A dominant male mandrill glares up at a rival in Lékédi Park, Gabon. Males prefer to determine a foe's strength by visual cues instead of fighting.

Photos by **Francisco Mingorance**

The largest and most colourful monkey in the world is also one of the most elusive, hidden in dense, remote Central African rainforests. Scientists are starting to discover more about mandrill behaviour thanks to innovative new techniques, reports Chelsea Wald.

CHASING RAINBOWS

Deep in the Gabonese rainforest, something blinked. A pair of round amber eyes peeped out of the emerald gloom at American conservationist Michael Fay, who was just sitting down to rest when he noticed that he was being watched. Blink, and blink again. "Suddenly there's this little mandrill looking at me – just a baby, probably two years old," he recalls. "It was peering through the bushes, perched up on a log."

The mandrill soon darted away, but was quickly replaced by another on the same log. Blink, blink. "Then another one arrived, and another, and another," Fay smiles. "And I realised they were all lined up, taking turns." They had never seen a human before, figured Fay, a senior conservationist for the Wildlife Conservation Society. "They're all curious – like, 'Whoa: what is this?'"

It was a rare reversal of the typical interactions between humans and mandrills. Humans are usually the curious ones – especially scientists. Mandrills, on the other hand, are notoriously shy and difficult to find in the vast, tangled rainforest of western Central Africa. Old World monkeys related to baboons and drills (which are more threatened than mandrills, being Endangered), they inhabit a range spanning parts of Cameroon, Equatorial Guinea and the Republic of the Congo. But it is thought that they survive in largest numbers in Gabon, where they live alongside forest elephants, chimps, western lowland gorillas and leopards.

Mandrills fascinate scientists for several reasons – not least their extreme sexual dimorphism. Males can weigh over 30kg, nearly three times as much as females. And whereas females are relatively demure, males sport radiantly colourful adornments, smell pungent and grow intimidating canines used in fighting other males (see box, p43).

Mandrills are also remarkable for the size of their social groups, known as hordes, which may comprise some 800 individuals – females and young at the core, with males on the periphery. But though they sometimes travel in vast numbers, they are hard to find and follow in the dense rainforest. "You hear them a lot more than you see them," Fay says, referring to their deep grunts and high-pitched crows. To track mandrills, scientists have had to be creative, taking advantage of encounters in relatively confined situations, such as mandrill highways in the forest and private parks with porous fences, to gather valuable data.

THE INVISIBLE MONKEY

Their research is urgently needed. The mandrill, like many other rainforest animals, is under pressure from deforestation and commercial bushmeat hunting. Populations across its range have probably declined by over 30 per cent during the past three decades – its IUCN Red List conservation status is now Vulnerable.

"It's incredible to me that this species, so present in cartoons and nature books, is very much ignored on the conservation front," says Fay who, as an adviser to the Gabonese president, is helping to bring attention to mandrills in that country. Now is the time, scientists say, to learn as much about these monkeys as possible – and to lay the groundwork for protecting them.

Mandrills are frustratingly elusive. Scientists often habituate wild gorillas and other primates to human presence. But whereas those animals form small groups, such habituation is impossible with this species, says Jo

Young mandrills at least two years old often forage in small groups.

Researchers released this baby from a trap set by hunters.

Setchell, a primatologist in the Anthropology Department at Durham University, who has worked with mandrills in Gabon. "If a group has 600 individuals, every day on which you contact that group there's going to be an animal that's never seen you before – so that animal will scream, and the whole group will flee. You don't get any opportunity for the animals to realise that you're there but you're not a threat."

What's more, it's hard to study their behaviour because it's impossible to keep track of who's who. Setchell once saw a horde crossing a river on a fallen tree. "You could see them just flooding across this tree, and there were others jumping from tree to tree above the river," she recalls. "There's no possibility of individual identification in that case." Some researchers have taken advantage of crossings such as that tree to make videos for later analysis. But in many cases, Setchell says, "the best thing you can do is count them, basically". More than 1,000 individuals have been counted in the largest hordes – making them possibly the largest stable wild primate groups anywhere.

One way to keep track of a mandrill horde is to fit individuals with radio-collars – if you can catch them. Lopé National Park in central Gabon is a mosaic of forests, where mandrills live, and savannah, which they avoid. Strips of forest bordered by savannah funnel the monkeys through relatively narrow corridors that serve as mandrill highways. Ecologist Kate Abernethy, of Stirling University and Gabon's National Centre for Research in Science and Technology, conducted research in Lopé for two decades. Since the late 1990s her team used air rifles from hiding places along such highways to dart mandrills with sedatives, collar them and release them back into the horde. Over 10 years Abernethy's team made contact with one horde several days each week, even as it travelled up to 15km a day and ranged some 200km².

MANDRILLS ARE ALSO REMARKABLE FOR THE SIZE OF THEIR SOCIAL GROUPS, WHICH MAY COMPRISE SOME 800 INDIVIDUALS.

The team's findings offer hope of a positive outlook for the species. Mandrills have an eclectic diet – they love fruit and all kinds of insects, and could probably survive a decline in any single food item. They also reproduce quickly: females aged four to twelve have one baby every two years. If an infant dies, which is common, the mother will bounce back and reproduce again the next year. Hordes seem to tolerate parasites and viruses well, despite widespread infection. "Mandrills," Abernethy says, "are probably quite resilient" – as long as there's rainforest in which they can live.

Abernethy also found that rainforests need mandrills. As hordes blaze a trail, they turn over the leaf litter on the forest floor, which is fertilised with their dung. They are food for pythons, leopards and probably birds of prey. And they disperse seeds, thereby helping the expansion of the forest on which they depend. ▶

Marie Charpentier (*far left*), director of the Mandrillus Project, tracks radio-collared mandrills with two of her assistants.

HIGH-RANKING MALES SHUFFLE RANKS OFTEN DURING MATING SEASON – STATUS TAKES A TOLL.

The blue folds on an adult male's muzzle accentuate snarls during face-offs with rivals.

Young males stay with the horde until they become subadults at six to nine years old.

THE BUSHMEAT TRADE

Scientists aren't alone in looking for mandrills. Hunters often use dogs to track the monkeys, trapping them in trees. Hunting rainforest animals – from insects to great apes – for food has been a way of life in rural Central Africa for millennia, but in recent decades it has grown into an unsustainable industry. Logging roads provide access to the heart of the rainforest and allow hunters to transport their catches to cities, where large and rare animals such as mandrills sell for a premium. The survival of nearly 100 species may be threatened by the trade, and the decline in large animals including apes and forest elephants – also killed for their ivory – has already been catastrophic. Hope rests with initiatives to protect species while promoting sustainable harvesting, providing income and protein for the poor.

Mandrill bushmeat commands high prices at Central African markets.

Karl Ammann/naturepl.com

There is one place where wild mandrills let humans get close to them. Lékédi Park, in the town of Bakoumba in southern Gabon, was once the maintenance centre for a cable car that carried manganese some 76km for loading at Pointe-Noire, a port in the Republic of the Congo. When the cable car closed in the early 1990s, the company converted the centre into a private wild park.

In 2002 and 2006, scientists released a total of 60 captive-born mandrills into the giant park, which also held wild mandrills. Wild males mated with the captive-born females, and the group has grown to more than 100 in size, moving in and out of the park through its porous fences. With every new generation they have become increasingly wild, yet remain habituated to humans.

RED MEANS DANGER

It's an ideal situation for studying mandrill behaviour – hence it's the location of the Mandrillus Project, which was launched in 2012 by evolutionary biologist Marie Charpentier of the Centre d'Ecologie Fonctionnelle et Evolutive in Montpellier, France.

Studying captive mandrills is, of course, relatively straightforward – but they may not behave in the same way as wild ones. Take high-ranking males, for example – those with the brightest colours. In captive groups, high-ranking males tend to maintain their status for a long time, despite frequent fighting. But in the wild they shuffle ranks more often, especially during mating season – probably because maintaining status takes a toll. Charpentier's group has found that high-ranking males pay a price in terms of underlying physical fitness during mating season. That may be why she rarely sees older high-ranking males. "Males tend to be at the top of the hierarchy early in their prime, when they are just young adults, because they are stronger."

Charpentier's team also witnessed close-up some of the threats from humans, and the pugnacity of male mandrills. One day, when photographer Francisco Mingorance – whose images accompany this article – visited the Mandrillus Project, the team found a baby mandrill caught in a hunter's trap outside the park fence. During the two hours it took them to free the infant "the dominant male attacked us furiously", Mingorance recalls. Eventually the baby was released and reunited with its mother.

This brought home the greatest threats to mandrills: commercial bushmeat hunting, followed by deforestation (see box, above). In neighbouring countries such as Cameroon, where human populations are much larger, the forests are "dead and empty", says Setchell. Gabon is much less populated, so still can practise what some call "conservation before the crisis".

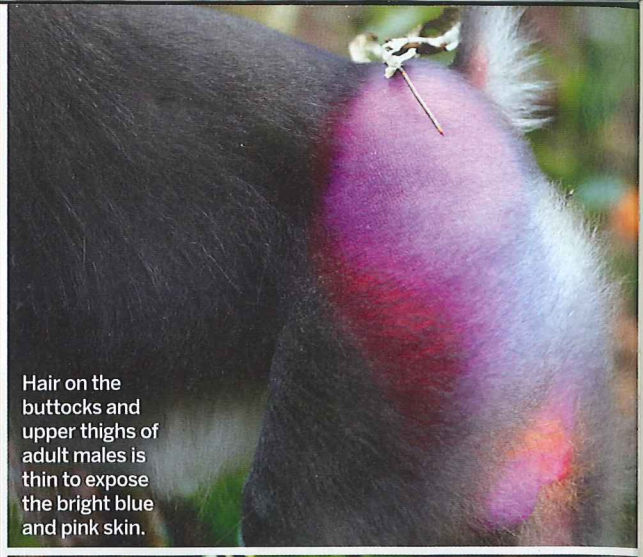
IN NEIGHBOURING COUNTRIES SUCH AS CAMEROON, WHERE HUMAN POPULATIONS ARE LARGER, FORESTS ARE DEAD AND EMPTY.

The importance of Gabon as an ecological stronghold was underscored by the 'MegaTransect' undertaken by Fay in 1999–2000. On a 3,200km trek across the Republic of the Congo and Gabon, his team hacked through thick understorey to document the plants and animals living in the most remote areas.

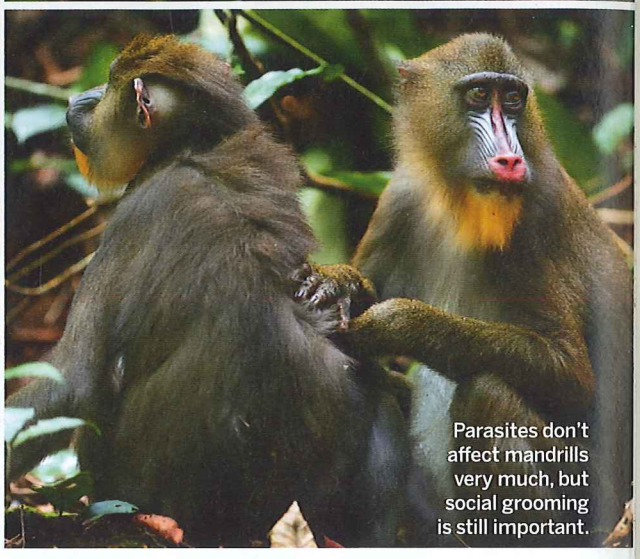
That groundbreaking expedition was crucial in persuading the Gabonese president, Omar Bongo, to designate ▶

MANDRILL

Mandrills eat fruit, seeds and insects. Adult males tend to feed on the forest floor, while juveniles often forage in trees.



Hair on the buttocks and upper thighs of adult males is thin to expose the bright blue and pink skin.



Parasites don't affect mandrills very much, but social grooming is still important.

AN AFRICAN EDEN?
ECOTOURISM IN GABON

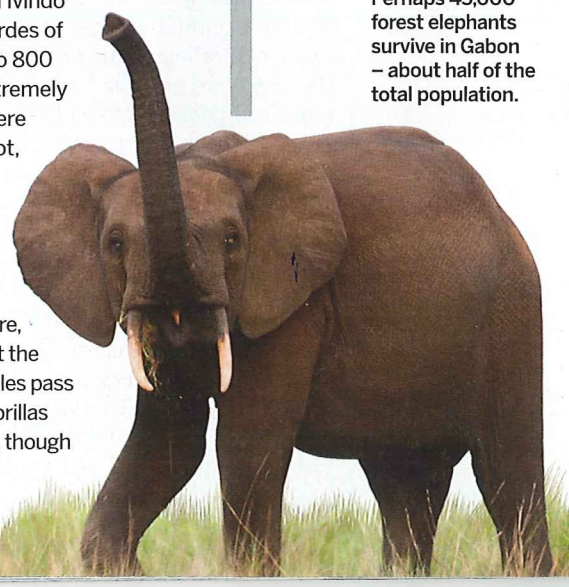
In 2002, when President Omar Bongo created 13 national parks covering over 10 per cent of the country's area, Gabon became a hot ticket. Travel writers and tour operators promised surfing hippos, forest elephants and gorilla encounters. Since then the reality of developing ecotourism in a country with little travel infrastructure has bitten. Even so a few places are accessible to tourists, offering some exceptional experiences.

Western lowland gorillas, forest elephants and sitatunga antelopes visit Langoué Bai, a muddy forest clearing in Ivindo National Park. In Lopé, hordes of mandrills numbering up to 800 can be seen – if you're extremely lucky. Visits to Lékédi, where mandrills are easier to spot, are also possible.

Loango National Park is the best-known location. Though you'd be fortunate to see a surfing hippo, leatherback turtles nest here, elephants and buffalos visit the beach, and humpback whales pass from July to September. Gorillas and chimps might be seen, though they're not yet habituated.

Nick Garbutt/naturepl.com

IT'S SIMPLY VERY DIFFICULT TO COUNT ANIMALS THAT RUN QUICKLY AROUND DENSE FORESTS IN ENORMOUS CLUMPS.



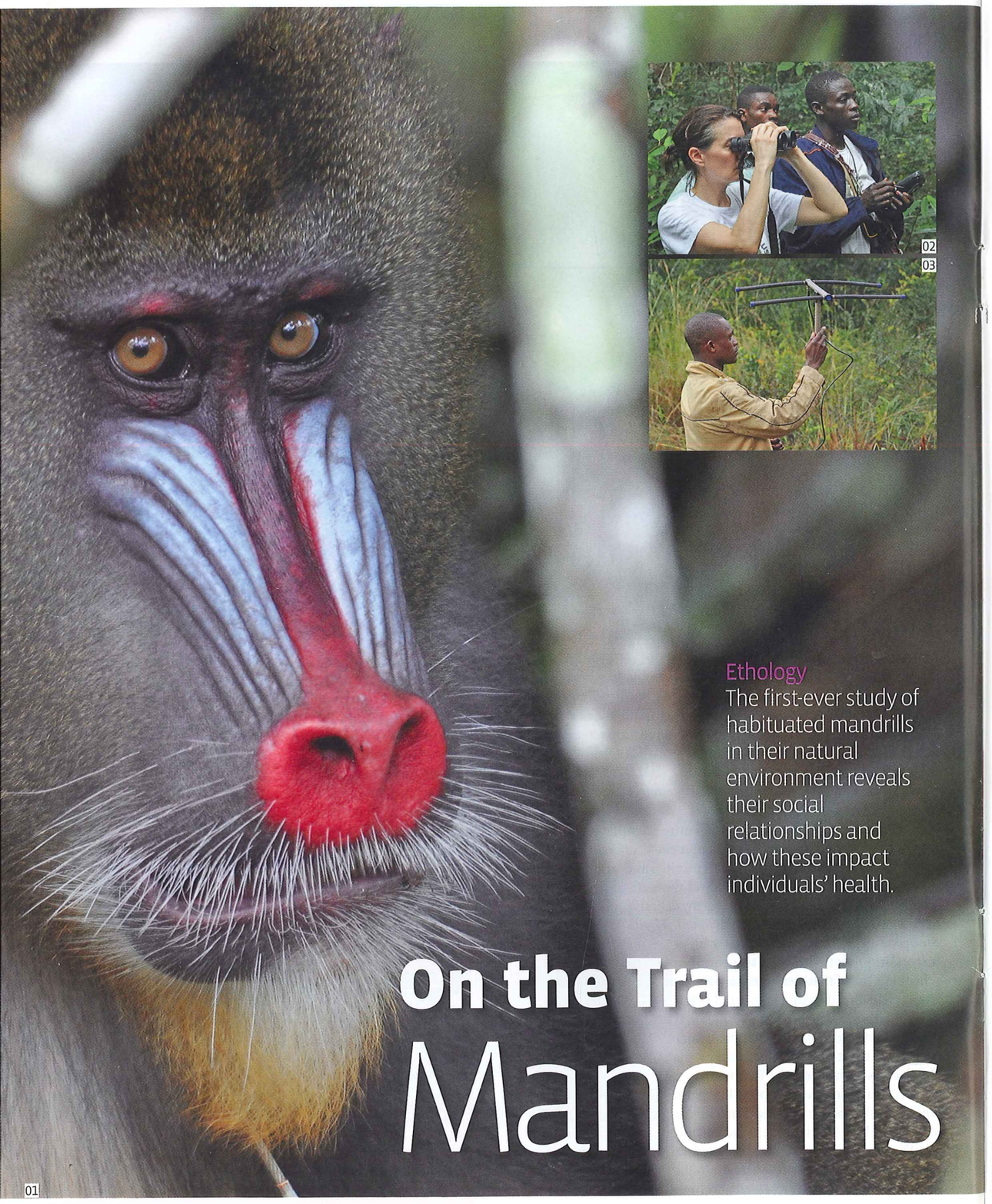
Perhaps 45,000 forest elephants survive in Gabon – about half of the total population.

13 new national parks protecting more than 10 per cent of the country's area. His son Ali Bongo Ondimba, who took over the presidency in 2009, appointed Lee White – a British-born zoologist and Abernethy's husband – head of the country's national parks. Under White's leadership, and with the help of Fay, Abernethy and the Wildlife Conservation Society, Gabon has made strides towards securing its parks from poaching and generating revenue from ecotourism (see box, left). Its parks are now the "primary places on Earth where mandrills will survive in large numbers", says Fay.

What those numbers are, however, remains the biggest mystery of all. "Nobody knows how many mandrills there are in the wild, to an order of magnitude," says Abernethy. This makes it hard to plan and evaluate conservation measures – and even to know whether numbers in Gabon are declining or holding steady.

The problem comes down, again, to the mandrills' elusive ways. It's simply very difficult to count animals that run quickly around dense forests in enormous clumps. To conduct a meaningful census, money will be needed. So, too, will the cleverness and creativity that mandrills demand of the scientists who study them. "Unfortunately, at the end of 20 years, I have not really cracked it," Abernethy says. But she'll keep trying.

CHELSEA WALD *writes about science and the environment – visit www.chelseawald.com to find out more information.*



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Ethology
The first-ever study of habituated mandrills in their natural environment reveals their social relationships and how these impact individuals' health.

On the Trail of Mandrills

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© PHOTOS: C. DELHAY/CNRS PHOTOTHÈQUE

05

BY LAURE CAILLOCE

The "hunt," so to speak, is on. The Mandrillus project team, who has left its research station located in Bakoumba (Southern Gabon) a few kilometers away, parks its jeep at the edge of the forest in Lékédi Park. It's just before sunrise, on an April morning in 2013.

Anesthetic darts and blowpipes are prepared for catching the mandrills, together with syringes, scales, a portable ultrasound, and a host of other essential equipment. Everything needs to be ready before the mandrills come down from the trees. Once awake, these primates, endemic to central Africa, quickly move to other parts of the equatorial forest. Losing sight of them in such a dense environment would mean hours of tracking to find their trail again. The researchers know only too well: day in, day out, from dawn to dusk, they have spent the past 18 months monitoring a group of about a hundred individuals.

It is the first time that such a population has been studied in the wild, and the scientists are anxious to have some of their many questions answered: how is the group structured? What are the determinants of the relationships between individuals? Does a mandrill's health depend on the strength or quality of its social network? How do individuals behave toward parasitized conspecifics? "While our capture campaigns provide valuable information on the morphology and health status of each individual, 90% of our work consists of behavioral observation," explains Marie Charpentier, behavioral ecologist at the CEFE,[1] who founded this long-term project in early 2012.

If, in the first months of the study, the scientists were only able to recognize about 20 of the mandrills, they can now identify 75 with the naked eye. "We look at which individuals stay together, groom or defend each other from aggressive third parties," explains the researcher. "Automated data will also be available soon, as the mandrills are being fitted with radio-transmitter collars to record which group

01 Number 33, a non-dominant male, is the females' favorite in the mandrill group studied.

02 03 Recruited by Marie Charpentier (with the binoculars) in the town of Bakoumba, these field assistants observe the mandrills every day. One of them uses a GPS antenna to locate three females fitted with radio collars.

04 05 Social relationships between the individuals in the group, such as the behavior of these females with their young, are under constant study.

06 The animals are knocked unconscious with anesthetic darts.

07 08 Ultrasound can measure the thickness of the mandrills' intercostal muscles.

09 Once all the mandrills are fitted with radio collars, the researchers will be able to know which individuals are close to one another.

10 Male mandrill canines can measure up to 5 centimeters.

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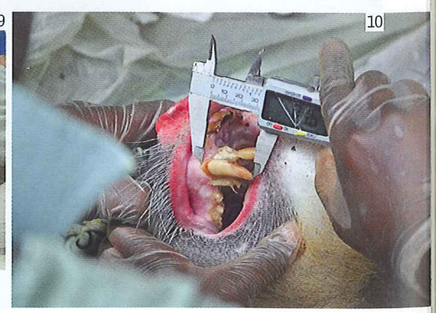

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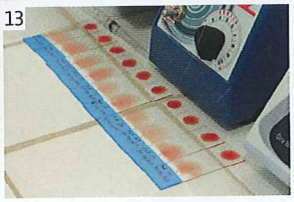

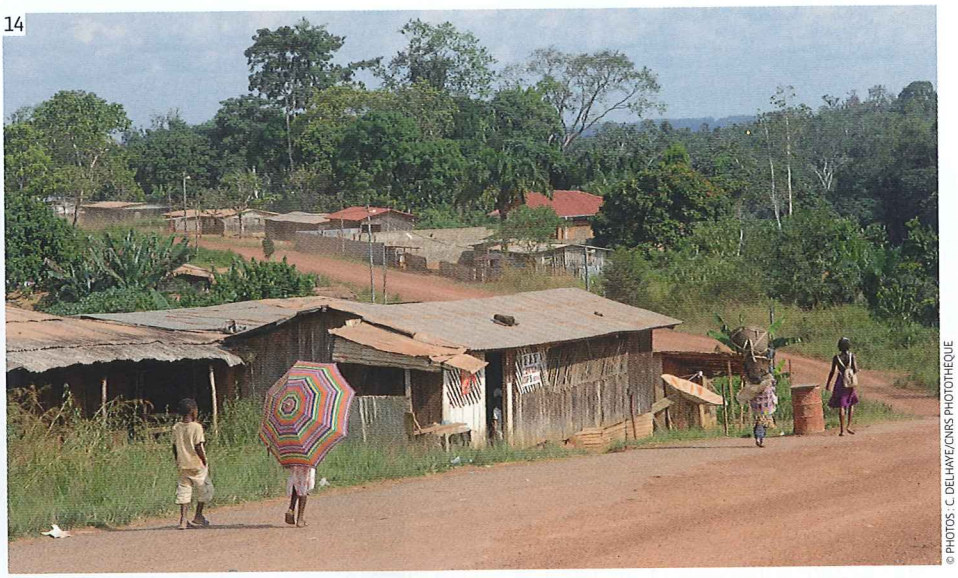

© PHOTOS - C. DELHAYE/CNRS PHOTOTHEQUE

members stick together." However impressive, this setup is all the more justified since little is known about these primates. Until now, such detailed studies on mandrills' social behavior only targeted individuals living in captivity.

The team's observations reveal a matrilineal structure with migrant males, as in baboons and macaques. Mandrill groups are mostly made up of females, with temporary inclusion of adult and adolescent males, only one of which is dominant. "Social connections within a group seem to be mainly determined by family ties. Females with the same mother stick together, but we suspect that individuals with the same father also have close relationships, something genetics can help us confirm." For this purpose, fecal samples are also collected during observation days in the forest. DNA is extracted from these samples to establish the family relationships of the group members.

Another nagging question for Charpentier is kin recognition: "Though it seems easy for individuals with the same mother to recognize one another—as they maintain special ties with her—this appears more difficult for those with the same father, as males do not participate in the rearing of the young and often leave the group after a short time. How do such relatives recognize one another? By their voice? By their smell?"

This early April morning, the team will not only take blood or urine samples from the mandrills they capture, they will also record their vocalizations and take odor samples by rubbing pieces of cotton on their skin. One thing is certain, until Charpentier and her team find the answers they are looking for, Lékédi Park will be the destination of many more expeditions.

01. Centre d'écologie fonctionnelle et évolutive (CNRS / UM2 / UM1 / Université Paul-Valéry / Montpellier Sup Agro / EPHE / Cirad / IRD / Inra).

11 12 Sylvère Mboumba, the research station's manager, analyzes fecal samples to detect gastro-intestinal parasites and measure the stress hormone cortisol.

13 Mandrill blood samples are also tested for parasites.

14 Bakoumba, a few kilometers from Lékédi Park, serves as a base camp for the researchers.

15 From their observations, the researchers can now identify 75 individuals with the naked eye.

A **photo** report and the **documentary** *Bakoumba, Forest of Mandrills,* can be viewed on the online version of the magazine:
› www.cnrs.fr/cnrsmagazine

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