



‘A frightening and fascinating masterpiece of science reporting
that reads like a detective story’ Walter Isaacson

EBOLA

THE NATURAL AND HUMAN HISTORY

DAVID QUAMMEN

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About the Book

In 1976 a deadly virus emerged from the Congo forest.

As swiftly as it came, it disappeared, leaving no trace.

Over the four decades since, Ebola has emerged sporadically, each time to devastating effect. It can kill up to 90% of its victims. In between these outbreaks, it is untraceable, hiding deep in the jungle. The search is on to find Ebola's elusive host animal. And until we find it, Ebola will continue to strike.

Acclaimed science-writer and explorer David Quammen first came near the virus whilst travelling in the jungles of Gabon, accompanied by local men whose village had been devastated by a recent outbreak. Here he tells the story of Ebola, its past, present and its unknowable future.

About the Author

David Quammen is an author and journalist who travels widely to some of the remotest corners of the earth. He writes for a broad range of publications such as *Harper's*, *Esquire*, *The Atlantic*, *Rolling Stone* and the *New York Times*, and is a Contributing Writer at *National Geographic*. His journalism has won him three National Magazine Awards, and he is the recipient of the Academy Award in Literature from the American Academy of Arts and Letters.

Quammen is the author of several acclaimed science natural history titles, as well as a number of novels. His most recent book, *Spillover*, from which this book is largely extracted, is an exploration into how some of the world's most deadly viruses crossed over from non-human animals into humans. *Spillover* won the Science and Society Book Prize, from the National Association of Science Writers, in the United States, and the Society of Biology Book Award.

ALSO BY DAVID QUAMMEN

NON-FICTION

Spillover

The Reluctant Mr. Darwin

Monster of God

The Song of the Dodo

ESSAYS

Natural Acts

The Boilerplate Rhino

Wild Thoughts From Wild Places

The Flight of the Iguana

FICTION

Blood Line

The Soul of Viktor Tronko

The Zolta Configuration

To Walk the Line

EDITED

On the Origin of Species: The Illustrated Edition

The Best American Science and Nature Writing 2000, with
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Ebola

*The Natural and
Human History*

DAVID QUAMMEN

INTRODUCTION

DURING THE SPRING and summer of 2014, people around the world have watched with concern, appalled fascination, sympathy, and no small amount of personal fear as an outbreak of Ebola virus disease (EVD) has unfolded and spread among three troubled countries in West Africa—Guinea, Liberia, Sierra Leone—and then made a disconcerting leap, by airplane, to Nigeria. Having smoldered for months, killing victims by the dozens, it flamed in August of that year and began stacking up mortalities, week by week, in the hundreds. By then it had become the worst Ebola outbreak in the history of this peculiar, disconcerting disease. The story of the 2014 outbreak was so rivetingly awful that it competed for headline space with contemporaneous events in Syria, Ukraine, and the Gaza Strip.

But an outbreak of Ebola is very different from the dire realities of politics and war: more ineffable, more spooky. Ebola virus is invisible, except through an electron microscope or by way of its pathogenic effects. It is impersonal. It is apolitical. It seems to kill like the tenth plague of Egypt in Exodus—the one inflicted by an angel of death.

This last impression is misleading. Ebola is no death angel; it's mystifying but not preternatural. It's just a virus—albeit a virus that, inconspicuous elsewhere, tends to be hellaciously destructive when it gets into a human body.

Every newly emerging infectious disease, EVD included, begins as a mystery story. The mysteries are several. What's causing the sudden explosion of misery and death?

If it's a virus, what sort of virus? Has science ever seen anything like it? Where has it come from? Any virus must abide in a living creature, in order to replicate and survive over time, so ... which creature? And how has it moved from that creature into humans? Can the new virus be controlled? Can it be battled with pharmaceutical therapies or vaccines? Can it be stopped? Or is this outbreak going to be the Next Big One, a catastrophic pandemic, destined to sweep around the world and kill some sizable fraction of the human population, like the Black Death of the fourteenth century or the influenza of 1918? Disease scientists and public health officials are the intrepid investigators, the Sam Spades and Philip Marlowes and Detective Chief Inspector Jane Tennisons, who muster out to address these mysteries. In the case of Ebola, they have solved some but not all.

This little volume, excerpted and adapted from my 2012 book *Spillover*, with some additional material, is an attempt to place the 2014 West Africa outbreak—and a separate independent outbreak, which has recently flared in the Democratic Republic of the Congo—within a broader context that makes sense of those mysteries and their partial solutions. My offering here is merely a partial view of the history and science of Ebola, and a somewhat personal one, which has grown from my own modest travels through Ebola habitat, and from a chance encounter in the forest with two men who had seen the virus at its worst, killing their friends and loved ones. (To be clear: I myself have never had that harrowingly instructive experience, and I have not visited West Africa to observe or report on the current outbreak.) I also include here some treatment of Marburg virus, for two reasons: because it is closely related to Ebola virus, within the filovirus family, and because certain important questions that remain unanswered about Ebola virus *have* been answered for Marburg, as you'll see, suggesting valuable (though guarded) inferences about Ebola itself.

Ebola virus disease has been mostly an African affliction (so far), and although it's unique, it is no anomaly. It just represents an especially dramatic version of a global phenomenon.

Everything comes from somewhere, and strange new infectious diseases, emerging abruptly among humans, come mostly from nonhuman animals. The disease might be caused by a virus, or a bacterium, or a protozoan, or some other form of dangerous bug. That bug might live inconspicuously in a kind of rodent, or a bat, or a bird, or a monkey, or an ape. Crossing by some accident from its animal hideaway into its first human victim, it might find hospitable conditions; it might replicate aggressively and abundantly; it might cause illness, even death; and in the meantime, it might pass onward from its first human victim into others. There's a fancy word for this phenomenon, used by scientists who study infectious diseases from an ecological perspective: *zoonosis*.

That's a mildly technical term, unfamiliar to most people, but it helps clarify the biological complexities of swine flu, bird flu, SARS, West Nile fever, emerging diseases in general, and the threat of a global pandemic. It helps us comprehend why medical science and public health campaigns have been able to conquer some fearsome diseases, such as smallpox and polio, but are unable to conquer others, such as dengue and yellow fever. It's a word of the future, destined for heavy use in the twenty-first century. A zoonosis is an animal infection that's transmissible to humans.

Bubonic plague is a zoonosis. All strains of influenza are zoonoses. So are monkeypox, bovine tuberculosis, Lyme disease, Marburg, rabies, Hantavirus Pulmonary Syndrome, and a strange affliction called Nipah, which has killed pigs and pig farmers in Malaysia, as well as people who drink date palm sap (sometimes contaminated with the virus from bat droppings) in Bangladesh. Each of them reflects the

action of a pathogen that can cross into people from other species. This form of interspecies leap is common, not rare; about 60 percent of all infectious diseases currently known either cross routinely or have recently crossed between other animals and us. Some of those—notably rabies—are familiar, widespread, and still horrendously lethal, killing humans by the thousands despite centuries of efforts at coping with their effects, concerted international attempts to eradicate or control them, and a pretty clear scientific understanding of how they work. Others are new and inexplicably sporadic, claiming a few victims or a few hundred in this place or that, and then disappearing for years.

Smallpox, to take one counterexample, is not a zoonosis. It's caused by the variola virus, which under natural conditions infects only humans. That helps explain why a global campaign mounted by the World Health Organization (WHO) to eradicate smallpox was, as of 1980, successful. Smallpox could be eradicated because that virus, lacking the ability to reside and reproduce anywhere but in a human body (or a carefully watched lab animal), couldn't hide.

Zoonotic pathogens can hide. That's what makes them so interesting, so complicated, and so problematic. These pathogens aren't *consciously* hiding, of course. They reside where they do and transmit as they do because those happenstance options have worked for them in the past, yielding opportunities for survival and reproduction. By the cold Darwinian logic of natural selection, evolution codifies happenstance into strategy.

The least conspicuous strategy of all is to lurk within what's called a reservoir host. A reservoir host is a species that carries the pathogen, harbors it chronically, while suffering little or no illness. When a disease seems to disappear between outbreaks, its causative agent has got to be *someplace*, yes? Well, maybe it vanished entirely from planet Earth—but probably not. Maybe it died off throughout

the region and will only reappear when the winds and the fates bring it back from elsewhere. Or maybe it's still lingering nearby, all around, within some reservoir host. A rodent? A bird? A butterfly? A bat? To reside undetected within a reservoir host is probably easiest wherever biological diversity is high and the ecosystem is relatively undisturbed. The converse is also true: Ecological disturbance causes diseases to emerge. Shake a tree, and things fall out. Capture a bat for food, and you might catch something else too. Butcher a chimpanzee, to feed your family or your village, and who knows what grisly surprises might emerge. The event of transmission, when a pathogen passes from one kind of host to another, is called spillover.

Now you're equipped with the basic concepts. Here's the starting point for all that follows: Ebola is a zoonosis.

1

ALONG THE UPPER Ivindo River in northeastern Gabon, near the border with the Republic of the Congo, lies a small village called Mayibout 2, a sort of satellite settlement, just a mile upriver from its namesake, the village of Mayibout. In early February 1996, this secondary community was struck by a horrific and bewildering chain of events. Eighteen people in Mayibout 2 became suddenly sick after they participated in the butchering and eating of a chimpanzee.

Their symptoms included fever, headache, vomiting, bloodshot eyes, bleeding from the gums, hiccupping, muscle pain, sore throat, and bloody diarrhea. All eighteen were evacuated downriver to a hospital in the district capital, a town called Makokou, by decision of the village chief. It's less than fifty miles as the crow flies from Mayibout 2 to Makokou, but by pirogue on the sinuous Ivindo, a journey of seven hours. The boats bearing victims wound back and forth between walls of forest along the banks. Four of the evacuees were moribund when they arrived and dead within two days. The four bodies, returned to Mayibout 2, were buried according to traditional ceremonial practice, with no special precautions against the transmission of whatever had killed them. A fifth victim escaped from the hospital, straggled back to the village, and died there. Secondary cases soon broke out among people infected while caring for the first victims—their loved ones or friends—or in handling the dead bodies. Eventually thirty-one people got sick, of whom twenty-one died: a case fatality rate of almost 68 percent.

Those facts and numbers were collected by a team of medical researchers, some Gabonese, some French, who reached Mayibout 2 during the outbreak. Among them was an energetic Frenchman named Eric M. Leroy, a Paris-trained virologist and veterinarian then based at the Centre International de Recherches Médicales de Franceville (CIRMF), in Franceville, a modest city in southeastern Gabon. Leroy and his colleagues identified the disease as Ebola hemorrhagic fever (a name now replaced by Ebola virus disease, reflecting the recognition that bloodiness is not quintessential) and deduced that the butchered chimpanzee had been infected with Ebola. “The chimpanzee seems to have been the index case for infecting 18 primary human cases,” they wrote.¹ Their investigation also turned up the fact that the chimp hadn’t been killed by village hunters; it had been found dead in the forest and scavenged.

This was one piece of evidence, with much more to follow, that chimps and gorillas, like humans, are highly susceptible to Ebola. And if they suffer misery and speedy death from the virus, Leroy and other researchers reasoned, then they cannot be its reservoir host, the creature in which it abides inconspicuously over the long term. Instead, the dead chimp at Mayibout 2 was a clue. This sort of occasional role of an ape as an intermediate victim, catching the virus, passing it to humans, could perhaps help lead toward identification of the reservoir host itself. Was it some animal, large or small, with which chimpanzees come into contact?

Four years later, I sat at a campfire in deep forest near the upper Ivindo River, about forty miles due west of Mayibout 2. I was sharing dinner, from a big pot, with a dozen local men who were working as forest crew for a long overland trek. These men, most of them from villages in northeastern Gabon, had been walking for weeks before I joined them on the march. Their job involved carrying heavy bags through