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978-1-107-05257-4 - The Long Struggle Against Malaria in Tropical Africa
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The Long Struggle Against Malaria in Tropical Africa

This book is the first history of malaria control efforts in tropical Africa. It is a contribution to the emerging subdiscipline of the historical epidemiology of contemporary disease challenges.

The Long Struggle Against Malaria in Tropical Africa investigates the changing entomological, parasitological, and medical understandings of vectors, parasites, and malarial disease that have shaped the programs of malaria control and altered the transmission of malarial infections. It examines the history of malaria control and eradication in the contexts of racial thought, population movements, demographic growth, economic change, urbanization, warfare, and politics. It will be useful for students of medicine and public health, for those who are involved with malaria research studies, and for those who work on the contemporary malaria control and elimination campaigns in tropical Africa.

James L. A. Webb, Jr., is professor of history at Colby College, where he teaches African health history and global health history. He is the recipient of a National Institutes of Health/National Library of Medicine Grant for Scholarly Writing in Biomedicine and Health. His books include *Global Health in Africa: Historical Perspectives on Disease Control* (2013), edited with T. Giles-Vernick, and *Humanity's Burden: A Global History of Malaria* (2009). His articles have appeared in *The Lancet*, *Journal of the History of Medicine and Allied Sciences*, *Journal of African History*, *Journal of World History*, and *Environmental History*.

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The Long Struggle Against Malaria in Tropical Africa

JAMES L. A. WEBB, JR.
Colby College

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In memory of
Philip D. Curtin (1922–2009)
A pioneer in historical epidemiology

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Preface

The Long Struggle Against Malaria in Tropical Africa is about the history of efforts to control malaria in tropical Africa from the beginnings of modern scientific knowledge about the disease in the late nineteenth century to the present. It is intended as a contribution to the emerging subdiscipline of the historical epidemiology of contemporary disease challenges. It investigates the changing medical understandings of the disease and explores the changing entomological and parasitological understandings that have shaped the programs of malaria control and altered the transmission of malaria. It examines the history of malaria control in the contexts of racial thought, population movements, demographic growth, economic change, urbanization, warfare, and politics. The goal is to blend disciplinary approaches and knowledge in a historical epidemiology that will be useful for students of medicine and public health, for those who are involved with malaria research studies, and for those who work on the contemporary malaria control and elimination campaigns in tropical Africa.

The book reveals a long history of well-intentioned malaria interventions that have been allowed to lapse. When a high degree of control over malaria transmission has been lost, epidemic malaria has afflicted age cohorts that had previously been protected by virtue of their acquired immunities. In this sense, the aftermaths of the lapsed projects cannot be accurately characterized as the re-establishment of a prior pattern of transmission or a state of equilibrium. This historical perspective on malaria control has been developed in part through the consultation of archival materials that are not available through PubMed and thus are largely unknown to the biomedical community.

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The Long Struggle Against Malaria in Tropical Africa highlights the central issue of acquired immunity. Early in the twentieth century, European-trained physicians recognized a principal epidemiological difference between the response of nonimmune Europeans and partially immune Africans to malarial infection. The nature, role, and duration of the immunological response after initial infection were of critical importance in shaping malaria interventions. In the interwar period, European assumptions about the significance of acquired immunity helped to determine whether Africans should receive chemical therapies and, if so, the dosage regimens that were appropriate.

The issue of acquired immunity re-emerged in the immediate aftermath of the Second World War, when a highly successful malaria control effort in Freetown, Sierra Leone, lapsed and malaria resurged. It was central to the debates over whether to attempt the eradication of malaria in rural Africa during the build-up to the Global Malaria Eradication Program (GMEP) of the World Health Organization (WHO). It re-emerged again, following the closure of the WHO malaria eradication pilot projects, when resurgent malaria struck some of the populations that had been protected from infection during the life of the pilot projects. It looms as an issue in the context of contemporary campaigns to control or eliminate malaria as commitments in some quarters to sustaining the gains from malaria interventions have waned.

The Long Struggle Against Malaria in Tropical Africa is organized chronologically. "An Introduction to African Malaria" presents some deep historical background on the emergence of African malaria infections and genetic mutations to malarial pressure and provides historical context for understanding the role of acquired immunity in tropical Africa. The first two chapters are focused on the first half of the twentieth century. "European Vulnerability" discusses the arrival of Europeans in tropical Africa and examines the efforts that Europeans took to protect themselves from malaria, including the establishment of separate residential neighborhoods in coastal towns. It discusses the early European projects in mosquito control and the European efforts to improve the health of Africans who worked directly for Europeans in mining enclaves or who lived in urban environments. "African Immunity" introduces African efforts at mosquito control and African antimalarials and explores European knowledge and attitudes toward African malarial infections and treatment in rural environments, including European-owned farms and plantations. The discovery of African adult acquired immunity and African childhood vulnerability raised fundamental

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questions for European colonial medical officers about how to address the "African" malaria problem.

The third chapter, "An Aborted Campaign for Eradication," examines tropical Africa's malaria control and eradication pilot projects during the era of the global malaria eradication campaign (1950–1965) that was overseen by the WHO. The projects, based on the use of synthetic insecticides for indoor residual house-spraying, dramatically reduced malaria in endemic zones but could not sustain the interruption of transmission because mosquito resistance to the insecticides emerged and the projects did not have the full support of African populations in the project zones.

The fourth chapter, "Positive Turbulence," investigates the unexpected malaria dynamics of the early era of independence (1965–1980) in much of former British and French colonial Africa. Independent African governments did not embrace the WHO's vision of pre-eradication malaria programs, preferring to allocate scarce resources to other medical problems, yet deaths from malaria declined. This was in good measure owing to the widespread availability of the inexpensive antimalarial drug chloroquine and to the rapid urbanization of tropical Africa.

The fifth chapter, "Silent Resurgence," explores the last two decades of the twentieth century, when the broad use of chemical therapies selected for drug-resistant malaria parasites and signaled the end of an era. The dramatic decline of the efficacy of chloroquine, in particular, caused malaria death rates in children to climb precipitously. This chapter also examines the rise of synergistic infections with human immunodeficiency virus (HIV) and tuberculosis in the context of the weakening public health infrastructure seen throughout much of Africa.

The sixth chapter, "The Campaign for Elimination," discusses the twenty-first-century commitment to fighting malaria in Africa, one that depends on the continued efficacy of a new class of antimalarial drugs based on the alkaloid artemisinin and on the widespread distribution of insecticide-treated bed nets. It examines the new hopes for eventual eradication that are based on a new paradigm of "elimination." It explores contemporary control efforts in light of the ongoing processes of urbanization and the limitations posed by ongoing civil conflict in Africa.

A final reflection, "Perspectives," compares the difficulties that have been encountered in past malaria control and eradication interventions with those in the current campaigns. It emphasizes the need for those involved in planning contemporary control and eradication programs to design and implement safeguards against the resurgence of malaria.

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This book developed from an earlier research project on the global history of malaria. During an initial research stint at the Wellcome Unit for the History of Medicine at Oxford, I had the good fortune to be introduced to research materials that had been gathered by a team of eminent scholars who had initiated and then abandoned a project on the history of malaria in East Africa. At the Wellcome Unit, I had a first inkling that it might be possible to write a broad historical epidemiology of African malaria. I am grateful to Mark Harrison, the Director of the Wellcome Unit, for facilitating my visits in Oxford.

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I am grateful for a grant for Scholarly Writing in Biomedicine and Health from the National Library of Medicine of the National Institutes of Health. It purchased two semesters of release from teaching that provided the time to write this book.[1]

I have presented some of the arguments in this book at symposia and invited lectures. I would like to thank my hosts for their invitations to visit their institutions and for many illuminating formal and informal sessions: Sharon Abramowitz at the University of Florida, Liliana Andonova at the Graduate Institute of International and Development Studies (Geneva), Lindsay Braun and Melissa Graboyes at the University of Oregon, John Brooke at Ohio State University, Peter Brown and Mari Webel at the Institute for Developing Nations at Emory University, Clifton Crais at Emory University, Elizabeth Eames and Leslie Hill at Bates College, Myron Echenberg at McGill University, Elfatih Eltahir at the Massachusetts Institute of Technology, Tamara Giles-Vernick and Ken Vernick at the Institut Pasteur (Paris), David Gordon at Bowdoin College, Mark Harrison at the University of Oxford, Marcelo Jacobs-Lorena at the Johns Hopkins Bloomberg School of Public Health, Emmanuel Kreike at Princeton University, Alan Magill at the Bill and Melinda Gates Foundation, Anouar Majid at the University of New England, Jim McCann at Boston University, Sheryl McCurdy at the University of Texas School of Public Health in Houston, Rod McIntosh at Yale University, Amanda Kay McVety at Miami University of Ohio, Frank Richards and Amy Patterson at The Carter Center, Clive Shiff and Nina Martin at the Johns Hopkins Malaria Research Institute, Frank Snowden at Yale University, Kerry Ward at Rice University, Bob Wirtz at the Centers for Disease Control, Tim Ziemer at the President's Malaria

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Initiative/USAID, and Patrick Zylberman at the Ecoles des Hautes Etudes en Santé Publique (Paris).

An earlier and abbreviated version of Chapter 3, presented at a Yale symposium, appeared as "Malaria Control and Eradication Projects in Tropical Africa, 1945–1965," in Rick Bucala and Frank Snowden (eds.), *The Global Challenge of Malaria: Past Lessons and Future Prospects* (New York: World Scientific Publishing, 2014).

Over years of research, I have greatly benefited from conversations with malaria specialists who advance the work of governments, non-governmental organizations, international agencies, and university research centers. I have also been deeply enriched by my conversations with historians of medicine, Africanist historians, environmental historians, ecologists, entomologists, parasitologists, physicians, and public health specialists. I am appreciative of countless helpful conversations and challenges to ideas and assumptions. In addition to the scholars mentioned above, I would like to thank Jean-Paul Bado, Sanjoy Bhattacharya, David Bradley, Kent Campbell, Hal Cook, Dana Dalrymple, Monica Green, Rich Hoffmann, Al Howard, Margaret Humphreys, Bill Jobin, Tony Kiszewski, Christian Lengeler, Socrates Litsios, Michael Macdonald, Greg Maddox, Stuart McCook, Louis Molineaux, Pepe Nájera, Randy Packard, Rich Pollack, Andrew Read, Aafje Rietveld, Alan Schapira, and Geoff Targett for their willingness to discuss a wide variety of technical and historical issues. I have learned from them all.

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Glossary

Anophelines: Mosquitoes of the genus *Anopheles*. Some species in this genus are capable of hosting and transmitting the malaria parasites to human beings.

Anthrophily: The propensity of the female of mosquito species to prefer a blood meal from *Homo sapiens sapiens* (human beings) to that from another animal species. These propensities vary among anopheline species and are an important determinant of vector capacity to transmit malaria.

Bionomics: The study of ecological variables that provide insight into an organism's relationship to its environment.

Endophagy: The propensity of the female mosquito to take a blood meal inside a human dwelling.

Endophily: The propensity of the female mosquito to rest inside a human dwelling after taking a blood meal.

Exophagy: The propensity of the female mosquito to take a blood meal outdoors.

Exophily: The propensity of the female mosquito to rest outdoors after taking a blood meal.

Gametocytes: The final stage in the lifecycle of the malaria parasite. The female anopheline mosquito takes up these male and female forms of the parasite when she takes a blood meal from an infected host, and the gametocytes combine sexually in the mid-gut of the mosquito.

Holoendemicity: A state of year-round, heavy transmission of malaria. Malaria in holoendemic zones is stable, with rates of parasitemia

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continuously greater than 75 percent among children under 1 year of age and with spleen rates greater than 75 percent in the 2- to 9-year-old age cohort but low in adults. There is a considerable degree of effective immunity outside of the childhood years.

Hyperendemicity: A state of seasonal, intense transmission of malaria. Malaria in hyperendemic zones is often considered to be stable, characterized by rates of parasitemia continuously greater than 50 percent among children under 1 year of age and with spleen rates continuously greater than 50 percent in the 2- to 9-year-old age cohort and greater than 25 percent in adults. The degree of acquired immunity outside of the childhood years is lower than in holoendemic zones.

Hypoendemicity: A state of low transmission of malaria. Malaria in hypoendemic zones is characterized by rates of parasitemia of 10 percent or less among children aged 2–9 years and with spleen rates of 10 percent or less in the same cohort. The degree of acquired immunity is low.

Mesoendemicity: A state of seasonal, unstable transmission of malaria. Malaria in mesoendemic zones is characterized by rates of parasitemia of between 11 and 50 percent among children aged 2–9 years and with spleen rates of between 11 and 50 percent in the same cohort. The degree of acquired immunity outside of the childhood years is lower than in hyperendemic zones.

Parasitemia: The state of parasitization of the human bloodstream. Asymptomatic infections involve latent parasitemia.

Protozoa: A phylum or group of phyla that contain single-celled microscopic animals with a defined nucleus. The malaria parasites are protozoa (rather than bacteria or viruses).

Quinine: The first disease-specific drug in the western *materia medica*. It is an alkaloid that is isolated from the bark of the cinchona tree.

Sporozoite: The final form of the malaria parasite that develops within the female anopheline mosquito and is injected from the mosquito's salivary glands when she takes a blood meal.

Vector capacity: The ability of the infected female mosquito to transmit the parasite, which is determined by a number of variables, including zoophily. If a female anopheline mosquito infected with a human malaria parasite takes a blood meal from another animal, the sporozoites injected during the blood meal are unable to complete their lifecycle.

Vector competence: The ability of the female mosquito to host a parasite. The lifespans of some anopheline species are shortened after infection by the parasites. Some anopheline species have immune systems that are largely competent to prevent infection by the parasites. Other

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anopheline species have evolved to host the parasites without incurring major fitness costs.

Zoonoses: Diseases that have their origins in nonhuman animal species and that jump species barriers to infect human beings.

Zoophily: The propensity of the female of mosquito species to prefer a blood meal from an animal species other than *Homo sapiens sapiens* (human beings). These propensities vary among anopheline species and are an important determinant of vector capacity to transmit malaria.

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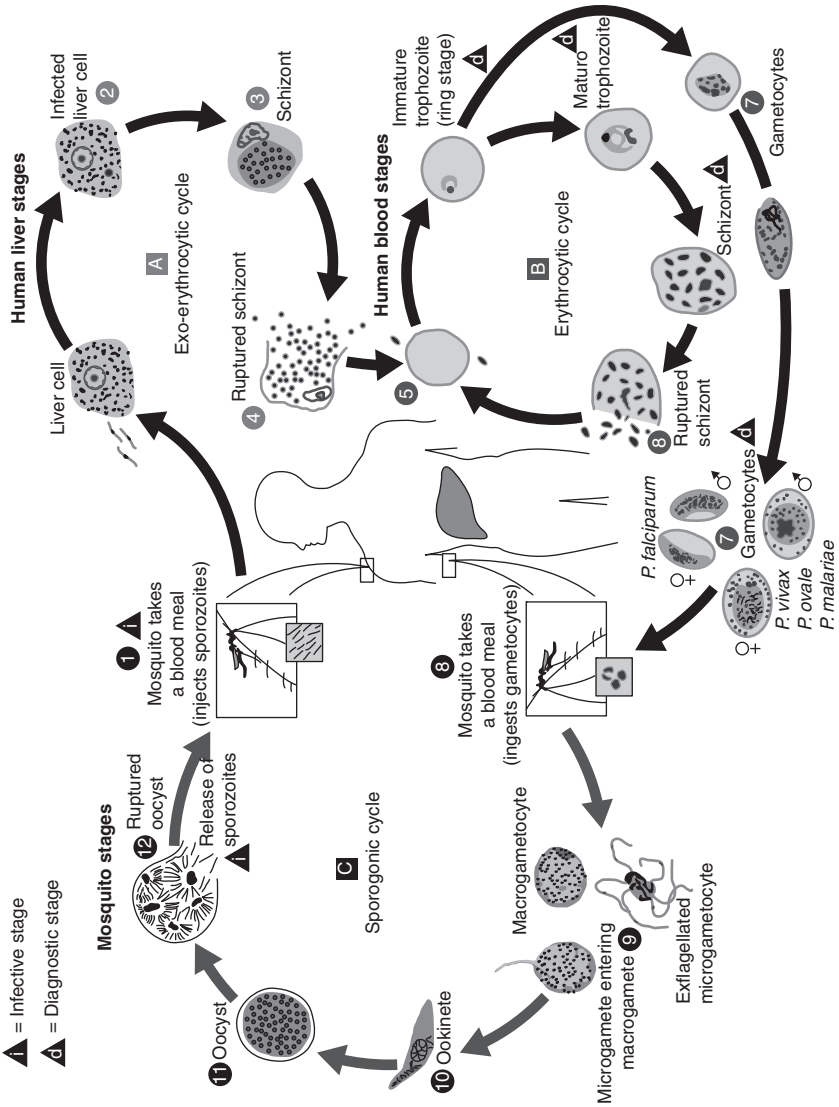

The Lifecycle of the Malaria Parasite
Adapted from the CDC website: http://www.cdc.gov/malaria/about/biology

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