ONE

Emile

BETWEEN THE LOW-LYING MOUNTAINS of southwestern Guinea, the small village of Meliandou sits atop a remote and barren hillside, overlooking coffee plantations and rice paddies. Residents live in thirty-one cinder-block homes with makeshift shutters, some painted green, some topped with corrugated tin roofs, separated by narrow unpaved alleys, connected by laundry lines on which shirts and sheets dry under the hot African sun. They are connected to the outside world by a single, bumpy red dirt road, and a lone bridge that is so rickety that the few visitors who venture so far out into the hills tend to test it before rolling their cars over the wood planks. Villagers commute by car and bus to nearby towns to sell spinach, corn, and bananas. In a region of remote outposts of human existence, separated by miles of track through the jungle, Meliandou stands out. It is so isolated that the only working well in the area is across the bridge. Its name, in the local Kissi language, means "this is as far as we go."

Meliandou sits in the most insular part of the three countries that make up the southwest coast of West Africa. The village is just a few miles from where those three countries—Guinea, Sierra Leone, and Liberia—meet at a single point.

The children of Meliandou, far up in the Guinean mountains, contented themselves by playing in the lush nature that surrounded them. A hollow tree on the edge of the village was particularly appealing. It was home to a colony of fruit bats; if the kids timed their swipes just right, they could sometimes catch a bat and grill it over a small fire, adding a little protein to their diets.

The tree sat at the edge of the forest, through a field of waist-high grass about fifty meters from Emile Ouamouno's home, on a path villagers used to access a nearby stream.[1] One day in late November or early December 2013, the two-year-old wandered near the tree, perhaps as his mother worked nearby, just to play. Maybe a bat bit Emile. Maybe he touched some guano, then touched his eye. Whatever happened, in a single moment, a microscopic particle, a fraction of the size of a human blood cell, entered Emile's body. It attached itself to one of his cells, and a sequence of ribonucleic acid, RNA, began replicating. It made dozens of copies of itself, then hundreds, then millions.

Days later, Emile developed a fever. He began vomiting. There was blood in his stool. His mother could do nothing but care for her son as he deteriorated, quickly, in her arms. On December 6, not even three years after he was born, Emile died. Scientists from the World Health Organization would later conclude Emile had been the first victim of that microscopic particle called Ebola.[2] Today, his body lies beneath an unmarked grave, identified only by the stones placed atop it. Villagers, afraid of the silent and invisible killer unleashed in their midst, burned the tree that housed the bats.

How the Ebola virus actually spreads from animal hosts to humans—a process known as zoonosis—is not exactly clear to scientists. Before it reaches a human body, the virus lives within another species peacefully, without causing symptoms. That other species that houses a virus is called the reservoir host, and just about any species can be a reservoir host for something: fleas on rats carried the bubonic plague, mice carry hantavirus, mosquitoes carry the Zika virus and chikungunya, two diseases currently racing across the planet. But when it comes to Ebola, scientists still do not know with complete certainty what animal carries the virus when it is not infecting humans. The reservoir host is probably a bat, though no one can say for sure exactly which species of bat is at fault. Investigators who visited

Meliandou after the fact captured eighty-eight bats, most of them Angolan free-tailed bats, the same species that lived in the hollowed out tree; none showed signs of the virus.

But how Ebola spreads from human to human is abundantly clear: billions of virus particles infest every drop of an infected victim's bodily fluid. The slightest contact can lead to infection. When another person touches bodily fluid, the virus spreads, either through tiny abrasions in the skin or mucus membranes, like the eye or mouth. And as the virus spreads through one host, it creates the conditions for its own leap to another host. As Ebola takes hold in a body, that person becomes more and more contagious; at the moment of death, a body is at its most contagious, like a land mine ready to explode, organic shrapnel endangering anyone within reach.

As Emile worsened, he became more and more of a risk to those around him. He died in his grandmother's house, across the village from the home where he had spent his short life, where he had shared a bed with his pregnant mother. She became ill just days later; she gave birth to a stillborn baby a few days after that, and within a week of her son, she too was dead. Emile's three-year-old sister broke out in a fever on Christmas Day. She died four days later.

It did not take long for Emile's grandmother to feel sick, too. She did not trust the shaman who had tried traditional healing practices, with no effect, on her daughter and grandchildren, so she traveled to Gueckedou, the closest city of any size—home to 80,000 residents—which sits right at the border with Liberia and Sierra Leone. There, the grandmother stayed with a friend, a nurse who worked in the city's hospital. Days of treatment did not reverse her symptoms, so she returned to Meliandou, where she became the fourth victim.

Cholera and other diseases killed frequently in Meliandou. But no one in the village had any idea what was ravaging Emile's family. Some believed the family was cursed by the gods, or by someone they had wronged. Some believed the entire village was cursed.

The Ebola virus disease has infected humans in dozens of towns and villages across Africa since it was first discovered in 1976. Many of those outbreaks come and go, raging and burning themselves out in remote corners of jungle so fast that those who are infected do not have the chance to seek medical treatment in a larger community, where the virus could

jump to a new host. So, too, might the outbreak in Meliandou have ended, once the first victims passed away.

But while Meliandou may be remote, it is tied tightly enough to neighboring villages, through generations of tribal relations, that people nearby knew Emile's grandmother. Hundreds of mourners came to her funeral. Ritual demands that those mourners prepare the body for burial, touching her infected body and washing her for the afterlife. The funeral offered the virus its best opportunity to leave Meliandou. It leapt to the grandmother's sister, who took it with her to her village, Dawa. She died January 26, four weeks after her sister; a day earlier, another Dawa villager came down with a fever and bleeding.

Jean Claude Kpoghomou, a doctor in another small village called Tekolo, was nervous. He had heard about the deaths in Meliandou, caused by a strange fever that looked to him like cholera. Diseases like cholera, malaria, and dysentery were common in West Africa, deadly but treatable, more cause for concern than panic. Two years before, a major cholera outbreak had claimed lives in the Forest Region, and Kpoghomou worried it might be back. On January 24, he called a superior to report that cholera had returned. That superior called his own boss at a health office in Gueckedou, who in turn called a regional health director in Nzerekore. The director alerted Guinea's Ministry of Health in Conakry.[3] It was their first hint that something was wrong. A small team of Guinean and World Health Organization (WHO) officials visited Meliandou to investigate. They too believed they were looking at cholera. The idea that they might be facing Ebola, the deadliest virus known to mankind, never occurred to them. As far as anyone knew, Ebola was a disease of Central African countries like Uganda and the Democratic Republic of the Congo. It had never been found in Guinea or anywhere close to Guinea.

"Part of the difficulty [in identifying the Ebola virus] was that the likely suspected cause of the outbreak was cholera," Chris Dye, WHO's director of Strategy, Policy and Information recalled later. "If you go into the investigation with the view that you're looking for a bacterial infection like cholera, you very well may miss a virus like Ebola."

At the same time, the virus took another route out of Meliandou, when the nurse who had hosted Emile's grandmother became sick. The nurse traveled to Macenta, another town of almost 90,000 people, to see a friend

who was a doctor. The doctor lived in a small home with his son, who shared a room with the nurse for a single night. The next day, the nurse visited Macenta's hospital. In the waiting room, he collapsed and died.

Months later, in a report published in the *New England Journal of Medicine*, thirty-one scientists identified the nurse, clinically referred to as S14, or the fourteenth suspected case of Ebola, as the tinder that turned a small spark in a remote corner of Guinea's Forest Region into a roaring flame. In the six days between his first symptoms, on February 5, and his death, on February 10, he helped the disease travel through several districts in Gueckedou, then to Macenta.

The doctor who hosted the nurse was the next victim, and the virus's next potential path to a larger population. He was stunned at the nurse's death—and perhaps more shocked when he himself came down with a fever. The doctor alerted the regional health authorities in Nzerekore, the second time they were warned that some deadly disease was present. The doctor left Macenta for Conakry; had epidemiologists known the Ebola virus was traveling toward an impoverished city of a million people, panic would certainly have set in. But the virus's first effort to reach Conakry died, along with the doctor, somewhere along the bumpy dirt roads that lead through the rural counties. His body was taken to Kissidougou to be buried. Soon the first cases began to appear in Kissidougou.

The doctor's son, who had spent a night in the same room as the infected nurse, developed his own symptoms. So did a colleague of the doctor's who worked in the hospital's lab. Then a nurse and the doctor's two brothers. All five died.

Back in Gueckedou, Dr. Alexis Traore watched his hospital fill up fast with patients experiencing the same symptoms: vomiting and diarrhea. The vast majority did not recover. Traore was the first medical professional in Guinea to begin to suspect that they might not be dealing with another cholera epidemic. The patients he was seeing all had fevers, a symptom that does not occur with cholera.

But when the doctor ordered tests, his hypothesis appeared incorrect. Cholera is rampant in West Africa, and early treatment is essential to survival. Therefore, the tests on hand at the hospital in Gueckedou were designed to sound alarms at even the smallest hint of the disease. That allowed the earliest possible warning, to facilitate faster treatment. It also

resulted in false positives. Tests on seven of the nine patients under Traore's care were positive for cholera.

The death of the doctor in Macenta and the spread of the mystery illness into Kissidougou shook the staff at the regional health office in Nzerekore. But by the time they reported the outbreaks to the Ministry of Health in Conakry, nearly thirty people had died in at least eight cities and towns. Finally, Guinean officials asked for help from the World Health Organization, based in Geneva. Those officials began at step one of any medical crisis: tracking those who had come into contact with the last known victim in an attempt to re-create the path of contagion. The process, one of the most elemental in the practice of epidemiology, is called contact tracing.

Within days, the tracing led the first WHO investigators from the nurse who died in Macenta to the outbreak at Traore's hospital in Gueckedou. It was the first hint that the two clusters were somehow connected. WHO officials began to suspect they were dealing with a hemorrhagic fever—though once again, they settled on the wrong answer: Lassa.

Lassa fever is better known and better understood than Ebola. It is endemic to West Africa, where it is transmitted from rats to humans. First detected by Western scientists in 1969, when two missionaries died in the town of Lassa, Nigeria, it infects between 100,000 and 300,000 people every year. Of those, about 5,000 die. Those who are lucky experience only a mild fever, a headache, and pronounced weakness as the virus runs its course. Those who are not so lucky—about one in five patients—experience vomiting, facial swelling, and even hearing loss. The most unlucky will die within two weeks of multiple organ failure.[4]

The Lassa diagnosis made sense, more sense than cholera. In some areas of Sierra Leone and Liberia, between 10 percent and 16 percent of all patients admitted to hospitals each year test positive for Lassa. When word reached Esther Sterk, an epidemiologist in Geneva with Médecins Sans Frontières (MSF)—known in the United States as Doctors Without Borders—on March 14 that a mysterious disease was killing people in the Forest Region of Guinea, she initially assumed Lassa had reared its head. She forwarded a report describing the symptoms to Michel Van Herp, MSF's top hemorrhagic fever epidemiologist.

But Van Herp, who had spent time on the ground in Africa responding to outbreaks of all kinds of nasty bugs, wondered if something else was killing Guinean villagers.

"It is definitely a hemorrhagic fever," Van Herp told his colleagues. "We must really take into consideration that it is worse than Lassa. I think it's Ebola."[5]

Van Herp had made the leap no one else in Geneva had: the virus that was beginning to spread in West Africa might be something altogether new for the region. No one in the area—not the medicine man in Meliandou, not the doctor in Macenta, not Traore in Gueckedou, not even Ministry of Health officials in Conakry—had ever seen Ebola before. Every previous outbreak had happened in Sudan, the Democratic Republic of the Congo, Gabon and Uganda. Those countries were 2,000 miles away from Guinea, a virtual world apart.

Around the same time, the same reports reached Dr. Pierre Formenty. Formenty is one of the world's top Ebola experts, a WHO epidemiologist who had spent two decades fighting the worst infectious diseases as they broke out in remote corners of the globe. That March he was in the Democratic Republic of the Congo at a three-day training session to teach medical professionals how to take blood samples from suspected Ebola patients. E-mails from colleagues at WHO, describing the symptoms in Guinea, said that transmission of the new disease had occurred after funerals, when the deceased were washed and buried according to local custom.

It is not possible, Formenty knew, to transmit Lassa fever after death. He ruled out Marburg, another hemorrhagic fever similar to Ebola, as the root cause of the outbreak. Marburg's reservoir host, the animal in which it rests until it finds a human carrier, is the Roussettus bat, which lives in colonies in caves, and most people infected by Marburg come into contact with the disease while mining those caves. The mining industry in Guinea is based on open-cut pits, which are not good habitats for large Roussettus colonies. Postmortem transmission of a hemorrhagic fever in an area ill-suited to Marburg suggested only one thing to Formenty: Ebola.[6]

A few days later, a team of WHO scientists and Ministry of Health officials traveled to the Forest Region from Conakry to trace contacts as far back as they could. The path led them, eventually, down that single unpaved

road, into Meliandou. For the first time, they identified Emile as the initial victim.

As the WHO team traced contacts backward to Meliandou, they discovered other branches of the disease radiating out from the tiny village, across international lines. Two weeks earlier, on March 3, a thirty-seven-year-old woman named Sia Wanda Koniono had died after suffering symptoms identical to the others. Koniono had come from a village across the border in Sierra Leone. A second woman still in Sierra Leone, Koniono's daughter, had also taken ill. An in-law, Kumba Yaya, had just died in a hospital there.[7]

Another woman, Finda Tamba, had left Guinea when she fell ill, to seek treatment at a hospital in Foya-Borma in neighboring Liberia. As in Guinea, Liberian medical officials had no idea what Ebola was and no idea how to protect themselves. Tamba died on March 20. Her sister, Tewa Joseph, soon became ill.[8]

Faced with mounting evidence that a hemorrhagic fever was burning in remote rural corners of three countries, the international medical community mobilized. MSF, often the first nongovernmental organization to land in a danger zone, deployed three emergency teams, one from neighboring Sierra Leone, one from Geneva, and one from Brussels. The first team arrived on-site on March 18. They began collecting blood samples from victims of the outbreak. They wrapped the samples in three layers of protective materials designed to absorb any spills. Those samples left Guinea through Conakry on March 21, in the cargo hold of an overnight Air France flight bound for Paris.

The samples then made their way to two labs, one at the Institut Pasteur in Paris, and one in Lyon that could also test for hemorrhagic fever. Formenty called the lab in Lyon to ask them to test the samples for Ebola.[9]

The following morning, Sylvain Baize, an infectious disease expert at the Institut Pasteur, had identified a virus family called filoviruses in the samples, though he could not be certain exactly what species of virus was present. He alerted the World Health Organization, then went back into the lab. By that evening, he had found evidence of Ebola.[10] Hours later, on March 22, 2014, nearly four months after Emile had died, WHO officially declared it had confirmed the presence of Ebola in Guinea. They did not warn of potential cases that had yet to be confirmed in Liberia or Sierra

Leone; it would be months before they confirmed those countries were infected.

The first situational report issued by WHO, three days later, showed just how quickly the virus had spread: it showed eighty-six total cases of Ebola in Guinea and fifty-nine deaths.

By the time the world knew that the flame spreading across the Forest Region was Ebola, eight villages and cities were on fire. And while earlier outbreaks quickly ebbed for lack of new hosts, this epidemic was about to find new fuel. A few days earlier, the same day the Ebola-tainted blood left Conakry for Paris, a trader who made his living exchanging goods in the Forest Region arrived in Conakry.[11] He was not feeling well; he had a fever.