The Historical Ecology of Malaria in Ethiopia

Deposing the Spirits

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Malaria's Metaphor

A Chess Game or a Square Dance

> At first the disease attacks the head/mind: The person complains that his head hurts. It then spreads to the shoulders and then to the whole body. . . . First one person is struck down, then another. Five, six people in a house even. Not to mention the neighbors. Everyone knows it is the nidad [malaria, lit. "to catch fire"].
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> —Asres, healer/magician (Ethiopia, 1953)

> In each house we were able to find three or four patients who complained of subjective symptoms, such as chilling, severe headaches, sweating, pain in the back . . . high fever . . . muddling delirium with coma, ending in death. . . . Since they are so far away from even the simplest clinic, which means no [way] of saving their lives, they are dying like bees in a smoked hive.
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> —Mogues A., student, Gondar Public Health College (Ethiopia, 1958)

Malaria is an infectious disease like no other. It is a dynamic, shape-shifting force of nature that constitutes Africa's most deadly and debilitating vector-borne disease. During its historical coevolution with humankind, malaria has evaded biomedicine's struggles to eradicate it or control its movement. It has mocked efforts by humans to pursue it through single-stranded tactics: applications of DDT, vaccines, chloroquine tablets, and molecular-level genetic manipulations. Despite biomedicine's efforts to find solutions in one-dimensional panacea, malaria survives as a unique human affliction of ecology that justifies a study of its history and its future that accepts its complexity and its local dynamism as one of its fundamental features. Though its impact has a global scale, all malaria is complex, resilient—and local.

Biomedicine's failures to cope with or "eradicate" malaria to date have, in fact, begged a return to a more comprehensive ecological understanding

of malaria and its transmission. To paraphrase a political metaphor: All malaria is local, and it is a complex tapestry of nature's forces. Moving within this complexity is a disease organism (plasmodium), a vector (an anopheles mosquito), and a host (the human malaria sufferer).

This book's geographic focus is Ethiopia and that country's kaleidoscope of ecological landscapes. In these places of malaria infection there are fits and starts of policy, human tragedy, and a few triumphs of overcoming periodic crises. Ethiopia's history showcases episodes of malaria and even may point the way forward for the larger global battle.

The goal of this book is to tell an engaging story of human disease ecology that resets our understanding of this deadly disease in human, narrative terms. Medical science is a necessary but not sufficient lens from which to understand the disease. *The Historical Ecology of Malaria in Ethiopia* aims to display the human ecology of the disease with an appreciation of the science of landscape change and the dynamics of a vector-borne infectious disease that has been an enduring element of human history. Malaria continues to shape the tropical and subtropical world in terms of its economic burden and human costs—spiritual as well as physical. Malaria persists and will continue to adjust to changes in both the climate and the human condition. Therein lies a story that is intensely human, but also best explained by ecological science. This book is the final research and writing stage of five years of field study, archival research, and laboratory analysis of mosquitoes, parasites, and human agency in the unstable character of malaria affliction. Ethiopia will be the fascinating stage on which the drama unfolds.

Ethiopia is a landscape that reveals malaria's local history, its global implications, and, perhaps, its future. The region's diverse microecologies defined by elevation and rainfall reflect the astonishing varieties of settings where malaria has coevolved with human settlement and environmental change. In areas along Northeast Africa's borders, where lowland river valleys and warm temperatures nurture mosquito habitat year-round, there is endemic malaria within the local people's bodies, within which constant exposure to the parasites has brought an odd kind of acquired immunity. But those immune populations are small and politically isolated in low borderland regions. In highland areas, where most people live, the altitude and cool temperatures have restricted malaria's effects to "unstable," episodic outbreaks—once or twice a decade, but still especially deadly to adults and to young vulnerable people alike. People's limited exposure has made the "shivering fever" only periodic. This means that the vast majority of people have no acquired immunity to the disease and

tend to view it as an affliction of the "other," a disease from outside places and outside forces. In many places Ethiopia's landscapes are in states of transition caused by climate warming, movements of people, and changes in agriculture and land use that invite mosquito populations to shift unexpectedly in species composition or in the abundance of the mosquitoes that are the disease's elusive vectors. Perhaps most importantly, Ethiopia gives us many examples of human landscapes on which malaria plays its deadly game and a lens through which we perhaps can understand its complex strategies as they may appear decades in the future. Malaria may well be a recurrent menace in AD 2060 or for generations thereafter. Or perhaps human medical ingenuity will finally eradicate it globally. But don't bet on it.

To tell the story, we seek a metaphor, or maybe two, to help us imagine a complexity such as malaria's. One such metaphor might be a human-malaria chess game that, over time, becomes a mixing of belief systems and collective behaviors that will shape and describe its causes, prevention, and control. Human science makes a move and malaria responds with a matching move. The end game is control and then eradication. But perhaps a dance metaphor is equally valid, since there is a fluidity of the point and counterpoint between humans and this disease. The human malaria connection is an ever-changing dance, which includes moving forward and back, spinning with partners in tandem or sometimes in opposite directions. Movements of both human beliefs and biological actions. Overlapping meanings. Those belief systems include bioscience and local, preventive behaviors.

One example of changing belief systems in the science world took place in 1880 at a Paris conference when an obscure French colonial army officer named Charles Louis Alphonse Laveran, who had worked in French colonial medical service, presented research about a type of creature—a protozoan—that he believed was the parasite that caused malaria. Laveran had paid his dues as a French army medical officer in malarial colonial Algeria trying to solve the mystery of malaria's cause. After meeting skepticism from science at that first conference, in the next four years Laveran seems to have convinced Louis Pasteur and Italian malariologists about the protozoan cause, and thereby malariology magically merged with germ theory. The earth moved, though it took a quarter century more for bioscience to understand that mosquitoes were the missing link that delivered the infectious agent.[1] But other systems of local knowledge about malaria and its causes existed simultaneously and have continued. Therein lies part of the story.

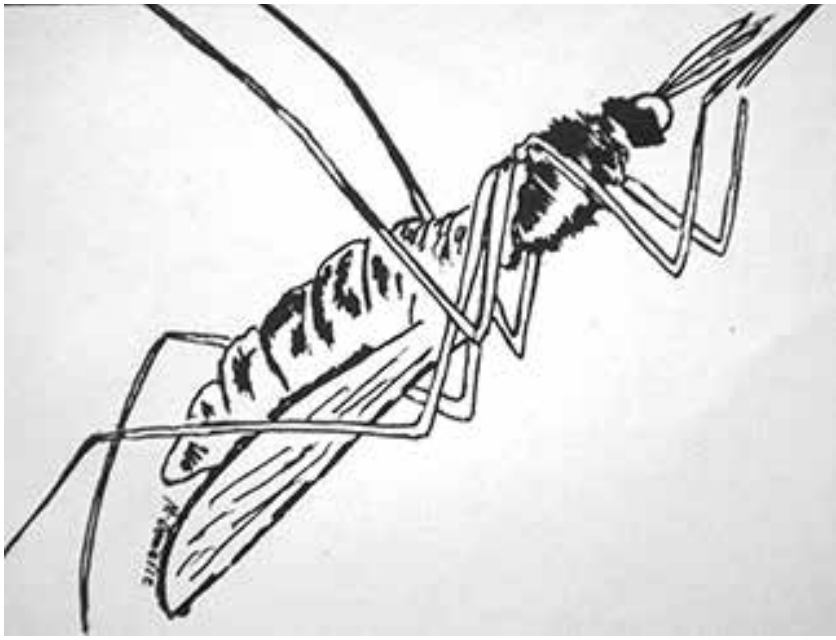

Figure I.1. *An. arabiensis*, Ethiopia's primary vector. (*Source*: Ethiopian Ministry of Health poster. Photo by author.)

Compare that growing European germ theory belief at the turn of the nineteenth century about malaria's cause with that of the Ethiopian healer and freelance cleric named Asres, who understood the ecology of the "shivering fever" (*nidad*) as a product of spirits (*zar*)—perhaps thirty-six or thirty-seven of them, he said, who mischievously afflicted humans at their whim. Asres's belief was closer to that of the dance metaphor, which perhaps was a closer approximation of the swirl of mosquitoes, parasites, and their clever adaptations to humans' steps. But Asres the Ethiopian healer also observed that the fevers occurred in people in some places but not others and to certain types of people but only rarely to others. European travelers quickly learned about malaria from this kind of local knowledge in Ethiopia, which was combined with others' travel experiences in malarial parts of Europe and the Americas. Knowledges merged, swirled, and competed. *Deux a deux* (or "do-si-do," to paraphrase that Cajun dance step).[2]

What kind of mental picture is most helpful in understanding malaria's character as a disease and where a solution for eradication or control might reside? Will malaria's solution derive from the view of complexity

that underlies quantum physics (Nobel Prize winner Werner Heisenberg's famous principle of uncertainty) or from gene mapping and genetic manipulation of mosquitoes in laboratories in Geneva or Davis, California? Biosciences punch and mosquitoes/parasites counterpunch.[3] And so it goes.

The approach I take here is to blend stories of place, of time, and of movement. These stories include personal experiences of affliction and of ideas of faith (science, religion, or some combination of beliefs about the natural world). But the stories also include abject failures, local triumphs, the persistence of human will, and nature's own adjustments. Overall, the story is one of collective will in human science, beliefs, and the adaptive genius of coupled human and natural systems. The players in this game of chess—or this dance—vary over time, but by the end of the twentieth century they included mosquitoes, parasites, lab scientists, fieldworkers, sprayers of DDT and other antimosquito products, farmers, and well-meaning international consultants. The fields of play were not so much chessboards as they were laboratories, puddles with cattle hoofprints, pits dug for harvesting clay, houses without window screens, farm field edges, and so on.

Ultimately, the story of malaria, its past, and its future is one in search of a metaphor for a struggle within ecology, an image that evokes movement, adaptation, and complexity. For that the dance offers the appropriate image, no?

What Is Malaria Ecology?

Malaria is a disease that relies on a complicated series of interactions among a parasite-vector-host triad—plasmodium pathogens (there are five kinds that affect people), anopheline mosquito vectors, and bloody meals that the mosquitoes take from both humans and other animals. Changes in the environment/ecology of any of these factors—of their dance—can influence the disease over time, reducing or promoting the frequency of contacts among these players. Who gets malaria, and when? That complexity is both a fact of nature and an element of meaning essential to human understanding of the disease and its elusive character.

Back to the bioscience for now. Malaria in humans is the result of an infection by any one of five species of the protozoan parasite *Plasmodium*, the life cycles of which are quite similar. Infection begins when a female mosquito injects malaria *sporozoites* into a human's skin as she salivates while probing for blood vessel. These sporozoites soon glide through the skin and enter the bloodstream and then move into the victim's liver. There the protozoan undergoes a phase of asexual multiplication and, as *merozoites*, invade red blood cells to begin another stage of asexual reproduction that repeats itself

almost indefinitely. Then some magic: The parasites transform to stages called *trophozoites* and *schizonts*, then back again to merozoites. Still with me? As parasites become abundant in the bloodstream, they reduce the efficiency of the infected red blood cells to carry oxygen, reduce the number of blood cells, and flood the bloodstream with their waste products. The body's reaction is to increase its temperature—*fever*—giving the affliction we call malaria. Or what most Ethiopians call *nidad* (being afire) or *woba* (fever). Both words connote malaria by describing an obvious symptom. In contrast, European terms for the disease (malaria or paludisme) come from their understanding of malaria's watery locations, referring to pre–germ theory ideas about the disease's most commonly understood wetland ecology. There is a bit of irony there.

Let's stick to the science for now. Meanwhile, the parasites swimming in the bloodstream periodically give rise to male and female cells (gametocytes) that circulate in the victim's blood. It is these sexual stages of the parasite that are critical for transmission from a mosquito when she bites. The gametocytes mate while in the mosquito's gut and then migrate to her salivary glands as she takes the blood. Fertilization occurs and the asexual offspring (sporozoites) wait patiently to be part of the fluid transferred in the bite of an unsuspecting human—or animal—host. This is an obviously complex transaction and torturous journey for those malaria parasites. The blood she takes nurtures her eggs with proteins and lipids, but also deposits the disease agents into that creature that provided—without their knowledge or consent—their blood. She drinks for her species/survival. And the complex, but incredibly persistent cycle of malaria continues. . . . No wonder it took Italy, France, Algeria, British India, Canada, America, and Britain over a century of medical science to figure this sequence out.[4] Mosquitoes and parasites did it as a matter of course, a matter of pursuing the inexorable needs of their own life cycles. Shall we blame them?

Telling the Story: A Matter of Scale

The chapters that follow are essays that move a story—malaria's human and natural ecology—through places and time. They present the malaria game (or dance) from different points of view and moments of discovery that took place in Europe and in Ethiopia. The goal here is to acknowledge the sometimes chaotic sequencing of knowledge, the human terms of belief in the laboratory and in malaria-prone communities.

The story told here opens in the eighteenth century and in a place remote from Europe and America, but central to the Nile Valley, in fact, near the river's source. It progresses to the nineteenth century when naturalists

and medical science in Europe, America, and colonial laboratories groped for answers to the causes of the "fever" and why it occurred in certain places and at certain times and not others. The story then moves ahead to the optimism of the post–World War II world when people believed that travel to the moon and disease eradication were worthwhile goals (and possible ones), and sciences of parasitology, entomology, and economics could bring health and prosperity—eventually. Ethiopia and the ecology of "unstable" malaria is a good place to watch this dance, with its nuances of cultures and geography. Finally, the tale moves to a view from the mosquito herself, who cavorts, dodges, and adapts to the changing human setting around her. At times she seems under our control, but then she breaks loose and inflicts her toll on the elements that sought to control her and the disease she carried. The epilogue considers the moves of the dance and prospects for control, management, or even "eradication" as a final solution.

The choice here is to focus on Ethiopia: at the local scale of river valleys, of people's movements, ideas about illness, and the ecological interactions among mosquitoes, parasites, and people. Malaria makes its moves or dances its dance in local places. We grow dizzy even if we try to measure its effects and numbers globally or on a continental scale. The local nature of the story connects the ideas to real lives and real places that fall outside the numbers.