to primate conservation. We now have clear guidelines as to the actions that need to be taken. Certainly many questions need to be addressed to make primate conservation a reality: What will direct human depopulated areas towards a process of ecological recovery? What are effective measures to reduce the transmission of diseases between people and nonhuman primates? How is it possible to reduce the national and international trade in bushmeat? How will climate change impact specific regions and their primate species? These questions provide the foundation for research programs that will make a real difference and will generate the information needed to construct informed conservation/management plans. It is a very exciting and challenging time for people interested in primate conservation; there is sufficient background information to ask really thrilling and meaningful questions, and the tide has turned so that there is a real willingness to fund and bring about significant change. I sincerely hope that some of you who have read my story of how I became involved in primate conservation see how things have changed in the last couple of decades, become excited about the current possibilities, and invest your time and energy to conserving primates and their habitats. Good luck.

Suggested Readings

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Acknowledgments

This research has been funded by a great many funding agencies. I would like to single out National Geographic for taking risks on fun ideas, Wildlife Conservation Society for being with us in the initial years, and the National Science and Engineering Research Council of Canada for its flexibility in funding. I would like to especially thank Lauren Chapman for being with me throughout the years, the graduate students for making things fun, and the Uganda field assistance for all the help and knowledge, particularly our program directors Dr. Patrick Omeja and Dr. Dennis Twinomugisha.