People, Parasites and Places:

Biological and Social aspects of human hookworm infection and eradication in British territories, c.1900-1936

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I confirm that the work submitted is my own, except where work which has formed part of jointly authored publications has been included. My contribution and the other authors to this work has been explicitly indicated below. I confirm that appropriate credit has been given within the thesis where reference has been made to the work of others.

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Abstract

This thesis discusses disease eradication, extinction, and the interactions of parasites, environments and societies through studies of hookworm in Jamaica, the Windward Islands Association (St Vincent, Grenada and St Lucia), and Cornwall in the early 20th century. I take an interdisciplinary and comparative approach, drawing together biology and history, to discuss hookworm (*Ancylostoma duodenale* and *Necator americanus*), a soil-transmitted parasitic worm which feeds on blood and can cause anaemia in its hosts.

Comparisons across the three case studies reveal that the social meanings, understandings and experiences of hookworm varied across and within contexts. Likewise, its biological transmission dynamics and even clinical presentation were shaped by socioecological context. Both environment and socioeconomic institutions affected its prevalence. Hookworm had an ambivalent relationship with colonial and capitalist modernity, with plantations and mines both providing opportunities for it to spread and problematizing its existence, helping drive efforts to induce its extinction. While extinction is generally considered a tragedy of modernity, in the context of hookworm eradication, extinction was conceptualised as a product of social and civilizational progress and as a means to produce a hygienic modernity. However, hookworm was understood differently by different actors, and the eradication programme in Jamaica in particular benefitted from the support of a wide section of Jamaican society. Some saw hookworm treatment as a way to improve their own quality of life, and were persuaded of its effectiveness both by its expulsion of a more visible parasite (*Ascaris*) and biomedical use of a time-honoured folk remedy (*Chenopodium*), while others saw hookworm treatment as a means to improve and modernise Jamaica and its people both physically and morally. Attempts to induce the extinction of hookworm highlight the ambivalent role of modernity in extinction, while also showing that hookworm was shaped by socioecological context, by people and environment in many different ways.

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Abbreviations

95%CI – 95% Confidence Intervals

95%CL – 95% Confidence Limits

Adv Parasitol – Advances in Parasitology

Am J Trop Med Hyg – American Journal of Tropical Medicine and Hygiene

BMC Vet Res – BMC Veterinary Research

BMJ – British Medical Journal

Disp. – Dispatch

Environ Sci Pollut Res Int – Environmental Science and Pollution Research International

Front Vet Sci – Frontiers in Veterinary Science

IDA – Iron-deficiency anaemia

Int J Epidemiol – International Journal of Epidemiology

Int J Parasitol – International Journal for Parasitology

J Allergy Clin Immunol – Journal of Allergy and Clinical Immunology

J Hyg – Journal of Hygiene

J Lab Physicians – Journal of Laboratory Physicians

JA – Jamaica Archives (Spanish Town)

Jam. Gaz. – Jamaica Gazette

JHC – Jamaica Hookworm Commission

JJAS – Journal of the Jamaica Agricultural Society

JPH – Jamaica Public Health

MAGB – Mining Association of Great Britain

MDA – Mass Drug Administration

Med Microbiol Immunol – Medical Microbiology and Immunology

NA – UK National Archives (Kew)

Nat Rev Dis Primers – Nature Reviews Disease Primers

NCM – National Coal Mining Museum for England Library (Wakefield)

NTD – Neglected Tropical Disease

Open Forum Infect Dis – Open Forum Infectious Diseases

Parasit Vectors – Parasites and Vectors

Phil Trans R Soc – Philosophical Transactions of the Royal Society

PLoS Negl Trop Dis – PloS Neglected Tropical Diseases

PNAS – Proceedings of the National Academy of Sciences

PT – Thomas family papers, Penryn Campus Archives and Special Collections (Penryn)

RAC – Rockefeller Archive Center (Sleepy Hollow)

RF – Rockefeller Foundation

Stud Hist Phil Biol & Biomed Sci – Studies in History and Philosophy of Biological and Biomedical Sciences

Sup. *Jam. Gaz.* – Supplement to the *Jamaica Gazette*

Trop Geogr Med – Tropical and Geographical Medicine

UWI – University of the West Indies

WHO – World Health Organisation

Chapter 1 General Introduction: Opening the can of worms

This thesis examines eradication programmes targeting parasites of humans, how these relate to extinction, and how the parasites involved interact with environments and human societies through three case studies of hookworm in the early 20th century. I adopt an interdisciplinary methodology interweaving biology and history to examine both the ecology and meanings of hookworm across three distinct locations – Jamaica, the Windward Islands Association and Cornwall – discussing interactions between parasites, environments and societies during a period when hookworm was the target of the earliest international efforts to eradicate an infectious disease.

Throughout, this thesis aims to elucidate the different ways which hookworm interacted with humans and environments in different places. This enquiry is pursued across 6 studies with their own specific research questions revolving around shared themes, as will be discussed in section 4 of this chapter. By comparing these different case studies in the general discussion (Chapter 8), some general observations about the interactions of people, parasites and places can be made. By integrating biological and historical modes of analysis, I explore in concert the epidemiology, socioecology, meanings and politics of hookworm and how these different between different contexts over the course of attempts to control and eradicate the parasite.

It is found that the transmission dynamics and clinical presentation of hookworm were shaped by socioecological context, though there were also important differences within contexts. Likewise, the ways hookworm was understood and the meanings assigned to it varied notably between case studies, and also between different elements within the societies studied. These differences in epidemiological and social contexts, furthermore, shaped differences in attempts to control and eradicate hookworm. However, across contexts, the extinction of hookworm was, in different ways, imagined as a both a consequence of social progress and modernity and a means to bring this about. This leads me to argue that hookworm had

an ambivalent relationship with capitalist modernity and colonialism. The socioecologies produced by plantation agriculture and mining facilitated its reproduction and transmission, but these same forces also problematized its existence and drove attempts to induce its extinction. Attempts to eradicate hookworm, moreover, were shaped by their context and often reproduced the power structures of colonialism. However, this too varied with political and social context; both hookworm and its eradication programmes were shaped by the particular socioecological configurations they emerged within.

The novelty of this study lies in both its methodology and its scope. It is built around a dialogue between two disciplines – biology and history – which are typically institutionally separated. In focusing on hookworm itself, it differs from previous historical studies which have mostly used hookworm as a lens to discuss other issues. In concerning itself with both the epidemiological and sociocultural aspects of hookworm, it moves beyond previous biological studies of the disease. Likewise, this thesis further enhances its interdisciplinarity by drawing from extinction studies to discuss disease eradication in terms of both health and extinction. Finally, I add detailed studies of hookworm to the literature of three locations which had previously lacked dedicated studies of the history of hookworm, despite, as I show, hookworm in these three locations having interesting and unusual histories.

1 Lifecycle and medical importance of hookworm

Hookworms are nematode worms which dwell within the small intestine and feed on blood.[1] People become infected through skin contact with ground which has been contaminated with the faeces of an infected person.[2] There are several species of hookworm, but the two which most commonly infect humans are *Ancylostoma duodenale* and *Necator americanus*.[3] Of the two species, *A. duodenale* is larger, produces eggs at a greater rate, and

[1] S. Brooker et al., 'Human hookworm infection in the 21st century', *Adv Parasitol* 58 (2004) pp.197-288.
[2] A. Loukas et al., 'Hookworm infection', *Nat Rev Dis Primers* 2/16088 (2016) p.16088.
[3] Ibid.

causes greater host blood loss, but both the adults and the larvae have a shorter lifespan than *N. americanus.*[4] *A. duodenale* is able to arrest its development within human hosts and can be transmitted orally as well as through the skin (percutaneously), whereas *N. americanus* can only infect people percutaneously.[5] For practical purposes, however, different hookworm species are generally considered together, as their lifecycles and symptoms are extremely similar. Furthermore, in regions where two species of hookworm are present, people are often infected with both, and time-consuming microscopical or genetic analysis is required to distinguish the species.[6] This results in most of the available historical records, particularly those generated by control and eradication programmes – which targeted hookworm as a category rather than any particular species – failing to record which species where present in what numbers in a particular location.

It is therefore not entirely clear which species were present in my case studies. Both species are present in the Americas, though *N. americanus* is more common, and has been identified in Jamaica.[7] However, the only published study of St Lucia does not distinguish between hookworm species.[8] Human hookworm in Grenada and St Vincent is likewise severely understudied, but a recent study of dogs identified infection with both *A. caninum* and *A. ceylanicum* in Grenada.[9] While primarily a parasite of dogs, *A. ceylanicum* is fully competent in humans and is increasingly being

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[4] Brooker et al., 'Human hookworm infection in the 21st Century'
[5] Ibid.
[6] Ibid.; Loukas et al., 'Hookworm infection'.
[7] A. C. A. Clements and K. A. Alene, 'Global distribution of human hookworm species and differences in their morbidity effects: a systematic review', *Lancet Microbe* 3 (2022) pp.e72-79; S. C. Rawlins et al., 'Parasitic infections in young Jamaicans in different ecological zones of the island ', *Trop Geogr Med* 43/1 (1991) pp.136-141; C. Nokes et al., 'Geohelminth infection and academic asssesment in Jamaican children', *Transactions of the Royal Society of Tropical Medicine and Hygiene* 85(1991) pp.272-273.
[8] R. Kurup and G. S. Hunjan, 'Epidemiology and control of Schistosomiasis and other intestinal parasitic infections among school children in three rural villages of south Saint Lucia', *Journal of Vector Borne Diseases* 47/4 (2010) pp.228-234. For a review of studies of Caribbean countries see E. S. Tikasingh et al., 'The control of hookworm disease in Commonwealth Caribbean countries', *Acta Tropica* 120(2011) pp.24-30.
[9] Tikasingh et al., 'The control of Hookworm Disease'; P. A. Zendejas-Heredia et al., 'Ancylostoma ceylanicum Hookworms in Dogs, Grenada, West Indies', *Emerging Infectious Diseases* 28/9 (2022) pp.1870-1872.

recognised as an important zoonosis, but it is not entirely clear how capable *A. caninum* is of infecting humans.[10] In August 1915 Angus MacDonald noted that both *A. duodenale* and *N. americanus* had been found in Grenada, though *N. americanus* was 'by far the more common'.[11] In Cornwall (Chapter 7) the historical records tend to refer to *A. duodenale* or ankylostomiasis, but as *N. americanus* was only described the same year hookworm was identified in Cornwall, it is difficult to be certain that it was not also present. I therefore generally refer to hookworms in this thesis, rather than the individual species. This is for several reasons: firstly, the historical records generally do not discriminate; secondly, the species are pathologically and ecologically alike; thirdly, it is likely that multiple species were present; fourthly existing literature on the regions I study is sparse; and finally publics and scientists alike typically defined 'hookworm' as the subject of eradication programmes rather than any individual species.

Adult hookworms live and feed in the small intestine.[12] They lay eggs, which are passed in the faeces of their host.[13] Eggs hatch in the soil in 24-48 hours into rhabditiform L1 larvae, which feed on the bacteria and debris, before moulting into L2, then L3 filariform larvae in 5-10 days.[14] L3 can survive in the soil in a state of developmental arrest for around 3-4 weeks (though they may lose infectivity after around 2 weeks).[15] Development rates, however, appear to be temperature-sensitive.[16]

[10] R. J. Traub et al., 'Zoonotic hookworms of dogs and cats – lessons from the past to inform current knowledge and future directions of research', *International Journal for Parasitology* 51 (2021) pp.1233-1241.
[11] UK National Archives, Kew [Henceforth NA], CO/321/294 Grenada: Sanitary Measures in connection with Ankylostomiasis Campaign (Dispatch 10263, 27th January 1917).
[12] Brooker et al, 'Human hookworm infection in the 21st century'.
[13] Ibid.
[14] Ibid.; Loukas et al., 'Hookworm infection'.
[15] A. O. Shalash et al., 'Hookworm infection: Toward development of safe and effective peptide vaccines', *J Allergy Clin Immunol* 148/6 (2021) pp.1394-1419 e1396; Loukas et al., 'Hookworm infection'; N. B. Mudenda et al., 'Modelling the ecological niche of hookworm in Brazil based on climate', *Geospatial Health* 6/3 (2012) pp.S111-S123.
[16] Mudenda et al., 'Modelling the ecological niche of hookworm in Brazil'.

L3, the infective stage, enter hosts percutaneously through hair follicles, and move towards heat and movement, actively seeking out hosts.[17] Inside the body, they migrate through the capillaries into the lungs.[18] L3 respond to host molecules by secreting a variety of macromolecules and enzymes which facilitate their entry into the host's digestive tract.[19] Upon entry into the host, host signals also trigger the resumption of larval development.[20] In the lungs, L3 enter the trachea, which they ascend, until involuntary coughing moves them into the gastrointestinal track where they are swallowed.[21]

Development of the L3 into adult stages occurs in the lumen of the small intestine.[22] The latency period between infection and commencement of egg-laying by the adult (when infection becomes detectable to microscopy) varies. Simon Brooker *et al*. give a range of 5-8 weeks, which is supported by the experimental infections reviewed by Soraya Gaze *et al.*, though latency periods of 14-100 days have been reported.[23] Adult *A. duodenale* typically live for 1-3 years in the small intestine and *N. americanus* 3-10 years.[24]

The World Health Organisation groups hookworms together with other parasitic worms sharing similar transmission pathways under the umbrella

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[17] Loukas et al., 'Hookworm infection'; S. Gaze et al., 'Immunology of experimental and natural human hookworm infection', *Parasite Immunology* 36(2014) pp.357-366.
[18] Loukas et al., 'Hookworm infection'; Shalash et al., 'Hookworm infection', Gaze et al., 'Immunology of experimental and natural human hookworm infection'.
[19] Brooker et al., 'Human hookworm infection in the 21st century'; Loukas et al., 'Hookworm infection'.
[20] J. M. Hawdon and P. J. Hotez, 'Hookworm: Developmental Biology of the Infectious Process', *Current Opinion in Genetics and Development* 6/5 (1996) pp.618-213.
[21] Loukas et al., 'Hookworm Infection', P. R. Chapman et al., 'Experimental human hookworm infection: a narrative historical review', *PLoS Negl Trop Dis* 15/12 (2021) pp.e0009908.
[22] Gaze et al., 'Immunology of experimental and natural human hookworm infection'.
[23] Ibid.; Brooker et al., 'Human hookworm infection in the 21st century'; S. Gaze et al., 'Immunology of experimental and natural human hookworm infection', *Parasite Immunology* 36(2014) pp.357-366; P. R. Chapman, et al, 'Vaccination of human participants with attenuated Necator americanus hookworm larvae and human challenge in Australia: a dose-finding study and randomised, placebo-controlled phase 1 trial', *Lancet Infectious Diseases* 21 (2021) pp.1725-1736.
[24] Loukas et al., 'Hookworm infection'.

term Soil-transmitted Helminthiases.[25] Soil-transmitted Helminthiases are the most widespread of the Neglected Tropical Diseases, infecting over a billion people primarily in low- or middle-income countries.[26] Hookworm specifically is today most prevalent in sub-Saharan Africa and Southeast Asia, partly because the larvae require warm and wet soils in which to grow.[27] In 2013 472 million (95%CL 437-511 million) people globally were estimated to be infected with hookworm.[28]

Infected individuals lose blood due to both hookworm feeding and haemorrhage at the site of attachment.[29] A mean of 0.03ml and 0.15ml of blood per worm per day is lost to *N. americanus* and *A. duodenale* respectively.[30] Though the amount of blood lost to a single worm is small, a large burden of worms can result in red blood cells being lost faster than they can be replaced, causing iron-deficiency anaemia (IDA). The pathology of hookworm therefore depends principally on the number of worms carried. It has been traditionally thought that 40-160 worms are sufficient to produce IDA, but the impacts of hookworm vary with species, host iron stores, diet, and infection with other parasites.[31] Hookworms principally cause IDA when present in large numbers within the host (i.e. when the host has a high parasite burden), particularly in conjunction with vitamin deficiencies or infection with other parasites such as *Schistosoma, Ascaris*

[25] WHO, 'Soil-transmitted Helminthiases', https://www.who.int/health-topics/soil-transmitted-helminthiases [Accessed 24th August 2024].
[26] A. Montresor et al., 'The global progress of soil-transmitted helminthiases control in 2020 and World Health Organization targets for 2030', *PLoS Negl Trop Dis* 14/8 (2020) pp.e0008505.
[27] Loukas et al, 'Hookworm infection'.
[28] Global Burden of Disease Study 2013 Collaborators, 'Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013', *The Lancet* 386/9995 (2015) pp.743-800.
[29] Loukas et al., 'Hookworm Infection'
[30] Brooker et al., 'Human Hookworm Infection in the 21st Century'
[31] Brooker et al., 'Human Hookworm Infection in the 21st Century', Loukas et al., 'Hookworm Infection'; A. Byrne et al., 'Impact of hookworm infection and preventive chemotherapy on haemoglobin in non-pregnant populations', *Tropical Medicine and International Health* 26(2021) pp.1568-1592.

or *Plasmodium* (which causes malaria).[32] In regions where it is endemic, hookworm contributes significantly to the prevalence of anaemia.[33]

2 Historical significance and historiography of hookworm

Hookworm is both medically important and historically significant. Hookworm eradication programmes sponsored by oil billionaire John D. Rockefeller after 1909 operated across large parts of the world, and are often seen as origin points of international health and precursors to today's global health.[34] Even historians who have taken a pessimistic view of their success, such as John Farley, note the importance of Rockefeller hookworm programmes in providing a template for later health efforts.[35] However, hookworm was also significant outside of the realm of health philanthropy. As historians Warwick Anderson, Nicole Trujillo-Pagan and Anne Perez Hattori have demonstrated, during this period hookworm also played an important role in expanding US colonial, economic and military governance in its emerging overseas empire.[36] Steven Palmer has similarly argued that hookworm programmes also formed 'laboratories of creole modernity' which shaped the developing Latin American nation-states, where important work on hookworm was taking place even before the arrival of the

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[32] Brooker et al., 'Human Hookworm Infection in the 21st Century', Loukas et al., 'Hookworm Infection'; J. C. Calis et al., 'Severe Anemia in Malawian children', *Malawi Medical Journal* 28/3 (2016) pp.99-107; E. Vaumourin et al., 'The importance of multiparasitism: examining the consequences of coinfections for human and animal health', *Parasites and Vectors* 8/545 (2015); J. L. A. Webb, 'Syndemic anemia in British Malaya: An early global health encounter with hookworm and malaria co-infections in plantation workers', *Social Science and Medicine* (2020).

[33] Lancet Global Burden of Disease 2021 Anaemia Collaborators, 'Prevalence, years lived with disability, and trends in anaemia burden by severity and cause, 1990–2021: findings from the Global Burden of Disease Study 2021', *Lancet Haematology* 10/9 (2023) pp.E713-E734.

[34] E.g. J. Farley, *To Cast Out Disease: A History of the International Health Division of the Rockefeller Foundation (1913-1951)* (Oxford: Oxford University Press, 2004); S. P. Palmer, *Launching Global Health: The Caribbean Odyssey of the Rockefeller Foundation* (Ann Arbor: University of Michigan Press, 2010).

[35] Farley, *To Cast Out Disease* pp.2,284.

[36] W. Anderson, *Colonial Pathologies: American Tropical Medicine, Race, and Hygiene in the Philippines* (London: Duke University Press, 2006); W. Anderson, 'Going through the Motions: American Public Health and Colonial "Mimicry"', *American Literary History* 14/4 (2002); N. E. Trujillo-Pagan, 'Worms as a Hook for Colonising Puerto Rico', *Social History of Medicine* 26/4 (2013) pp.611-632; A. P. Hattori, *Colonial Dis-ease: US Navy Health Policies and the Chamorros of Guam, 1898–1941* (Honolulu: University of Hawaii Press, 2004).

Rockefeller Foundation.[37] Within the field of tropical medicine, Lise Wilkinson has described the importance of the 'hookworm connection' between the Rockefeller Foundation and the London School of Hygiene and Tropical Medicine.[38]

Despite the medical and historical significance of hookworm, however, there has been little dialogue between biology and history in discussing hookworm. While scientists such as Elisha Tikasingh and Cheryl Elman have taken an interest in the history of hookworm, and historians such as Palmer and Farley have drawn from the literature on the biology of the parasite, they have not integrated biological and historical methods.[39] In this thesis I show that integrating qualitative archival study with quantitative epidemiological analyses reveals that the meanings, social understandings, transmission dynamics and clinical presentation of hookworm were shaped by social, economic and environmental context. Epidemiological studies have previously demonstrated the influences of social, economic and environmental factors on hookworm infection, while historical studies have tended to focus on the parasite's social meanings and political roles.[40] By

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[37] S. P. Palmer, *Launching Global Health: The Caribbean Odyssey of the Rockefeller Foundation* (Ann Arbor: University of Michigan Press, 2010).
[38] L. Wilkinson, 'Burgeoning Visions of Global Public Health: The Rockefeller Foundation, The London School of Hygiene and Tropical Medicine, and the 'Hookworm Connection'', *Stud Hist Phil Biol & Biomed Sci* 31/1 (2000) pp.397-407.
[39] E. S. Tikasingh et al., 'The control of hookworm disease in Commonwealth Caribbean countries', *Acta Tropica* 120(2011) pp.24-30.C. Elman et al., 'Extending Public Health: The Rockefeller Sanitary Commission and Hookworm in the American South', *American Journal of Public Health* 104/1 (2014) pp.47-58; Palmer, *Launching Global Health;* Farley *To Cast Out Disease*.
[40] E.g. E. F. G. A. Avokpaho et al., 'Factors associated with soil-transmitted helminths infection in Benin: findings from the DeWorm3 study', *PLoS Neglected Tropical Diseases* 15/8 (2021) pp.e0009646; S. S. R. Ajjampur et al., 'Epidemiology of soil transmitted helminths and risk analysis of hookworm infections in the community: Results from the DeWorm3 Trial in southern India', *PLoS Neglected Tropical Diseases* 15/4 pp.e0009338; G. A. Alula et al., 'Prevalence of Intestinal Parasitic Infections and Associated Risk Factors among Pregnant Women Attending Prenatal Care in the Northwestern Ethiopia', *BioMed Research International* 2021/3387742 (2021); S. Witek-McManus et al., 'Epidemiology of soil-transmitted helminths following sustained implementation of routine preventive chemotherapy: Demographics and baseline results of a cluster randomised trial in southern Malawi', *PLoS Neglected Tropical Diseases* 15/5 (2021) pp.e0009292; M. Anegagrie et al., 'Environmental characteristics around the household and their association with hookworm infection in rural communities from Bahir Dar, Amhara Region, Ethiopia', ibid.6 pp.e0009466; J. C. Calis et al.,

examining multiple facets of hookworm – its social, environmental and biological beings – in concert, I show that biology, environment and society are not separate, but rather act together in shaping hookworm.

Most of the historical work on hookworm has drawn, as this thesis also will, upon the records generated by the various Rockefeller-sponsored control and eradication programmes directed against the parasite. Early works on the topic by historians such as Mary Boccaccio and James Cassedy focused on the first of these, the Rockefeller Sanitary Commission for the Eradication of Hookworm Disease (1909-1914), which worked across the US South.[41] John Ettling in 1986 provided a detailed account of this work, which remains a standard reference work.[42] Following the perceived success of the US work, Rockefeller hookworm programmes expanded rapidly across the globe, under the umbrella of the new International Health Commission of the Rockefeller Foundation, which was founded in 1913 as work in the US wound down. Farley has chronicled the rapid expansion of the International Health Commission and its successors, while Palmer has provided detailed accounts of the development of the first six Rockefeller Foundation hookworm campaigns across the circum-Caribbean.[43] Rockefeller hookworm campaigns have been conducted under several names: the International Health Commission (1913-1916) was later reorganised into the International Health Board (1916-1927) and then the

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'Severe Anemia in Malawian children', *Malawi Medical Journal* 28/3 (2016) pp.99-107; R. L. Pullan et al., 'Spatial and Genetic Epidemiology of Hookworm in a Rural Community in Uganda', *PLoS Neglected Tropical Diseases* 4/6 (2010) pp.e713; Hattori, *Colonial Dis-ease,* A.-E. Birn and A. Solórzano, 'Public health policy paradoxes: science and politics in the Rockefeller Foundation's hookworm campaign in Mexico in the 1920s', *Social Science and Medicine* 49 (1999) pp.1197-1213.

[41] M. Boccaccio, 'Ground Itch and Dew Poison: The Rockefeller Sanitary Commission 1909–14', *Journal of the History of Medicine and Allied Sciences* 27/1 (1972) pp.30-53; J. H. Cassedy, 'The "Germ of Laziness" in the South, 1900-1915: Charles Wardell Stiles and the Progressive Paradox'', *Bulletin of the History of Medicine* 45/2 (1971) pp.159-169.

[42] J. Ettling, *The Germ of Laziness: Rockefeller Philanthropy and Public Health in the New South* (London: Harvard University Press, 1981).

[43] J. Farley, *To Cast Out Disease: A History of the International Health Division of the Rockefeller Foundation (1913-1951)* (Oxford: Oxford University Press, 2004); S. P. Palmer, *Launching Global Health: The Caribbean Odyssey of the Rockefeller Foundation* (Ann Arbor: University of Michigan Press, 2010).

International Health Division (1927-1951).[44] Rather than confuse the reader with this movement between RSC, IHC, IHB and IHD, I will for the sake of clarity use Rockefeller Foundation (RF) to refer to Rockefeller philanthropies throughout, even where, as in the US, this is anachronistic.

Much of the historiography on hookworm in the US has been political in mode, interested in the relationships between state, citizen and philanthropist.[45] This political approach has been internationalised by scholarship such as Anne-Emanuelle Birn and Armando Solorzano's work on Mexico.[46] More Marxian readings have explored the relationships between state, medicine, philanthropy and capital, with the RF's focus on building public health systems and preoccupation with diseases thought to hinder productivity proving amenable to such interpretations.[47] Postcolonial scholarship has found hookworm useful for exploring the relationships not only between state and subject, coloniser and colonised, but also between body and medicine, exploring how hookworm could both reinforce and challenge bodily, racial and colonial boundaries.[48] The relationships between hookworm and racial boundaries are examined in Australia, Papua and Melanesia by Anne Stuart, in the Philippines by Anderson and in the US by Matt Wray.[49] Wray, for instance, examines the relationships between racist anxieties about the American 'poor white', eugenics, and hookworm, positing that hookworm treatment was seen as a means of racial redemption and improvement for infected white Americans – but not Black hookworm

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[44] Farley, *To Cast Out Disease* p.9.
[45] Cassedy, 'The "Germ of Laziness" in the South, 1900-1915'; Boccaccio, 'Ground Itch and Dew Poison'.
[46] A.-E. Birn and A. Solórzano, 'Public health policy paradoxes: science and politics in the Rockefeller Foundation's hookworm campaign in Mexico in the 1920s', *Social Science and Medicine* 49(1999) pp.1197-1213.
[47] E. R. Brown, *Rockefeller Medicine Men: Medicine and Capitalism in America* (Berkley: University of California Press 1979).
[48] Hattori, *Colonial Dis-ease;* Trujillo-Pagan, 'Worms as a Hook for Colonising Puerto Rico'; E. A. Stein, 'Colonial Theatres of Proof: Representation and Laughter in 1930s Rockefeller Foundation Hygiene Cinema in Java', *Health and History* 8/2 (2006) pp.14-44.
[49] A. Stuart, 'We Are All Hybrid Here: The Rockefeller Foundation, Sylvester Lambert, and Health Work in the Colonial South Pacific', *Health and History* 8/1 (2006) pp.56-79; M. Wray, *Not Quite White: White Trash and the Boundaries of Whiteness* (Durham: 2006); W. Anderson, *Colonial Pathologies: American Tropical Medicine, Race, and Hygiene in the Philippines* (London: Duke University Press, 2006).

victims. Trujillo-Pagan notes a similar phenomenon in Puerto Rico, where the Puerto Rican *Jibaro* (smallholder) formed an analogous example of embarrassing white poverty amid endemic hookworm.[50] These themes have also been analysed culturally, for example by Stephanie Larson, who discusses the 'figurative hookworm' in American Southern Gothic literature; and by Eric Stein, who examines RF 'hygiene theatre' in colonial Java, exploring portrayals of hookworm as well as how Javanese viewers read and understood these films.[51] I will expand, particularly in Chapter 6, this scholarship into understudied contexts in the British Caribbean by exploring hookworm's status in the eyes of British colonial doctors as a signifier of backwardness, and the ways in which their understandings of hookworm fractured along race, class and gender lines within a colonial setting (the Windward Islands) where this has not previously been examined.

In other colonial settings, historians have explored the relationships between medicine and disease, and doctor and patient. In India, for example, hookworm features in broader historiographical discussions about the relationships between the British-Indian medical tradition and the discipline of tropical medicine and the effectiveness of international health efforts.[52] This latter theme is also taken up by James Webb, who also uses historical campaigns against hookworm to critique present-day preventative chemotherapy; and by Palmer's inquiry into deaths caused by RF treatment for hookworm.[53] Hookworm has been used to examine the relationships

[50] Trujillo-Pagan, 'Worms as a hook for colonising Puerto Rico'.
[51] S. A. Larson, 'Printing Parasites: Hookworm and Public Health Narratives in Southern Fiction', *Literature and Medicine* 36/1 (2018) pp.208-229; E. A. Stein, 'Colonial Theatres of Proof: Representation and Laughter in 1930s Rockefeller Foundation Hygiene Cinema in Java', *Health and History* 8/2 (2006) pp.14-44.
[52] N. Bhattacharya, *Contagion and Enclaves: Tropical Medicine in Colonial India* (Liverpool: Liverpool University Press, 2017); S. N. Kavadi, "Parasites Lost and Parasites Regained': Rockefeller Foundation's Anti-Hookworm Campaign in Madras Presidency', *Economic and Political Weekly* 42/2 (2007) pp.130-137.
[53] J. L. A. Webb, 'Syndemic anemia in British Malaya: An early global health encounter with hookworm and malaria co-infections in plantation workers', *Social Science and Medicine* (2020) ; J. L. A. Webb, 'Battling Soil-Transmitted Intestinal Worm Disease: From the Hookworm Campaigns of the Rockefeller Foundation to Contemporary Mass Drug Administration', *Gesnerus* 74/2 (2017) pp.229-239; S. P. Palmer, 'Toward Responsibility in International Health: Death following Treatment in Rockefeller Hookworm Campaigns, 1914–1934', *Medical History* 54/(2010) pp.149-170.

between medicine and society by Palmer's study of the impact of Latin American migrant clinics on knowledge of hookworm and Rosmarijn Hoefte's accounts of anti-hookworm campaigns in Suriname.[54]

Historians have tended to focus on medicine, society and politics, but the approach of scientists to the RF hookworm programmes has generally been epidemiological, exploring the relationships between disease and risk factors, or disease, medicine and outcomes. Elman, Robert Maguire and Barbara Wittman use RF data from the US to model risks of hookworm infection, while Alice Anderson and Thomas Allen similarly use Geographical Information Systems to investigate links between soil type and hookworm infection risk.[55] Tikasingh, Dave Chadee and Samuel Rawlins are more descriptive, collating RF data on Caribbean Commonwealth countries with more recent surveys to briefly characterise hookworm's declining prevalence.[56] Uses of RF data, however, are not confined to epidemiology: Hoyt Bleakley and John Henderson, for instance, use it to argue that deworming had a positive impact on school attendance in the US.[57]

Quantitative approaches using historical RF data on hookworm have focused on the US. This is despite the fact that the US data, based on those who attended travelling dispensaries, do not form nearly so complete or representative a sample of the population as data generated by subsequent

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[54] S. P. Palmer, 'Migrant Clinics and Hookworm Science: Peripheral Origins of International Health, 1840–1920', *Bulletin of the History of Medicine* 83/4 (2009) pp.679-709; Palmer, *Launching Global Health;* R. Hoefte, 'The Difficulty of Unhooking the Hookworm: The Rockefeller Foundation, Grace Scheiders-Howard, and Public Health Care in Suriname in the Ealy Twentieth Century' in Barros, Palmer and Wright (eds.) *Health and Medicine in the circum-Caribbean, 1800-1968* (Abingdon: Routledge, 2009) pp.211-226; R. Hoefte, 'Cleansing the world of the germ of laziness: hygiene, sanitation, and the Javanese population in Suriname', *História, Ciências, Saúde–Manguinhos* 21/4 (2014) pp.1437-1455.

[55] Elman et al., 'Extending Public Health'; A. L. Anderson and T. Allen, 'Mapping Historic Hookworm Disease Prevalence in the Southern US, Comparing Percent Prevalence with Percent Soil Drainage Type Using GIS', *Infectious Diseases: Research and Treatment* 2011/4 (2011) pp.1-9.

[56] Tikasingh et al., 'The control of hookworm disease in Commonwealth Caribbean countries'.

[57] H. Bleakley, 'Disease and Development: Evidence from Hookworm Eradication in the American South', *The Quarterly Journal of Economics* 112/1 (2007) pp.73-117; J. A. Henderson, 'Hookworm Eradication as a Natural Experiment for Schooling and Voting in the American South', *Political Behaviour* 40(2018) pp.467-494.

‘intensive’ programmes which aimed to survey entire populations. This thesis contains the first studies to analyse historical data on hookworm collected outside of the US by ‘intensive method’ surveys. In Chapter 2, for example, I am able to use data from 169,380 people across 330 ‘districts’ of Jamaica, in which around 99% of the population of those districts were tested, to examine environmental and social influences on hookworm prevalence. This approach has not been applied outside of the US before; the US data, being county-based and derived from dispensaries rather than surveys, is both lower-resolution and less complete than the Jamaican data. In Chapter 4, meanwhile, I am able to use data from Jamaica’s National Bacteriological Laboratory covering 30,607 individuals who were tested for multiple parasites to test for associations between different parasitic worms; to the best of my knowledge, this question has not been posed of historical records covering any area before.

This thesis addresses both conceptual and geographical gaps in the historiography. Globally, detailed studies of the history of hookworm are lacking – it is rare for a country to have been studied by more than one author (Figure 1.1). I take a comparative approach to three regions which have not yet received specific studies of hookworm: Jamaica, The Windward Islands Association (St Lucia, Grenada and St Vincent) and Cornwall. Within the circum-Caribbean, the island Caribbean has been largely overlooked: scholarship on hookworm has tended to focus on the southern US, with a handful of historians discussing Central America and the Caribbean basin as well as Puerto Rico and Trinidad and Tobago (Figure 1.2).

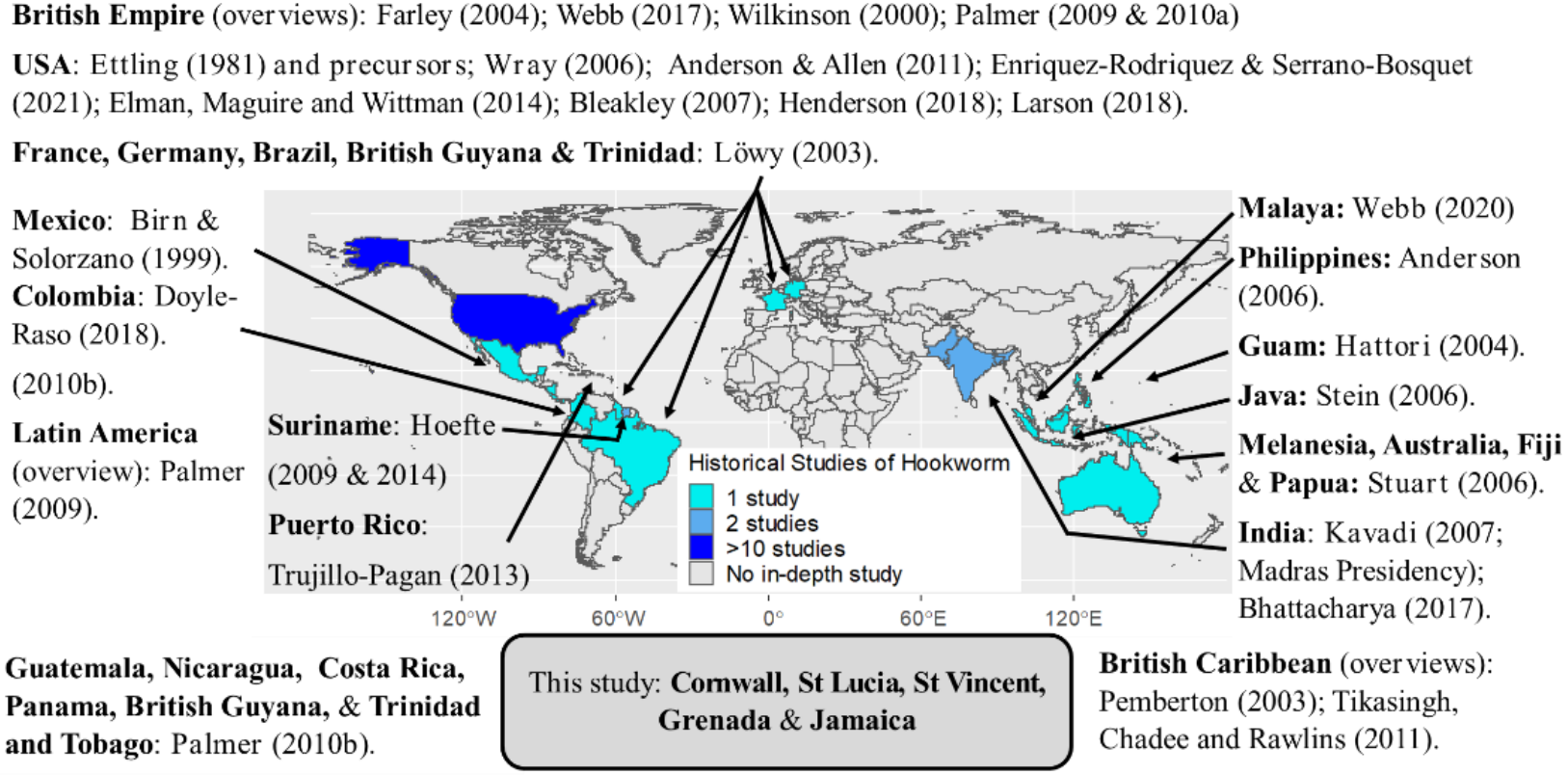

Figure 1.1: Historical studies of hookworm.

Where a study provides only a brief (<3 page) summary of events in a particular country, it was not counted as an in-depth study for the purposes of colouring the map, but was noted in the surrounding text. 2024 national borders are used: this means that Pakistan and Bangladesh are coloured with India, as both the studies of hookworm focus on the pre-partition period, and that Stein's study of Java results in all of Indonesia being coloured.

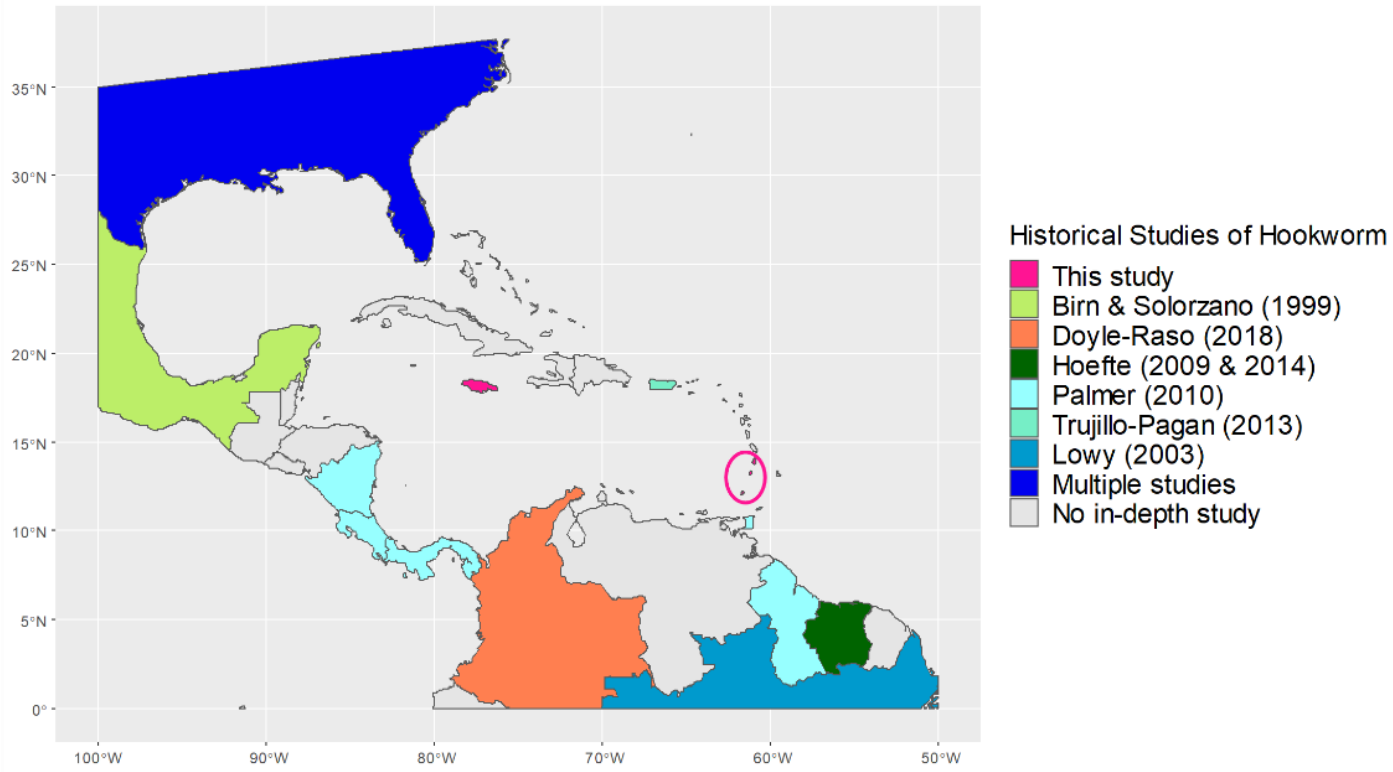

Figure 1.2: This thesis' case studies in the Caribbean, situated within the existing historiography of hookworm in the circum-Caribbean. While historical studies on hookworm are lacking across the region as a whole, the island Caribbean is particularly under-served.

Brief overviews of hookworm programmes in the British Caribbean are provided by Rita Pemberton and Tikasingh *et al.*; while useful, these provide only a few paragraphs outlining the measures taken.[58] There has also been some confusion over the dates of RF programmes, which this study clarifies. In Jamaica, Pemberton claims that cooperative work between the government and RF terminated in April 1926, while Tikasingh *et al.* claim that RF work ended in 1925.[59] I show that hookworm work continued for another decade, until 1936 (though the hookworm programme was taken over by the government in 1933). In St Lucia, Tikasingh *et al.* report that hookworm work lasted for 7 years between 1915 and 1922; I examine reports which show that the work continued until 1924 (confirming Pemberton's account).[60] In Cornwall, where the disease was not normally endemic, the presence of hookworm in the deep tin mines has been noted by historians of mining, and occasionally by historians of hookworm, but I again provide the first in-depth account of this particular outbreak.[61] Addressing the history of hookworm in areas which have not previously received in-depth studies is not merely completionism or gap-filling; I will argue throughout that hookworm and its eradication programmes were contextual, and shaped by place and socioecological context in significant ways. As such, studying hookworm in different contexts allows exposition of how hookworm differs between contexts.

Historians have tended to be interested in using hookworm to discuss politics, colonialism and developments in health and medicine. In these discussions the worm itself is often left undiscussed. Using a novel interdisciplinary approach, I address this gap, by discussing hookworm both

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[58] Tikasingh et al., 'The control of hookworm disease in Commonwealth Caribbean countries'; R. Pemberton, 'A Different Intervention: The International Health Commission/Board, Health, Sanitation in the British Caribbean, 1914–1930', *Caribbean Quarterly* 49/4 (2003) pp.87-103.

[59] Pemberton, 'A Different Intervention' p.96; Tikasingh et al. 'The control of hookworm disease in Commonwealth Caribbean countries' p.27.

[60] Tikasingh et al. 'The control of hookworm disease in Commonwealth Caribbean countries' p.28; Pemberton 'A Different Intervention' p.97.

[61] C. Mills, *Regulating Health and Safety in the British Mining Industries, 1800-1914* (Farnham: Ashgate, 2010) pp.90,172-3,178,180,198; D. B. Barton, *A History of Tin Mining and Smelting in Cornwall* (Truro: D. Bradford Barton Ltd., 1967) pp.229,244; Palmer, *Launching Global Health* pp.43-44.

as a living animal and a meaning-laden category: how its ecology has differed between contexts, what it has meant to different people, how it has been understood, and how knowledge of it has been produced and circulated.

I am particularly interested in attempts to eradicate hookworm and induce its extinction. The RF hookworm programmes were, together with contemporary efforts against yellow fever, the prototypical eradication programmes which influenced the shape of later efforts against smallpox, malaria, polio and guinea worm.[62] I argue that such eradication efforts offer a different perspective on extinction to the conservation viewpoints which the new discipline of extinction studies has tended to focus on. Extinction is typically seen as a loss to be mourned, whereas the extinction of hookworm, I will show, was seen as a signifier of positive civilizational progress.[63] Whereas extinction has often been seen as a negative consequence of modernity, I will show that the extinction of hookworm was imagined by medical professionals and governments as both a positive outcome of an advancing modernity and a means to bring this modernity about.[64] In much of the extinction studies literature, extinction, as Dolly Jørgensen has shown, is anticipatory: something which is awaited as attempts are made to forestall it, or mourned even in advance of the death of the last individual of a species.[65] I will demonstrate that doctors attempting to control and eradicate hookworm also anticipated its extinction, but as a positive outcome of modernity and social progress which they actively attempted to produce, rather than avoid. Where I discuss extinction, therefore, I will mostly focus on this anticipation of extinction, and the identification of extinction with modernity and civilizational progress. Much the same could

[62] See N. L. Stepan, *Eradication: Ridding the World of Diseases Forever?* (London: Reaktion, 2011), especially pp.7ff, 68-76.
[63] U. K. Heise, *Imagining Extinction* (Chicago: University of Chicago Press, 2016).
[64] L. Head, *Hope and Grief in the Anthropocene: Re-conceptualising human-nature relations* (Abingdon: Routledge, 2016); M. V. Barrow, *Nature's Ghosts: Confronting Extinction from the Age of Jefferson to the Age of Ecology* (Chicago: University of Chicago Press, 2009); J. Schuster, *What is Extinction? A Natural and Cultural History* (New York: Fordham University Press, 2023).
[65] D. Jørgensen, 'Extinction and the End of Futures', *History and Theory* 61/2 (2022) pp.181-368.

be said of other diseases targeted for eradication, such as smallpox, but these have not been discussed from an extinction studies perspective either.

3 The Case Studies

My approach is comparative: I use three case studies in order to explore how hookworm was shaped by different places and social contexts. These (Jamaica, the Windward Islands and Cornwall) were chosen firstly because they show differences and similarities in socioecologies, understandings and eradication programmes of hookworm, facilitating comparisons; secondly because they previously lacked in-depth historical studies of hookworm; and thirdly because significant quantities of archival material in English were available for them. Furthermore, though geographically distant, the three were connected along imperial networks of trade, travel and knowledge circulation: for instance, I will discuss in Chapter 7 how figures such as tropical medic Patrick Manson and physiologist John Scott Haldane facilitated the movement of knowledge between Cornwall and the Caribbean.

Throughout, I will show how political, social and environmental differences between the case studies shaped hookworm in different ways. In particular, each of the case studies offers a different set of actors with differing attitudes towards hookworm and its control. In Jamaica, the prime mover was American RF doctor Benjamin Washburn, and I will show how his particular outlook and alliances with specific sections of Jamaican society (particularly the middle classes) shaped Jamaican views of hookworm. In the Windward Islands, while funded by the RF, British colonial doctors led the hookworm programmes, again resulting in their outlooks shaping efforts to induce the extinction of hookworm. In Cornwall, hookworm was tackled within Britain by a combination of Oxford- and London-based scientists and Cornish mine agents. This once more affected attitudes towards hookworm and its control, as hookworm became defined as a miners' disease which was also a tropical disease. However, these three contexts also shared commonalities, particularly in their peripheral experience of modernity.

Both Cornwall and British Caribbean were, by this period, declining extraction zones within what might be broadly and loosely defined as the

British periphery. Jamaica and the Windward Islands, being British colonies, were undeniably peripheral, but while Cornwall was not a colonial context, it may be considered peripheral or semi-peripheral in relation to the English core of London and the Home Counties. The extent of Cornwall's cultural distinctiveness and peripherality are central questions within Cornish Studies; I do not intrude on these debates, but rather draw from them the insight that Cornwall was peripheral to a certain extent.[66] Though I discuss parallels between Cornwall and the Caribbean, I also note that these were very different contexts in important ways.

Taking inspiration from the Warwick Collective's description of a single, uneven and combined modernity, I treat these three case studies as unevenly sharing a peripheral modernity.[67] The sugar industry of the Caribbean was, as has long been known, at the heart of the development of capitalist modernity, before the end of mercantilism and the development of mature capitalism began its decline.[68] Cornwall, meanwhile, had industrialised early but incompletely, with an extensive mining industry and an engineering industry surrounding it.[69] However, by the beginning of the 20th century, both the West Indian sugar and Cornish mining industries were in decline (Figure 1.3). In Jamaica, absolute output of sugar grew dramatically after 1914, but Carl Feuer argues that this concealed fundamental weaknesses in the industry which only manifested fully in the 1960s.[70] During this period centralisation, improved machinery, investment by foreign capital (mostly through the 1930s), and cartel sales and quotas allowed for dramatic increases in production.[71] However, these same forces ultimately undercut the industry – technological modernisation was not sustained; monoculture, centralisation and bringing marginal land into sugar production offered

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[66] These debates are reviewed by B. Deacon, *Industrial Celts: Making the Modern Cornish Identity 1750-1870* (Redruth: Cornish Social and Economic Research Group, 2018).
[67] S. Deckard et al., *Combined and uneven development: towards a new theory of world-literature* (Liverpool: Liverpool University Press, 2015) pp.10-15.
[68] E. Williams, *Capitalism and Slavery* (Chapel Hill: The University of North Carolina Press, 1944).
[69] Deacon, *Industrial Celts* pp.108-143.
[70] C. H. Feuer, 'Better Must Come: Sugar and Jamaica in the 20th Century', *Social and Economic Studies* 33/4 (1984) pp.1-49.
[71] Ibid.

diminishing returns; and foreign capital tended to extract profits out of rather than invest in Jamaica.[72] In previous centuries sugar had fundamentally reshaped the economies, societies and ecologies of the Caribbean.[73] By the 20th century, this was no longer the case; despite this brief resurgence, the Jamaican sugar industry never regained its preeminent position in the Jamaican economy, and Jamaica remained a declining extraction zone within the imperial economy.[74] Likewise, centralisation across both industries in the early years of the 20th century meant that they never again dominated the landscapes as they had in previous centuries; many mines and sugar estates closed in the 19th century and never re-entered production (Figure 1.4). During these declines, however, the mining and plantation industries produced socioecologies which shaped hookworm in distinctive ways, as I will demonstrate.

[72] Ibid.
[73] See, for example, D. Watts, *The West Indies: Patterns of Development, Culture and Environmental Change since 1492* (Cambridge: Cambridge University Press, 1987); T. G. Burnard and J. D. Garrigus, *The plantation machine: Atlantic capitalism in French Saint-Domingue and British Jamaica* (Philadelphia: University of Pennsylvania Press, 2016); J. R. McNeill, *Mosquito Empires: ecology and war in the Greater Caribbean, 1620-1914* (Cambridge: Cambridge University Press, 2010).
[74] See Watts, *The West Indies* pp.497-501.

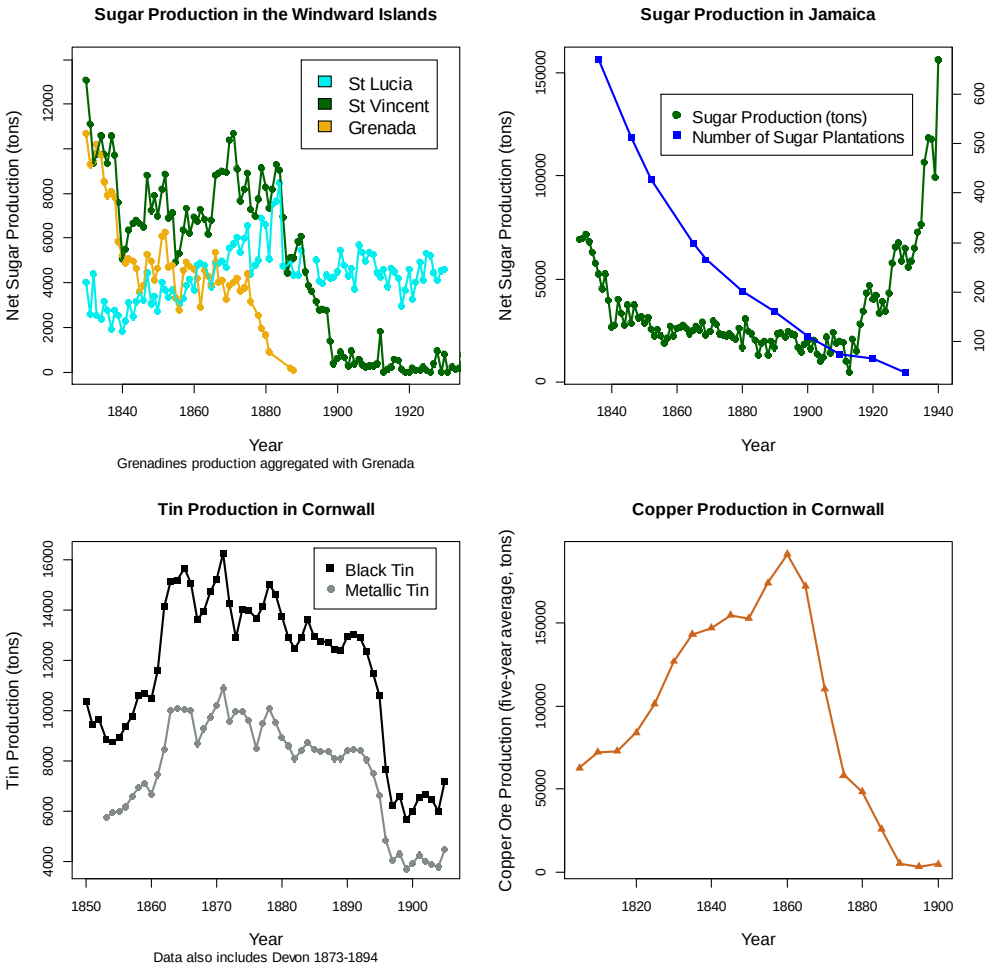

Figure 1.3: The decline of emblematic industries towards the beginning of the 20th century: sugar production in St Lucia, St Vincent, Grenada and Jamaica, and tin and copper production in Cornwall.

Black tin is tin ore, from which metallic tin was produced in Cornwall; copper ore was smelted in Swansea and South Wales. Note that the Jamaican sugar production declined more or less continually from 1833 to 1913, before recovering. Data from N. Deerr, 'The History of Sugar' (London: Chapman and Hall, 1949) pp.198-201; D.B. Barton, 'A History of Tin Mining and Smelting in Cornwall' (Truro: D. Bradford Barton Ltd., 1967) pp.110,182,231; D.B. Barton, 'A History of Copper Mining in Cornwall and Devon' (Truro: Truro Bookshop, 1961) p.90. G. Eisner, 'Jamaica. 1830-1930: A Study in Economic Growth' (Manchester: Manchester University Press, 1961) p.203.

Figure 1.4: Remnants of Papine estate sugar mill, University of the West Indies Mona Campus, Jamaica (above) and Botallack Mine engine house, Cornwall (below).
The sugar industry had sharply declined in the years before the period of this study, but continued to cast a long shadow over Jamaica's economy and society; likewise mining continued in Cornwall through the 20th century, but many mines such as Botallack had closed by the end of the 19th.

Both the Caribbean and Cornwall had played significant roles in the development of capitalist and industrial modernity – the sugar industry providing capital, and the mining industry providing minerals and steam

technology – but both took on more marginal roles into the first decades of the 20th century. The West Indies became an imperial backwater, and Cornwall a tourist destination. Palmer has explored the roles of hookworm within the 'liminal zones of capitalist expansion', just as Trujillo-Pagan, Perez Hattori, and Stuart have explored hookworm in areas which were being drawn into the spheres of colonial capitalist modernity. Here, I discuss hookworm in older peripheries which had formed modernity, and were now declining extraction zones.

Cornwall and the Caribbean were also both influenced, in different ways, by uneven and peripheral cultural relationships to the British centre. During this period, many West Indians, particularly among the middle classes, thought of themselves as British.[75] It came as a shock for members of the British West Indies Regiment who volunteered to fight for the 'mother country' in the First World War to discover that many Britons in Britain did not consider them as such, something which seems to have contributed to the growth of nationalism within the Caribbean over subsequent years.[76] In Cornwall, meanwhile, while certainly 'West Britons', the question of whether the Cornish should define Cornwall as a Celtic nation like Wales or Scotland or an English county like Somerset or Yorkshire was debated throughout the 19th century, and continues to be contested to this day.[77] This shared ambivalent alterity also had some interesting consequences for hookworm. I will show (in Chapter 7) that both the Caribbean and Cornwall were seen by metropolitan scientists and medics as exotic locations to which

[75] S. Hall and B. Schwarz, *Familiar Stranger: A Life Between Two Islands* (Milton Keynes: Penguin, 2017) Ch.2.
[76] R. Smith, *Jamaican Volunteers in the First World War: Race, masculinity and the development of national consciousness* (Manchester: Manchester University Press, 2004); G. Howe, *Race, War and Nationalism: a Social History of West Indians in the First World War* (Kingston: Ian Randle, 2002); M. Joseph, 'First World War veterans and the state in the French and British Caribbean, 1919-1939', *First World War Studies* 10/1 (2019) pp.31-48.
[77] As, again, reviewed by Deacon in *Industrial Celts* pp.228-246. For present-day debates see J. Willet and A. Giovannini, 'The Uneven Path of UK Devolution: Top-Down vs. Bottom-Up Regionalism in England – Cornwall and the North-East Compared', *Political Studies* 62(2013) pp.343-360; J. Willet, 'Liberal Ethnic Nationalism, Universality, and Cornish Identity', *Studies in Ethnicity and Nationalism* 13/2 (2013) pp.201-217.

they could travel to learn about tropical diseases – and in the case of Cornwall, this was driven by the presence of hookworm.

As I will discuss, the epidemic of hookworm which occurred in Cornwall was unusual in several ways; contrasting this with more typical examples of hookworm in places where it was endemic such as Jamaica and St Lucia allows for fruitful discussions of the ways hookworm was shaped by socioecological context. Likewise, while Jamaica and the Windward Islands were both British island colonies in the West Indies, the RF hookworm programmes, as I will discuss, took on localised forms in response to local conditions, which influenced important differences in how hookworm and its extinction were understood between the two colonies.[78] Similarly, as I will also show in relation to Jamaica and Cornwall, the particular geographies of different places shaped hookworm in important ways. By comparing across three diverse contexts, I show how hookworm was shaped by each, while also noting the sometimes surprising similarities between them. Before I outline the content of each chapter, therefore, I will briefly introduce each case study.

3.1 Jamaica

My most significant case study in terms of both length and time period covered is Jamaica. I focus on Jamaica principally because it had one of the longest-running RF hookworm programmes, which resulted in a large volume of material on hookworm being created and preserved. The hookworm programme ran continuously between 1919 and 1936, creating 17 years' worth of reports and leaving a substantial archival trace. By contrast, the much better-studied hookworm programme in the US South lasted only four years, while RF programmes in Guyana, for example, lasted around five years, and only one in Antigua.[79] Farley characterises RF policy in the decade from 1920 to 1930 as a 'Retreat from Hookworm', with programmes closing in Ceylon, India, Egypt and Mexico.[80] But during this period the hookworm work in Jamaica was in full swing and continued well

[78] The localisation of RF hookworm programmes is discussed in more depth by Palmer in *Launching Global Health* Ch.3.
[79] Tikasingh et al., 'The control of hookworm in Commonwealth Caribbean Countries'.
[80] Farley, *To Cast Out Disease* pp.75-87.

into the next decade. Furthermore, as I will discuss, the Jamaican colonial government collected data and information on hookworm even before this programme was instituted, further expanding the quantity of material on hookworm available. In this period Jamaica's medical systems, while under-developed, nevertheless included institutions which smaller colonies lacked, such as a network of public hospitals and a National Bacteriological Laboratory. Records generated by these institutions, preserved within the archives of the colonising power, as I will discuss below, offer additional data on aspects of hookworm which are otherwise difficult to study historically. Jamaica in this period, unlike many other colonies, was also home to a number of quasi-governmental and civil society institutions such as the Jamaica Agricultural Society and the Institute of Jamaica. This has allowed me to use material such as the *Journal of the Jamaica Agricultural Society*, as well as *Jamaica Public Health*, preserved in the National Library of Jamaica which developed out of the Institute of Jamaica. Jamaica thus offers a wealth of qualitative and quantitative material on hookworm which has not yet been studied. As a consequence of this rich archive, a much more granular and multidisciplinary approach can be taken to the study of hookworm in Jamaica than is the case in many other locations. For these reasons, I have focused heavily on Jamaica, and used my other two case studies as parallel case studies which shed further light on hookworm, its eradication, and its relationships with the different socioecologies produced within these peripheral sites of capitalist modernity.

Jamaica was also unusual in being among the locations where the RF hookworm programmes fulfilled their function as an 'entering wedge', and left a more developed health system behind them. The aim of RF hookworm campaigns was spur further government and public engagement in developing and extending public health.[81] In Jamaica, as is discussed by historians including Margaret Jones, Henrice Altink, Darcy Hughes Heuring and James Riley, the RF did drive a range of further programmes in Jamaica focusing on areas including health education, malaria, yaws and tuberculosis

[81] Birn & Solórzano 'Public health policy paradoxes', Farley, *To Cast Out Disease* p.61, Elman, Maguire & Whitman, 'Extending Public Health'.

subsequent to its entry in 1919 to target hookworm.[82] Though these historians refer to hookworm, however, none of them focus on it, and by focusing on hookworm I compliment their work on the RF and public health through interdisciplinary study of the different roles played by the parasite in the development of public health in Jamaica. This, I will show in Chapters 5, 6 and 8, is in marked contrast to the situation in the Windward Islands, further demonstrating the usefulness of my comparative approach, as differences between the two contexts highlight the contextual nature of hookworm and attempts to induce its extinction.

Conquered by Britain from Spain in 1655, by the 20th century Jamaica was, although the largest of the British West Indies and a regional centre, an imperial backwater with a mixed creole population composed predominantly of the descendants of enslaved Africans combined with indentured labourers and immigrants from India, China and Lebanon.[83] As across the Caribbean, sugar produced by enslaved labour had dominated the Jamaican economy in previous centuries, but the end of slavery in 1839 and, more importantly, the end of British tariff protections for West Indian sugar in 1846 brought about the decline of the sugar plantations.[84] While many sugar plantations closed in the second half of the 19th century, some survived and or diversified into new crops such as bananas, coffee, pimento and logwood.[85] By this period, Jamaican society had two distinctive features compared to other parts of the Caribbean: a large peasant class of 'small settlers', who had migrated inland and established smallholdings in the more

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[82] M. Jones, *Public Health in Jamaica, 1850-1940: Neglect, Philanthropy and Development* (Kingston: University of the West Indies, 2013); H. Altink, 'An American Race Laboratory: Jamaica, 1865-1940', *Wadabagei: A Journal of the Caribbean and Its Diaspora* 10/3 (2007) pp.53-83; J. C. Riley, *Poverty and Life Expectancy: The Jamaica Paradox* (Cambridge: Cambridge University Press, 2005); D.H. Heuring *Health and the Politics of 'Improvement' in British Colonial Jamaica, 1914-1945* (DPhil Thesis: Northwestern University, Illinois, 2011).
[83] Heuring, *Health and the Politics of 'Improvement'* Ch.1, see also L. Moore and M. A. Johnson, *Neither led nor driven: contesting British cultural imperialism in Jamaica, 1865-1920* (Kingston: University of the West Indies Press, 2004); B. L. Moore and M. A. Johnson, *They do as They Please* (Kingston: University of the West Indies Press, 2011).
[84] Ibid., see also P. Bryan, *The Jamaican People 1880-1902: Race, Class and Social Control* (Kingston: University of the West Indies Press, 2000).
[85] Bryan, *The Jamaican People* Ch.2.

forested mountains after the end of slavery, and a substantial middle class.[86] Small settlers worked their own farms, though they often supplemented their income with piecework and day-labour on plantations, while the middle classes might be teachers, clerks, lawyers, nurses or doctors.[87] Jamaica is heavily forested, particularly in the north, with a notable contrast between the southern plains and the central mountains (Figure 1.5): this geography, I will show in Chapter 2, played a role in shaping the distribution of hookworm.

[86] See Bryan, *The Jamaican People*, and also Moore & Johnson, *They do as They Please* and *Neither led nor driven.*
[87] Ibid.

Figure 1.5: Hope Botanic Gardens, Jamaica, looking north towards the mountains (above) and Holywell Park, in the Blue Mountains (below).
As I will discuss, differences in climate and vegetation between the plains and the mountains shaped the distribution of hookworm.

In Jamaica the hookworm programme ran from 1919 to 1936, but data were available from the island's hospitals as far back as 1913, thus framing a long study period from 1913 to 1936. Colonial Jamaican history is punctuated by rebellions: the 1831 Sam Sharpe Rebellion, the 1865 Morant Bay Rebellion,

and the 1938 Labour Rebellion. Following the 1865 Rebellion, direct rule from London was introduced in the form of Crown Colony Government. The period between the 1865 Morant Bay and 1938 Labour Rebellions is generally understudied, though it has attracted more scholarly interest in recent years.[88] Though my focus is on hookworm, therefore, I will make some novel contributions to Jamaican history, particularly in characterising how different groups within Jamaican society understood hookworm, and how they responded to it. For instance, I show that effective herbal treatments were used in Jamaican folk medicine in this period to treat roundworm (*Ascaris lumbricoides*). A brief overview of folk medicine in this period is provided by Brian Moore and Michelle Johnson, but the subject has received scant attention from other historians.[89]

I draw from a wide range of primary sources when discussing hookworm in Jamaica. Chief among these are the reports of the Jamaica Hookworm Commission (JHC, 1919-1936). Monthly reports were available through to

[88] Moore and Johnson, *Neither led nor driven* p.xi; for example B. L. Moore and M. A. Johnson, *Neither led nor driven: contesting British cultural imperialism in Jamaica, 1865-1920* (Kingston: University of the West Indies Press, 2004); B. L. Moore and M. A. Johnson, *They do as They Please: The Jamaican struggle for cultural freedom after Morant Bay* (Kingston: University of the West Indies Press, 2011); P. Bryan, *The Jamaican People 1880-1902: Race, Class and Social Control* (Kingston: University of the West Indies Press, 2000); H. Altink, *Destined for a Life of Service: Defining African-Jamaican Womanhood, 1865-1938* (Manchester: Manchester University Press, 2011); H. Altink, *Public Secrets: Race and Colour in Colonial and Independent Jamaica* (Liverpool: Liverpool University Press, 2019); R. Smith, *Jamaican Volunteers in the First World War: Race, masculinity and the development of national consciousness* (Manchester: Manchester University Press, 2004); K. Post, *Arise Ye Starvelings: The Jamaica Labour Rebellion of 1938 and its Aftermath* (The Hague: Martinus Nijhoff, 1978); V. Shepherd, *Transients to Settlers: The Experience of Indians in Jamaica 1845-1950* (Leeds: Peepal Tree, 1994). L. Putnam, 'Global child-saving, transatlantic maternalism, and the pathologization of Caribbean childhood, 1930s–1940s', *Atlantic Studies* 11/4 (2014) pp.491-514; L. Putnam, 'Citizenship from the Margins: Vernacular Theories of Rights and the State from the Interwar Caribbean', *Journal of British Studies* 53/1 (2014) ; L. Putnam, ' Circum-Atlantic Print Circuits and Internationalism from the Peripheries in the Interwar Era' in Connolly, Collier, Felsenstein, Hall and Hall (eds.) *Print Culture Histories Beyond the Metropolis* (Toronto: University of Toronto Press, 2016); H. Altink, 'An American Race Laboratory: Jamaica, 1865-1940', *Wadabagei: A Journal of the Caribbean and Its Diaspora* 10/3 (2007) pp.53-83; R. J. R. Elliott et al., 'Hurricanes, fertility, and family structure: a study of early 20th century Jamaica', *The History of the Family,* 28/4 (2023) pp.660-687; K. Morgan, *A Concise History of Jamaica* (Cambridge: Cambridge University Press, 2023).

[89] Moore & Johnson, *Neither led nor driven* pp.62-67. On folk medicine, note also A. Payne-Jackson and M. C. Alleyne, *Jamaican Folk Medicine: A Source of Healing* (Kingston: University of the West Indies Press, 2004).

1925: these were published in the *Jamaica Gazette*, which are preserved in annual volumes (in file CO/141) in the Colonial Office archives in the UK National Archives (Kew). Until 1931, these volumes also included supplements to the *Jamaica Gazette* containing annual reports from the JHC and the Island Medical Department; data from the National Bacteriological Laboratory were extracted from the latter. *Jamaica Gazette* volumes after 1931 do not contain these reports, but the annual medical reports containing JHC annual reports through to 1936 were printed separately, and were provided to me by the University of the West Indies (UWI) Medical Library. I have also made use of government correspondence from both the Colonial Office archives and the Jamaican National Archives (Spanish Town).

The *Journal of the Jamaica Agricultural Society*, accessed in the Natural History Museum library (London), also provided valuable information on folk use of medicinal plants and knowledge of parasitic worms, as well as on how hookworm was viewed outside of the government and the ways the JHC engaged with local institutions and figures such as Agricultural Society branches and their agricultural instructors. Finally, I use health education journal *Jamaica Public Health*, which offers a useful perspective on how the JHC attempted to persuade ordinary people to care about hookworm. I was able to access the full series of *Jamaica Public Health* at the National Library of Jamaica (Kingston), while I was in Jamaica using the UWI library and the Jamaica Archives.

I have also made extensive use of the medical histories provided by Riley, Jones and Heuring, which discuss life expectancy, the development of public health, and the politics of health during this period of Jamaican history, respectively.[90] These three discuss the JHC as a significant event in Jamaican medical history which had important effects upon life expectancy and the development of health systems, but none of them focus upon

[90] J. C. Riley, *Poverty and Life Expectancy: The Jamaica Paradox* (Cambridge: Cambridge University Press, 2005); M. Jones, *Public Health in Jamaica, 1850-1940: Neglect, Philanthropy and Development* (Kingston: University of the West Indies Press, 2013); D.H. Heuring *Health and the Politics of 'Improvement' in British Colonial Jamaica, 1914-1945* (PhD Thesis: Northwestern University, Illinois, 2011).

hookworm itself. This thesis provides the first study to discuss the meanings of hookworm in Jamaica, the ways in which it was understood by different people within Jamaican society, its interactions with the environment of Jamaica and its relationships with other worms.

3.2 The Windward Islands Association

My second case study is the Windward Islands Association. This was a group of islands in the windward subset of the Lesser Antilles under British rule; in the period I discuss, the association consisted of St Lucia, St Vincent and Grenada. These three are small mountainous volcanic islands on the eastern rim of the Caribbean. All have their own complex histories of encounter between Kalinago, Taíno, African, British, French, Dutch and Spanish; their amalgamation was a product of administrative convenience more than shared commonalities.[91] Sugar continued to be grown in the Windward Islands into the 20th century alongside other crops such as cacao and coffee.[92]

While the hookworm programme in Jamaica was administered by American RF doctors with the involvement of Jamaicans, in the Windward Islands the programmes were primarily led by members of the colonial medical service. This meant that not only did the programmes take differing approaches, but also that hookworm and its extinction were conceptualised differently than in Jamaica. While both Jamaica and the Windward Islands were British colonies, furthermore, there were important social and geographic differences between the two contexts. The Windward Islands were significantly smaller than Jamaica, and lacked Jamaica's demographically and politically significant middle classes. As I demonstrate in Chapter 5, Jamaica's middle classes played an important role in the hookworm programme. As I will show (and will discuss further in Chapter 8), these differences in social and political context created important differences in the hookworm programmes between Jamaica and the Windward Islands. Studying the hookworm programmes in three smaller islands, furthermore, highlights the several ways in which the programme in Jamaica was

[91] See Watts, *The West Indies* for a broad long-term overview.
[92] Watts, *The West Indies* pp.496,501-505.

unusual, as well as highlighting how the meanings and ecologies of hookworm varied between contexts.

In the Windward Islands my study period is framed by the duration of the hookworm programmes. These were instated in late 1914 and early 1915 across all three islands, but ended in 1917 in Grenada, 1918 in St Vincent and 1924 in St Lucia. My study therefore covers the decade from 1914 to 1924.

My key source here has been the British Colonial Office archives. These contain a large volume of correspondence and reports relating to the hookworm programmes, but there are some chronological gaps in the available reports relating to St Lucia. For this reason, I requested scans of the Rockefeller Foundation reports on hookworm in St Lucia from the Rockefeller Archive Center. These filled the gaps in the Colonial Office archives, and, containing the unedited reports submitted by doctor-in-charge Stanley Branch, also sometimes provided additional insights into Branch's perspectives and opinions. Though Pemberton and Tikasingh *et al.* provide brief overviews, this is the first in-depth study of hookworm on these islands.

3.3 Cornwall

Finally, I turn to a very different, but connected location: Cornwall. In Cornwall, hookworm was found before the foundation of the RF, and control efforts took a different form again, being a collaboration between metropolitan scientists and the Cornish mining industry rather than between colonial governments and an American philanthropy. This likewise created a different set of attitudes and control measures towards hookworm, though, as I will discuss, both peripheral and metropolitan knowledge shaped how hookworm was understood in Cornwall. I will also show that hookworm in Cornwall was embedded in an unusual socioecology, which shaped hookworm in a variety of different ways. Cornwall therefore offers a contrasting study, with many peculiarities which show just how far hookworm could be shaped by local context. However, there were also some commonalities between contexts, as I will discuss in Chapters 7 and 8.

Cornwall sits on the south-western tip of Great Britain. With a long coastline extending around its southern, western and northern edges and a complex geology, its main historic industries were farming, fishing and mining (Figure 1.6), before these were supplanted by tourism in the 20th century. As I will show, the history of hookworm in Cornwall is intimately connected with that of mining. Mining has long been a feature of the Cornish economy, but the industry expanded dramatically in the 18th and 19th centuries, in part driven by industrialisation and the development of steam-driven pumping engines.[93] The mines initially primarily worked copper, before the industry began focusing more on tin in the middle of the 19th century.[94] By the 20th century, however, mining was in decline and Cornwall was beginning to deindustrialise.[95] Throughout the heyday of Cornish mining and into the 20th century, large numbers of Cornish miners emigrated either temporarily or permanently, creating a mobile and fluid diaspora across the Americas, Africa, Australia and Asia.[96] This, I will show, had significant consequences for the health of miners in Cornwall.

[93] See Barton, *A History of Tin Mining and Smelting in Cornwall* & *A History of Copper Mining in Cornwall and Devon* (Truro: Truro Bookshop, 1961).
[94] Barton, *A History of Tin Mining* pp.99-154, *A History of Copper Mining* pp.75-89.
[95] Barton, *A History of Tin Mining* pp.184-288.
[96] P. Payton, *The Cornish Overseas: the epic story of the 'Great Migration'* (Fowey: Cornwall Editions, 2005).

Figure 1.6: Remnants of the St Just mining district, looking north-east from Wheal Edward (above), and Wheal Uny, looking north-west towards Carn Brea (below). The hard, mineral-rich granite produced the Cornish mining industry, and the sea facilitated easy travel to mining districts around the world – with some interesting consequences for hookworm, as I will show. The Redruth-Camborne mining district clustered around the base of Carn Brae.[97] I will show that the existence of such a dense mining landscape shaped hookworm in particular ways.

[97] It has been claimed that nearly the entirety of Cornwall's copper mining took place within eight miles of the summit of Carn Brea: Deacon, *Industrial Celts* p.47.

Assigning precise dates to the emergence of hookworm in Cornwall is difficult – as I will discuss, it was several years after anaemia among miners at Dolcoath Mine (Figure 1.7) was first noticed that this was identified as hookworm. Once hookworm had been identified in Cornwall, its arrival was retrospectively dated to around 1895; I searched the correspondence of the managers of Dolcoath Mine, the epicentre of the outbreak, through the 1890s, but failed to find any explicit reference to anaemia prior to its identification with hookworm in 1902.[98] Dating the end of the outbreak is, as I will also discuss, equally difficult. The latest available evidence of hookworm in Cornwall is provided by Robert Leiper in 1920, published in a brief *British Medical Journal* article.[99] I have therefore framed my study of Cornwall as covering the period between 1895 and 1920.

Figure 1.7: Dolcoath Mine: the epicentre of the outbreak of hookworm in Cornwall.

I have used a range of primary sources in my discussion of Cornwall. My discussions of the transmission dynamics, clinical presentation and symptoms of hookworm in Cornwall draw predominantly from medical and scientific literature which has not been re-examined since its initial

[98] Archives and Special Collections, Penryn Campus (Falmouth), Thomas Family Papers (ECP1) [henceforth PT], ECP1 Box 21 (1891-1904).
[99] R. Leiper, 'Hookworm in Cornwall', *BMJ* 1/3193 (1922) p.406.

publication at the time of the outbreak. Foremost among these are the studies of John Scott Haldane and Arthur Edwin Boycott, which appear in a variety of formats: the Home Office published two reports (on hookworm specifically, and on the health of Cornish miners more broadly), and the pair also authored a series of articles in the *Journal of Hygiene*.[100] Boycott subsequently presented a series of lectures on hookworm, the written versions of which are available from the Wellcome Collection.[101] In addition, I have used a volume collecting the work of mining doctor Josiah Court, including a lecture he gave to the Miners' Federation (the colliers' trade union) on hookworm and minutes of the subsequent discussion.[102]

I accessed a variety of local government documents at the Kresen Kernow archives (Redruth), including the reports of the Medical Officer of Health for the Camborne district. These included some information on hookworm, but the rest of the local government documents did not. Following this, I visited the Archives and Special Collections at Penryn Campus. These proved far more useful, as they contained not only the reference library of the former Camborne School of Mines (1888-1993), which I used to explore how hookworm was understood by the mining industry, but also the correspondence of Richard Arthur Thomas, mine agent for Dolcoath Mine during the time of the outbreak.[103] None of these sources had been accessed by historians of hookworm previously, and Arthur Thomas'

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[100] J.S. Haldane, *Report to the Secretary of State for the Home Department on an Outbreak of Ankylostomiasis in a Cornish Mine* (London: Home Office, 1902); J.S. Haldane, J.S. Martin & R. Arthur Thomas, *Report to the Secretary of State for the Home Department on the Health of Cornish Miners* (London: Home Office, 1904). J.S. Haldane & A.E. Boycott, 'An Outbreak of Ankylostomiasis in England No.I', *Journal of Hygiene* 3/1 (1903) pp.95-136; J.S. Haldane & A.E. Boycott 'Ankylostomiasis No.II' *Journal of Hygiene* [henceforth *J Hyg*] 4/1 (1904) pp.73-111; J.S. Haldane and A.E. Boycott, 'The Progress of Ankylostomiasis in Cornwall' *J Hyg*. 9/3 (1909) pp.264-270; A.E. Boycott, 'Further Observations on the Diagnosis of Ankylostoma Infection with Special Reference to the Examination of the Blood' *J Hyg* 4/4 (1904), A.E. Boycott, 'A Case of Skin Infection with Ankylostoma' *J Hyg* 5/3 (1905) pp.280-284.

[101] A.E. Boycott, *The Milroy lectures: on ankylostoma infection delivered before the Royal College of Physicians of London on March 2, 7, and 9, 1911* (Lancet: London, 1911) via Wellcome Collection, https://wellcomecollection.org/works/h95zje3a [7th October 2024].

[102] J. Court, *Miners' Diseases: Records of the Researches of Dr J. Court (of Staveley) into Miners' Nystagmus and Ankylostomiasis* (undated, held by the University of Leeds library)

[103] PT ECP1 Boxes 19,20,21,28 & 29.

correspondence, particularly the letters he sent to Haldane and Boycott, was especially useful in shedding light on the ways in which knowledge of hookworm was created and circulated. Arthur Thomas, I will show, played a key role in circulating knowledge far beyond Cornwall.

Following the threads of mining, I located in the National Coal Mining Museum for England library (Wakefield) a further handful of useful books on mining as well as records of meetings held by the Mining Association of Great Britain, the employers' association, discussing hookworm. These proved useful for exploring responses to hookworm and anxieties about it spreading to the coalfields.

Hookworm in Cornwall has not been the focus of a study since the time of the original outbreak. Likewise, the sources I have used have, as far as I know, not been used by historians previously. Taking an interdisciplinary approach to these sources and examining their quantitative and qualitative contents in concert allows me to explore how hookworm was shaped by Cornwall in unusual ways.

4 Chapter Outlines: A map of the thesis

As I have discussed, this thesis is concerned with the biology, ecology and meanings of hookworm, and the ways these interact within the context of medical efforts to control and eradicate hookworm. I have one overarching research question: how did hookworm, humans and environments interact? This provides my three themes of people, parasites and places, which guide my approach throughout. These overarching themes are distilled into three research questions which are addressed throughout the thesis (Figure 1.8). Firstly, how do human-shaped environments affect hookworm? Secondly, how have humans understood and experienced hookworm? And thirdly, how do attempts to induce the extinction of hookworm challenge or affirm understandings of extinction?

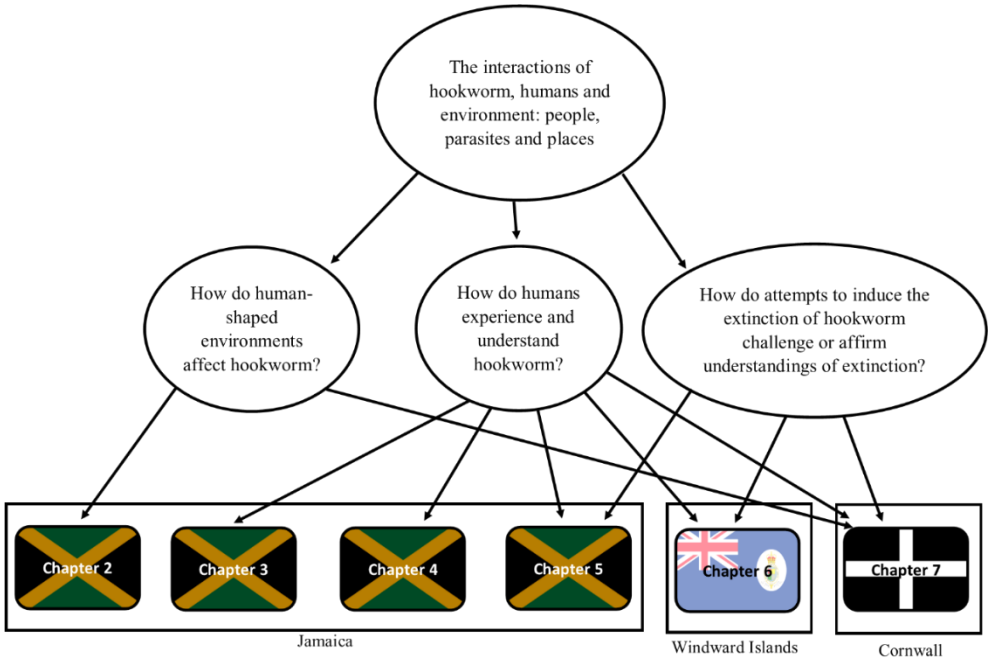

Figure 1.8: Research questions and structure of the thesis

I begin with my largest case study, Jamaica. Chapter 2 introduces the Jamaica Hookworm Commission (JHC) and its attempts to induce the extinction of hookworm. Following this, the chapter takes a novel approach drawing together spatial epidemiology with the history of medicine, in order to explore some social and environmental influences on hookworm infection and extinction. This allows me to investigate the forces shaping hookworm's transmission in a scientific manner, while also exploring how these forces were socially shaped, and how they interacted with the social and political meanings of hookworm.

In this chapter it is shown that the colonial elites desired the extinction of hookworm because they viewed it as a threat to productivity, particularly in the context of plantation work – a form of labour which they viewed as inherently civilising. The economic and ideological interests of the colonial elite were too intimately entangled to separate, and these shaped both how hookworm was viewed and how it was transmitted. Hookworm was significantly more prevalent in districts which contained plantations, as well as being influenced by rainfall, temperature and vegetation. Despite this, the burden of hookworms carried, and therefore the pathogenicity of hookworm infections, varied significantly, even between individuals living together. This chapter has been accepted for publication at *Cambridge PRISMS: Extinction*, and is therefore presented in paper form.

Colonial elites and medical professionals understood hookworm as a threat to profit and productivity, despite the fact that the plantations they valued spread hookworm. But how did ordinary Jamaicans encounter hookworm? To answer this question requires analysis of the handful of available documents in which ordinary Jamaicans narrate their own experiences. Chapter 3 uses letters sent from ordinary people to the JHC to explore the different ways hookworm was experienced and understood. This is primarily a social history of disease, but also draws from parasitology and quantitative data to explore trends in hookworm prevalence. It is found that hookworm was more common in adults than children, and slightly more prevalent among men than women, but experiences of hookworm varied widely. Some experienced hookworm infection as drowsiness, but others were severely debilitated. Likewise, while the colonial elites tended to think of hookworm as a threat to productivity, ordinary labourers were more likely to understand it as a threat to subsistence and survival.

Different people experienced hookworm in a range of different ways, but for many Jamaicans the symptoms of hookworm – drowsiness, giddiness, and fatigue – were not self-evidently tied to a worm. How, then, was knowledge of hookworm created? Chapter 4 discusses how knowledge of *Ascaris* and other parasitic worms shaped knowledge of hookworm, and persuaded people to engage with the JHC. This epistemic relationship between *Ascaris* and hookworm was undergirded by an ecological relationship, with the two species commonly co-infecting the same hosts. This chapter therefore integrates epidemiology and parasitology with history of medicine in order to untangle both the ecological and epistemic relationships between worms. Here reasonably high-quality data is available from Jamaica's Public General Hospitals; quantitative analysis of data collected by both the JHC and public hospitals is therefore used to test for associations between worm species. This is combined with qualitative surveys of discussions about hookworm and roundworm within the *Journal of the Jamaica Agricultural Society* and other literature, which are used to assess what Jamaicans knew about parasitic worms.

It is found that *Ascaris* and hookworm were both widespread and that infection with one was associated with an increased risk of infection with

the other. As *Ascaris* was larger and more visible, Jamaicans were familiar with it, knew it to be a threat to their health, and treated it with remedies including the plant semi-contract (*Chenopodium ambrisoides*). This allowed the JHC to use familiarity with *Ascaris* to persuade Jamaicans of the existence of another, more hidden, parasitic worm: hookworm. Moreover, biomedicine used chenopodium oil to treat hookworm, gaining credibility by using a plant which was widely used in folk medicine. Chenopodium's effectiveness at expelling *Ascaris* similarly provided more dramatic visual proof of the effectiveness of JHC treatment than that provided by hookworm. This chapter has been published in *Transactions of the Royal Society of Tropical Medicine and Hygiene,* and is therefore presented in paper form.

This was one of most important ways in which Jamaicans were persuaded to engage with the JHC, but it was not the only one. Chapter 5 builds on the preceding chapter by exploring the role of hookworm as a tool of health education in Jamaica, and the health education efforts which grew out of it. My approach in this chapter is entirely qualitative, using medical reports and health education literature to discuss how hookworm and its extinction were conceptualised. Washburn successfully recruited the influential and increasingly nationalist Jamaican middle classes into his project, in which he imagined a hygienic modernity which would both result from and produce the extinction of hookworm. At the same time as anticipating the extinction of hookworm, he also anticipated that the advance of 'modern medicine' and 'modern ways of living' would drive folk medicine extinct. Hookworm, as a tool of health education, would play an important role in this.

Having discussed many aspects of hookworm in Jamaica, I then turn to the Windward Islands in Chapter 6. I build on the discussion of how the extinction of hookworm was seen as a way to advance modernity in the previous chapter by exploring these themes in a similar, but distinct context. My approach in this chapter is primarily qualitative: the available reports in the British Colonial Office and Rockefeller Foundation archives contain some useful numerical data, but are dominated by rich seams of discourse, opinion and description. I therefore analyse the evidence contained within

these medical reports to explore the ways hookworm and its extinction were understood. This develops the thesis by focusing on what have been running themes up until this point, and elucidating them in more depth. The evidence of this new case study leads me to a slightly different line of argument to that of the previous chapter: I show that hookworm became for the colonial medical profession a signifier of backwardness and an uncivilised environment. The extinction of hookworm was therefore desired as an indicator of sanitary and civilizational progress. Despite the efforts of the medical service, however, hookworm persisted, and became instead a symbol of colonial failure, as many of those cured of hookworm subsequently acquired the parasite again.

Finally, I turn to Cornwall. Chapter 7 focuses on how Cornwall as a place shaped hookworm in a variety of ways, and, as the available evidence is mainly descriptive, takes a predominantly but not exclusively qualitative approach. I use medical literature from the time to characterise the ways in which Cornwall shaped the transmission dynamics and symptoms of hookworm, combined with Arthur Thomas' correspondence and industrial literature to explore how knowledge about hookworm was created and circulated, and how hookworm was understood. While broadly an environmental history, this chapter also characterises parasitological details of Cornish hookworm, and draws from the history of science in its exploration of the production and circulation of knowledge about hookworm. I provide the first comprehensive account of hookworm in Cornwall, and the first study focusing on the topic since the time of the outbreak. I also make comparisons to Caribbean context throughout this chapter, exploring how hookworm played different roles in different contexts, but also how knowledge of hookworm circulated between the two places.

My primary contention in this chapter is that the environmental and social conditions of the Cornish mines allowed hookworm to thrive, and shaped not only the transmission dynamics of hookworm, but also its symptoms and meanings. Hookworm arrived with miners returning from the Cornish diaspora, and could only survive in the warm, wet mud of the deep mines. Only a handful of mines offered suitable conditions, most notably Dolcoath

Mine, where hookworm was most prevalent and first noticed. The unique set of symptoms created by hookworm in Cornwall became known as 'Dolcoath Anaemia', and was characterised by skin irruptions known as 'bunches', shortness of breath on climbing ladders, and pallor of the lips and eyes. Following the identification of Dolcoath Anaemia with hookworm by John Scott Haldane in 1902, Cornwall and Dolcoath in particular became a research destination for scientists to study this exotic tropical disease, defining Cornwall as what I term a 'medical domestic exotic'. Despite fears that hookworm would spread to the collieries, hookworm slowly faded away over the next thirty years, as treatment ensured that the symptoms of Dolcoath Anaemia became rare, even as the parasite persisted. Hookworm's slow and largely unnoticed extinction coincided with and was enabled by the closure of the deep mines which had provided the conditions for its spread in the years following the First World War.

Throughout the thesis three key overlapping themes will surface: hookworm-human-environment relationships, extinction, and knowledge (Figure 1.9). Relationships will be addressed in Chapters 2, 4, 6, and 7; extinction in Chapters 2, 5, 6, and 7; and knowledge in Chapters 4, 5, and 7. Throughout this thesis, I have adopted an evidence-first approach, gathering material and data from relevant archives before determining and applying suitable methodologies from whichever discipline provided appropriate ways of answering my questions. Where possible, I have integrated quantitative methods drawn from epidemiology and parasitology with qualitative methods drawn from history, but my methods have been decided principally by the nature of the available evidence. Where large amounts of good quality data were available, as in Chapters 2 and 4, I was able to apply statistical methods with great success, and to bring these into dialogue with the results of qualitative interpretations of archival material. In other chapters (e.g. Chapter 5), however, I have relied primarily on qualitative evidence drawn from a range of archival and published sources. This has resulted in a disciplinary bricolage of methods and approaches, revolving around my central interest in the interactions of people, parasites and places.

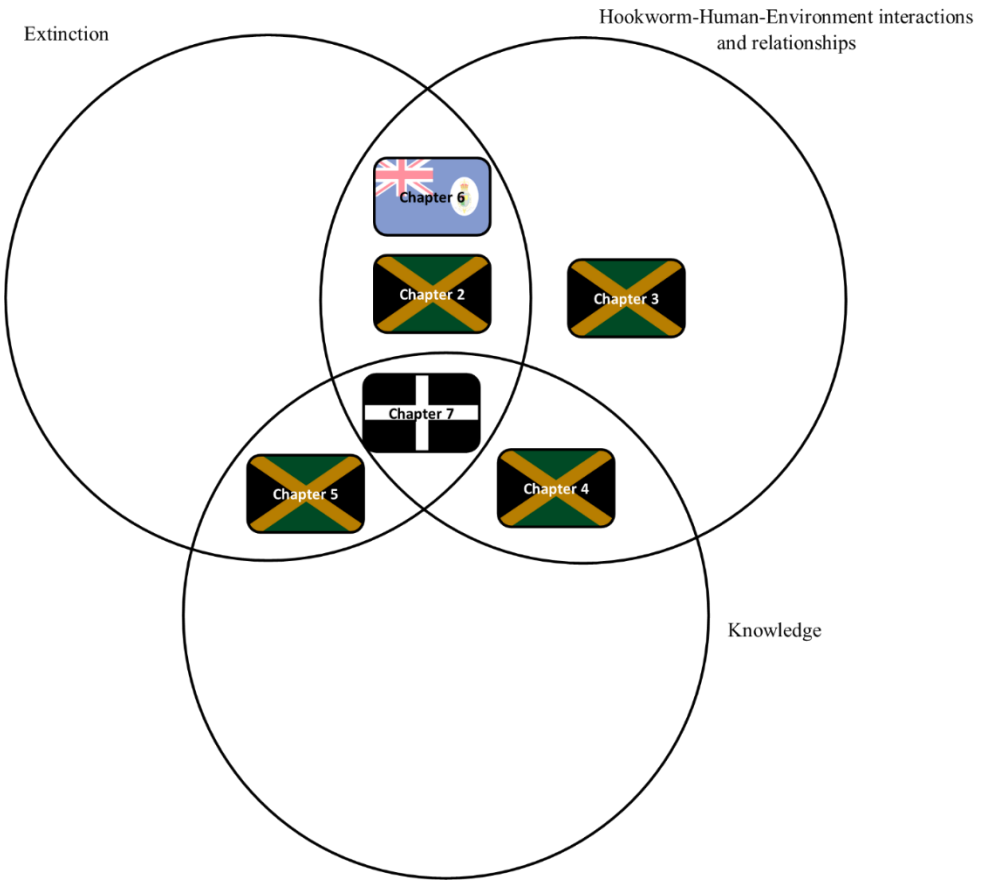

Figure 1.9: Venn diagram of themes in the thesis and chapters in which they are explored.

In this thesis I develop a new interdisciplinary approach, drawing from methods across history and biology in order to study hookworm and attempts to induce its extinction holistically. This approach is not only novel in itself, but is applied to previously unstudied contexts. This allows, as I will show, novel discussions of how hookworm is shaped by socioecological and historical context in its transmission dynamics, social meanings and clinical presentation. People, parasites and places, I show, interacted in complex ways, shaping hookworm as well as attempts to induce its extinction.

Chapter 2 Parasites and Plantations: Disease, Environment and Society in efforts to induce Extinction of Hookworm in Jamaica, 1919-1936

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Impact Statement

This paper examines an underappreciated form of extinction: an attempt to induce the extinction of a parasite. By doing so, it historicises extinction,

demonstrating that anthropogenic extinctions are driven by specific social, economic and ecological configurations, not by any one single 'humanity'. It further adopts a novel interdisciplinary method, extending both epidemiology and medical history, thereby bridging both and bringing two very different approaches into dialogue. This approach aims to speak to both disciplines and thereby have some impact on both fields. It demonstrates that diseases are influenced by a complex combination of social, environmental and individual factors, something always worth highlighting in a world where social medicine is now only remembered by historians and biomedicine is individualised to the point where its futuristic dream is 'personalised medicine'. Finally, it extends historical understanding, by elaborating on the medical landscape of an understudied period in Jamaican history: the period between the 1865 Morant Bay Rebellion and the 1938 Labour Rebellions.

Word Count excluding figures, tables and references: 4386

Abstract

Studies of extinction typically focus on unintended losses of biodiversity and culture. This paper, however, examines an attempt to induce extinction of a parasite: human hookworm (*Necator americanus* & *Ancylostoma duodenale*). Our interdisciplinary approach integrates medical history and epidemiology using records created by the Jamaica Hookworm Commission of 1919-1936. We show that the attempt to induce the extinction of hookworm was driven by its perceived effect on labour productivity and consequent status as an ideological and an economic threat. We use spatial epidemiology to describe the relationships between parasite, environment and the working conditions of plantation labourers. Using data from 330 locations across Jamaica in which 169,380 individuals were tested for hookworm infection we show that the prevalence of hookworm infection was higher in districts surrounding plantations. Prevalence decreased with the temperature of the coldest month, increased with the amount of rainfall in the driest month, and increased with vegetation quantity (normalized difference vegetation index). Worm burden (and thus pathology) varied greatly between individuals, even those living together; hookworm infection varied between environments, socioeconomic conditions and individuals. Nevertheless, the conditions of labour shaped the

distribution of hookworm. Plantations both spread and problematised hookworm, driving efforts to bring it to extinction.

Parasites and Plantations: Disease, Environment and Society in efforts to induce Extinction of Hookworm in Jamaica, 1919-1936

Introduction: Induced Extinction

While biology defines extinction as a single event, it is now commonly held in extinction studies that extinction is more of an ongoing process of unknotting webs, as ecological, cultural and emotional entanglements fall apart; even after the last individual of a species has died, memorialisation recapitulates extinction, and extinct species live on as ghosts in the ecological and cultural spaces they once inhabited (van Dooren 2014; Heise 2016; Jørgensen 2017; McCorristine and Adams 2019; Rose et al. 2017). Extinction, therefore, has no end. But where does extinction begin?

Most studies of extinction focus on unintended losses of species, biodiversity and cultures. This paper, however, offers an interdisciplinary perspective on an attempt to induce the extinction of a parasite: human hookworm. It aims firstly to elucidate a socioeconomic driver of extinction – the perceived effects of hookworm on labour productivity within a plantation system – using discursive historical analysis. Secondly, the interactions of the socioeconomic/socioecological institution of the plantation with environmental factors in shaping the prevalence of hookworm are explored through spatial epidemiology. Finally, this paper turns to the worm burden, the number of hookworms within individuals, in order to comment upon how far socioecological conditions can be said to determine the pathology of hookworm disease.

These will be studied through the records created by the Jamaica Hookworm Commission (JHC) of 1919-1936. The JHC was launched in 1919 (Jones 2013) as a cooperative endeavour between the colonial government and the Rockefeller Foundation (RF), which viewed hookworm as a convenient ‘wedge’ to induce foreign governments to build up public health systems (Birn and Solórzano 1999; Farley 2004). The RF was founded by Standard Oil baron John D. Rockefeller and absorbed his business-minded outlook; it aimed to cheaply build up public health systems, and believed that hookworm

eradication campaigns part-funded by local governments offered good returns in public health for a relatively small investment (Ettling 1981; Farley 2004). Initially headed by Powell Gardener, the JHC was soon taken over by fellow RF doctor Benjamin Earl Washburn.[1] It was absorbed by the colonial government in 1933, but continued until 1936, when the 'hookworm units' were reconfigured as 'mobile health units' focussing mainly on yaws (*Treponema pallidum pertenue* infection).[2]

Jamaica in 1919 was the largest of the British West Indies, and remained a regional centre, but was neglected by the imperial government (Jones 2013). Following emancipation and the end of slavery in 1838, and more importantly the ending of British tariff protections for West Indian sugar in 1846, the sugar industry which had made Jamaica's planter classes rich crashed (Bryan 2000). As the imperial government focused on India and Africa, Jamaica became a backwater colony, receiving no financial aid and few medical doctors from Britain (Heuring 2011). Kingston constituted the only major city, but several smaller towns were scattered around the island (Moore and Johnson 2011). Despite the decline of the sugar industry many plantations remained, growing cash crops such as sugar, bananas and coffee, and employing day-labour as well as indentured labourers from India (Bryan 2000; Shepherd 1994). Much of the population consisted of 'small settlers': subsistence farmers who had established their own smallholdings after emancipation (Moore and Johnson 2011). The urban poor crowded into subdivided houses and communal yards, while the urban middle class possessed significant political influence (Moore and Johnson 2011) which they used to influence health efforts according to their social and political goals (Heuring 2011). Access to biomedicine was limited, and many relied on a rich tradition of folk medicine (Jones 2013; Payne-Jackson and Alleyne 2004).

[1] UK National Archives, Kew [NA], CO/141/82 'Government Notices' *Jamaica Gazette,* 42:10 (1919).
[2] Jamaica Archives, Spanish Town [JA] IB/5/77/254 'Hookworm + Malaria Commissions – taking over by Government' (1933); University of the West Indies Medical Library, Mona [UWI] 'Medical Department: Report for the year ended 31st December, 1936' (1936).

Hookworm disease is caused by parasitic nematodes of the family Ancylostomatidae; the main parasites of humans are *Ancylostoma duodenale* and *Necator americanus* (Brooker et al. 2004). Adult hookworms attach to the wall of the small intestine, where they feed on haemoglobin from red blood cells (haematophagy) (Shalash et al. 2021). They copulate and lay eggs in the small intestine, which are then passed in the faeces (Loukas et al. 2016). Eggs hatch in the soil into saprophytic L1 larvae, before moulting into L2, then L3, larvae in 5-10 days (Brooker et al. 2004; Loukas et al. 2016). L3, the infective stage, move towards heat and movement, actively seeking hosts, and entering them percutaneously through hair follicles (Gaze et al. 2014). Once inside the body, they migrate through the capillaries into the lungs, ascending the trachea until involuntary coughing moves them into the gastrointestinal track where they are swallowed, thereby entering the alimentary canal (Chapman et al. 2021; Loukas et al. 2016). Host blood loss is directly dependent on burden; infection with a small number of hookworms is often asymptomatic, but higher burdens can produce iron-deficiency anaemia (Chapman et al. 2021; Loukas et al. 2016). It is therefore necessary to distinguish between infection – the presence of live parasites within a host – and disease – illness caused by the parasite. In the early 20th century both infection and disease were widespread across the circum-Caribbean region, from the American South to Suriname (Hoefte 2009; Pemberton 2003; Tikasingh et al. 2011).

By 1919, the RF had largely retreated from its earlier rhetoric of 'eradication' in favour of 'control', having realised that 'though the problem of complete eradication seems simple in theory, it is not so in fact' (Howard 1919).[3] But they still envisaged 'control' as a step along the way to extinction: in his initial pitch to the Jamaican colonial government in 1915, Hector Howard (RF International Health Board director for the West Indies) urged that his proposed measures be adopted so that hookworm could be 'controlled and ultimately eradicated'.[4] Margaret Jones and James Riley have both noted the 1920s as an important period in the changing medical landscape of Jamaica,

[3] C.f. NA CO/137/742 B.E. Washburn to Dr Hunt (Superintending Medical Officer) 6th Sept. 1920.
[4] NA CO/137/711 H.H. Howard to Colonial Secretary, Feb 8th 1915.

as life expectancy, access to sanitation, public health services and health education were improved (Jones 2013; Riley 2005). Both credit Washburn and the JHC with a role in this, though both emphasise the crucial role played by Jamaican groups and individuals in shaping their own health. Resurveys of areas in which the JHC had operated between 1919 and 1922 showed dramatically reduced prevalence of infection following treatment of those found infected by JHC mass-testing (Figure 2.1), indicating that humans were rapidly disentangling themselves from hookworm, perhaps inching this obligate parasite in the direction of extinction. With the reduction in control efforts at the end of the RF programmes, there is some evidence of a rebound in hookworm prevalence, but very little data is available (Tikasingh et al. 2011). More recent surveys show hookworm to be now uncommon, with reported prevalence in the 1990s ranging from 0 to 6% (Tikasingh et al. 2011). The JHC was an important event in the extinction story of hookworm, even though it did not intend to bring about its immediate demise.

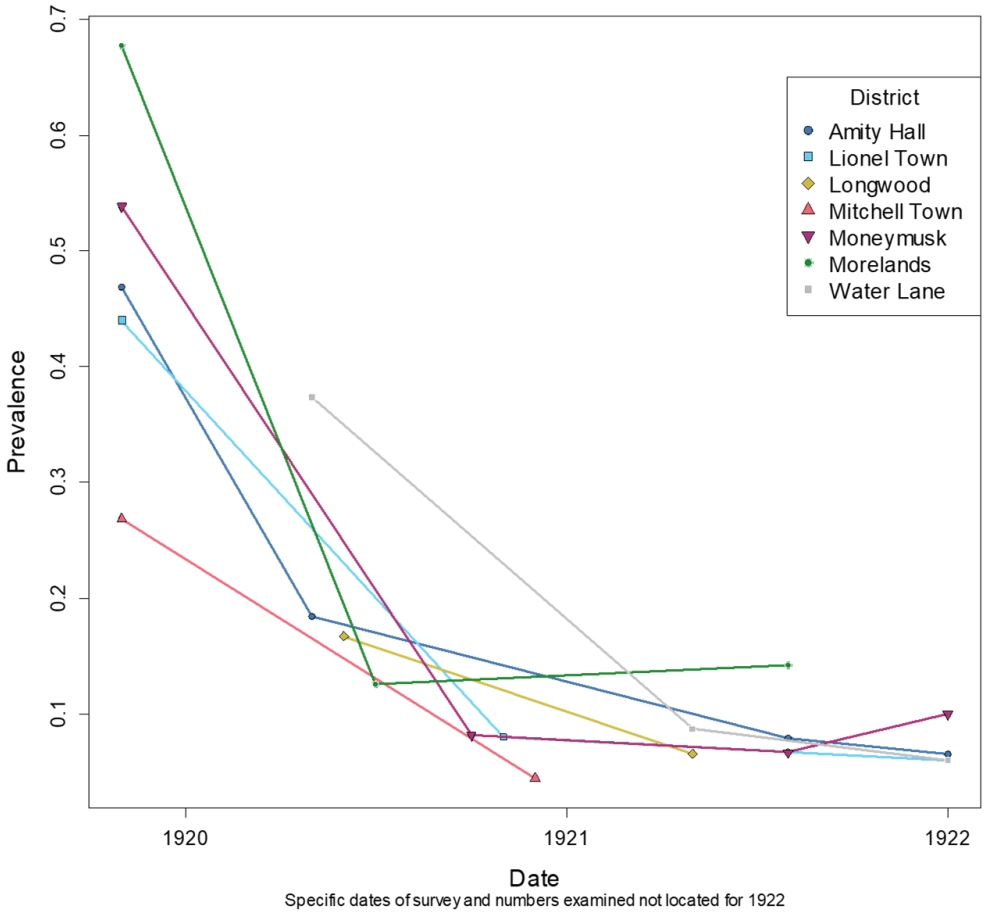

Figure 2.1: Results of prevalence surveys for hookworm infection in seven districts of Vere, St Catherine, pre- and post-JHC campaign, 1919-1922.
Data from NA CO/141/85 'Report of the Jamaica Hookworm Campaign for 1921' Supplement to the *Jamaica Gazette* 45:21 (1922) and NA CO/141/87 'Report of the Jamaica Hookworm Commission', Sup. *Jam. Gaz.* 47:2 (1924).

This paper explores the environmental and social influences on hookworm infection and describes how the planned extinction of hookworm was initiated as a result of the effect it was perceived to have on working capacity. Eugene Richardson has criticised epidemiology for the 'appalling silence of mathematical models' which privilege proximate risk factors and conceal a major cause of disease and death in the Global South: historical colonial and continuing neocolonial extraction (Richardson 2020). This current paper, by contrast, uses spatial epidemiology to integrate environmental and social analysis, demonstrating that temperature, rainfall, vegetation and the presence of plantations all shaped the prevalence of hookworm infection. Steven Palmer has argued that plantations led to increased burdens, and therefore increased pathogenicity, of hookworm (Palmer 2010); this paper explores the interactions of environment, hookworm and plantations as well as variations in burden between individuals.

Ideological & Economic Drivers of Extinction: Hookworm as a labour problem

This section explores how hookworm was viewed by the RF and the colonial authorities as a threat to labour productivity, necessitating hookworm's eradication. It uses reports and correspondence from the UK Colonial Office (CO) to examine the ways in which officials, doctors and plantation managers viewed hookworm, and why they desired its treatment and ultimate extinction.

As early as 1915, Howard wrote to the colonial secretary that 'the prevalence of ankylostomiasis among the labouring classes causes an enormous economic loss each year', a point which an anonymous official highlighted by means of a pen-drawn line to the left of the paragraph.[5] The CO found Howard's report 'far from reassuring'.[6]

By this point, the Jamaican government was already interested in hookworm. From at least 1913, it published monthly reports on hookworm from the public general hospitals, asked for reports on sanitation from its local health officers and began embarking on efforts to deworm prisoners, estate labourers and immigrants arriving from India as indentured labourers.[7] The settings of this 'thymolising' (thymol was the drug used to purge hookworm) are revealing – they are not only spaces where the state can enforce treatment through coercion, but also spaces which revolved around work. Prisons and indenture alike enforced regular working patterns to maximise productivity, and hookworm treatment formed a part of this. Deworming immigrants did not prevent hookworm becoming established on the plantations – it already was – but it ensured that labourers arrived on the plantations able to work at maximum capacity.

In 1920 Washburn wrote that 'Hookworm dissase [sic] is an important economic problem in Jamaica the control of which will result in increased

[5] NA CO/137/711 H.H. Howard to Colonial Secretary, Feb 8th 1915.
[6] Ibid.
[7] NA CO/141/76 'Island Medical Office Report' Sup. *Jam. Gaz.* 36:18 (2nd October 1913).

health and wealth for the people'.[8] Inability to work became a specific symptom of hookworm disease: Washburn asserted that a hookworm victim

> feels weak and is unable to do a full day's work because his knees become tired and his back aches and he cannot carry a load; and his poor work leads people to think that he is lazy.[9]

The blood loss and anaemia arising from heavy burdens of hookworm are biological processes; but this linkage to inability to work showcases that the symptomatology of a disease is shaped by the preoccupations of the society in question.

The Jamaica Hookworm Commission absorbed a societal preoccupation with work. The Jamaican upper classes (largely white) and middle classes (largely light-skinned people of mixed heritage; for a full discussion of the relationship between class and colour in Jamaica see Altink (2019)) combined the metropolitan view of work as inherently virtuous with racist anxiety about the need to 'civilise' the darker-skinned working classes (Moore and Johnson 2011). Ken Post has explained this in terms of a contest between peasant (small settler) and capitalist (plantation) modes of production (Post 1978). Jamaican elites felt that small settlers and labourers should prioritise paid work on plantations rather than shaping their working patterns around their own economic needs (Moore and Johnson 2011); but the labouring classes valued economic independence, landownership, and the freedom these provided, irrespective of elite accusations of laziness (Smith 2004). 'In the Caribbean', Brian Moore and Michelle Johnson argue, 'civilisation equalled hard work on the plantations' (Moore and Johnson 2011). Juanita de Barros has similarly noted that in the Caribbean 'the effects of hookworm disease…on labor productivity convinced medical researchers and those who funded their work that it had to be eradicated' (de Barros 2014).

The doctors working on the hookworm campaign valued work and economic productivity. They frequently referred to plantation managers benefitting from hookworm treatment producing more productive labour, using phrases

[8] NA CO/137/742 B.E. Washburn to Dr Hunt (Superintending Medical Officer) 6th Sept. 1920.
[9] NA CO/141/85 'Report of the Jamaica Hookworm Campaign for 1921' Sup. *Jam. Gaz.* 45:21 (19th October 1922).

such as 'the estate managers have expressed themselves as highly pleased with the benefits of the treatment…and the increased working ability of their employees'; 'estate labourers can do more and better and more regular work after being treated for hookworm disease'; and 'treatment for hookworm disease results in a noticeable increase in the working capacity of individual labourers'.[10] These reports also often include letters from plantation managers, who also viewed hookworm in primarily economic terms. H.B. Walcott, manager of the Amity Hall Estates, wrote that:

> Many individual labourers have had their health improved and this has resulted in their ability to do more regular work. Formerly there was a great deal of time lost from sickness, but since the hookworm campaign it has been rare to find a labourer who is unable to give full time. This is the most important economic factor resulting from the campaign…[11]

Washburn attributed improvements in (and enforcement of) sanitation by the plantations of lower Clarendon to the JHC demonstrating the 'great economic importance' of hookworm and sanitation.[12]

The pathology arising from loss of blood to hookworm was principally understood in economic terms. Hookworm became an economic threat to both the social and individual bodies, as it was understood to inhibit the host's ability to work. This represented both an economic threat and an ideological one, as plantation work was deemed inherently 'civilising' by the colonial authorities. Thus hookworm was defined as a major problem, necessitating control measures and placing it on the path to extinction. The fact that hookworm was viewed as a threat to work necessitated its destruction across society, as promoting work was a societal, even civilisational, concern for the colonial elites.

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[10] NA CO/141/84 'Report of the Jamaica Hookworm Campaign for 1920' Sup. *Jam. Gaz.* 44:22 (15th December 1921); NA CO/141/88 B.E. Washburn, 'Report of the Jamaica Hookworm Commission for 1924' Sup. *Jam. Gaz.* 48:7 (23rd April 1925); NA CO/141/91 B.E. Washburn, 'Report of the Co-operative Health Work in Jamaica during 1927', Sup. *Jam. Gaz.* 51:5 (26th April 1928).
[11] NA CO/137/742 B.E. Washburn to Dr Hunt (Superintending Medical Officer) 6th Sept. 1920.
[12] Ibid.

Parasites, Environment & Plantations

But what was the relationship between hookworm and the plantations valued by the colonial elites? Palmer has argued that plantations turned benign hookworm infections into hookworm disease, as plantations provided large densities of hosts, poor sanitation, and thus 'ideal ecologies' for the parasite's transmission, facilitating greater worm burdens (Palmer 2010). This section uses spatial epidemiology to untangle the relationship between parasite, environment and plantations, using data collected by the JHC across Jamaica.

The JHC eradication methodology was the RF 'intensive method' (Howard 1919). After securing cooperation and funding from the local Parochial Board, an area of operations was selected, and divided into 'districts' of around 500 people.[13] The Commission took a census of the number of people in a district before testing as many people as possible across all ages and genders for hookworm using salt flotation or centrifuging of faecal samples.[14] As well as adult workers, the JHC thought it important to test children, on whom they felt hookworm had 'dire effects', stunting growth and hindering their education and therefore their future opportunities and economic usefulness (this was another reason why hookworm's extinction was thought desirable).[15] Those whose samples were found infected with hookworm were treated with anthelmintics, usually thymol and chenopodium.[16] Previous epidemiological studies of hookworm using data collected by the RF have focused on the United States, where the 'dispensary method' was used alongside surveys of schoolchildren (Anderson and Allen 2011; Elman et al. 2014). These dispensaries were local spectacles, held in a public place and attempting to draw the local population to come forward for testing and treatment (Ettling 1981). Though successful at drawing crowds, the dispensaries did not aim to survey entire communities: dispensary and school-based records of hookworm therefore form a less complete sample than was

[13] NA CO/141/84 sup. *Jam. Gaz.* 44:22 'Report of the Jamaica Hookworm Campaign for 1920' (1921).
[14] Ibid.
[15] NA CO/141/88 B.E. Washburn, 'Report of the Jamaica Hookworm Commission for 1924' Sup. *Jam. Gaz.* 48:7 (1925); NA CO/141/85 'Report of the Jamaica Hookworm Campaign for 1921' Sup. *Jam. Gaz.* 45:21 (1922).
[16] Ibid.

obtained by the JHC. This is the first study to use historical data on hookworm prevalence collected by the intensive method.

The numbers of individuals examined and infected with hookworm from 368 districts was located in monthly and annual reports found in the *Jamaica Gazette* between 1919 and 1931 in the UK National Archives, Kew, and from the annual reports of the Island Medical Department between 1932 and 1936, accessed in the University of the West Indies Medical Library, Kingston. The hookworm commission eventually worked in all parishes, but data was only available for districts in 9 parishes, including a single district in Westmoreland.

To assign a latitude and longitude to each district, the namesake towns or villages of the district were searched for firstly on a 1901 map of the island, and secondly on an 1895 map.[17] If a district could be located from these maps, a pin was dropped on the same location in Google Maps, and the latitude and longitude of the pin was used. If a district could not be located from the older maps, the name of the district was searched for in Google Maps and the location of the present-day town was used. If no town was found, the coordinates of a church, school, police station or road bearing the name of the district was used. 309 districts were located this way and 21 districts were located by consulting maps held in the National Archives according to the same method.[18] In total 330 districts were located, in which 169,380 people were tested for hookworm.

Environmental data were extracted from WorldClim 2.0 (https://www.worldclim.org; Precipitation and Temperature), ISRIC (www.soilgrids.org; Soil Sand Content, Soil Grain Size and Soil Water pH)

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[17] E. Stanford, *Jamaica* (London: 1901) (49x60cm), David Rumsey Collection; NA CO/137/742 C. Liddell, 'Map of the Island of Jamaica, Prepared for The Jamaica Handbook' (1895).

[18] NA CO/700/JAMAICA37 'Sugar map of Jamaica, shewing sugar estates in 1790 and 1890'; CO/700/JAMAICA44 'Jamaica. General map showing products 8 miles to 1 inch'; CO/1047/513 'Jamaica General Map'; CO/700/JAMAICA50 'Jamaica'; CO 700/JAMAICA52 'Jamaica'; MFQ 1/885 'Map of Jamaica shewing the divisions of districts, and towns in which district courts are held'; WO/252/1065 'Spanish Town and surrounding country: Ordnance Survey Map'; WO/78/2424 'Jamaica: map showing roads, railways, counties, parishes, towns, schools and churches'; WO/78/567 'Jamaica. Map of the eastern part of the island…'.

and NASA MODIS (https://terra.nasa.gov/data/modis-data; Normalised Difference Vegetation Index (NDVI)). Values were averaged across a circle with a 500m diameter centring on the coordinates assigned to the district using *extract* from the *raster* R package. Presence of a plantation was taken from the list of estates in the 1919 *Handbook of Jamaica* – if a district name was found listed as the location of one or more plantations, this was noted in the dataset as both a binary indicator and as a categoric variable of the crops grown.[19] Districts which encompassed plantations were not always named after them, but in the absence of any information about the boundaries of the districts a namesake plantation strongly suggests that the plantation formed a major component of the district. 55 districts had associated plantations, mostly in the parishes of St Catherine (13) and St Mary (25).

Prevalence of hookworm infection was analysed after logit transformation to normalise residuals. A generalized least squares model with an exponential correlation coefficient of distance to account for spatial autocorrelation (*gls* from the *nlme* R package) was created to describe how prevalence varied across districts. Models using untransformed, log, and 2nd and 3rd order polynomial transformations of temperature and precipitation were created and Akaike Information Criterion (AIC) values were used to select the best fit. To select one precipitation and temperature variable each from the range of possible variables, models using these transformations were fitted to mean monthly temperature, minimum temperature, temperature of the coldest month and temperature of the hottest month alongside mean monthly precipitation, total annual precipitation, precipitation of the wettest month and precipitation in the driest month in all possible combinations of one rainfall and one temperature variable. The best fit model included precipitation in the driest month (as a second-order polynomial) and temperature of the coldest month (as a second-order polynomial).

Transformations of the remaining environmental variables were selected according to the same method by comparing models using untransformed, log and polynomial transformations using AIC values. NDVI and soil sand content were left untransformed, but soil pH fitted best when log-transformed

[19] *Handbook of Jamaica for 1919* (Kingston, Government Printing Office, 1919).

and soil grain size as a second-order polynomial. Following this, the function *dredge* (from the *MuMIn* R package) was used to find the model which best described how prevalence of hookworm infection varied with environmental factors.

JHC census data was available for 343 of the 368 districts; across these districts 99.2% of those censused (n=176,836) were tested for hookworm infection. Hookworm was most prevalent in the central mountains, and less prevalent along the southern coast (Figure 2.2). Prevalence ranged from 8.29% infected (n=712) in Hayes Cornpiece, Clarendon, to 96.7% (n=489) in Leinster, St Mary. The mean prevalence was 63.4% across all districts and 62.3% across all located districts.

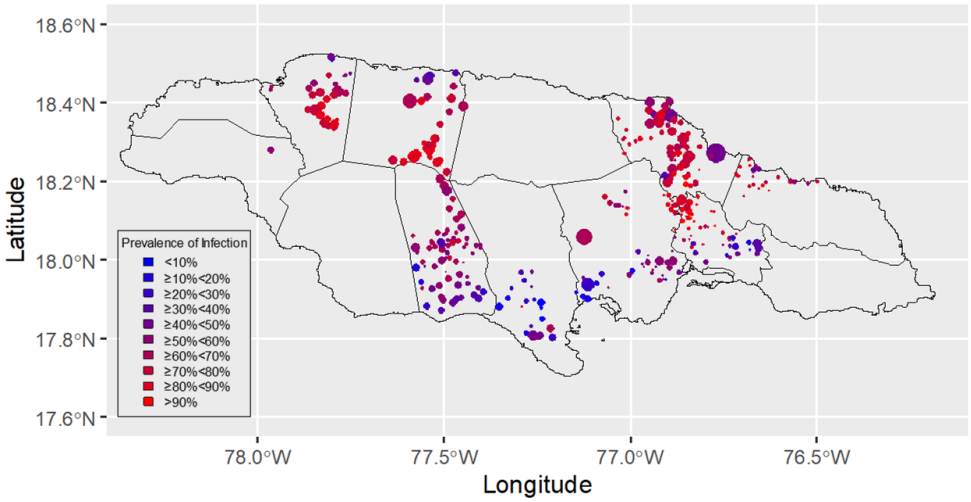

Figure 2.2: Prevalence of hookworm infection in 330 districts of Jamaica, 1919-1936.
Data from NA CO/141/83-93 *Jamaica Gazette;* CO/137/781-797 'Hookworm Reports'; and UWI, Medical Department Annual Reports. Dots scaled according to the number of individuals examined in each district. Redder dots indicate a higher prevalence of infection, larger dots indicate more individuals were tested.

The resulting model (Table 2.1) showed that hookworm was more prevalent in districts with a namesake plantation, more prevalent in wetter areas and had a curvilinear relationship with temperature (Figure 2.3). NDVI, a measure of vegetation quantity, was positively associated with hookworm prevalence, suggesting that hookworm was more prevalent in more rural areas.

Table 2.1: Generalised Least Squares Model of the prevalence of hookworm infection to various environmental variables in 330 districts of Jamaica, 1919-1936.

Variable	Coefficient Value	Standard Error
Precipitation in the Driest Month (mm)	8.70	±0.396
Precipitation in the Driest Month (mm, squared)	-1.45	±1.46
Precipitation in the Driest Month (mm, cubed)	-0.264	±1.12
Temperature in the Coldest Month (°C)	-2.88	±1.78
Temperature in the Coldest Month (°C, squared)	-0.36	±1.47
Temperature in the Coldest Month (°C, cubed)	3.70	±1.13
Presence of a Plantation in 1918	0.362	±0.0990
Normalised Difference Vegetation Index (NDVI units x 10^6)	1.11	±0.555

Table 2.2: Comparison of selected model with models incorporating fewer or additional environmental variables.
Transformations of Precipitation, Temperature and NDVI as in Table 2.1

Variables	Model AIC	Delta-AIC
Precipitation, Temperature, NDVI and Presence of a Plantation	649	-
Precipitation, Temperature, NDVI, Presence of a Plantation and Soil Sand Content	650	1
Precipitation, Temperature, NDVI, Presence of a Plantation and Soil pH (logged)	651	2
Precipitation, NDVI and Presence of a Plantation	651	2
Precipitation, Temperature and Presence of a Plantation	651	2
Precipitation, Temperature, NDVI, Presence of a Plantation and Soil Grain Size (2^{nd}-order polynomial)	652	3
Temperature, NDVI and Presence of a Plantation	654	5
Precipitation, Temperature, and NDVI	661	32

Table 2.3: Generalised Variance Inflation Factors of variables in the model shown in Table 2.1.

Variable	Generalised Variance Inflation Factor
Precipitation in the Driest Month (mm, 3rd-order polynomial)	2.55
Temperature in the Coldest Month (°C, 2nd-order polynomial)	2.79
Presence of a Plantation in 1918	1.03
Normalised Difference Vegetation Index (NDVI units x 10^6)	1.23

The selected model provided the best fit to the data with the fewest variables. Neither the addition of soil sand content or soil water pH, nor the removal of temperature or NDVI significantly changed model performance (delta-AIC<3; Table 2.2). However, the removal of precipitation or presence of a plantation, or the addition of soil grain size significantly impaired model performance; this suggests precipitation and plantations were of greater importance than temperature or vegetation. Generalised Variance Inflation Factors for the selected model (calculated using *vif* from the *car* R package) indicated only modest collinearity between variables included in the final model (GVIF<5; Table 2.3).

The positive relationship of prevalence and precipitation in the driest month is consistent with desiccation killing hookworm larvae in the soil, thereby reducing transmission (Ajjampur et al. 2021; Elman et al. 2014; Loukas et al. 2016; Mudenda et al. 2012; Wardell et al. 2017). Hookworm was least prevalent in the hottest areas, which was unexpected, as hookworm eggs and larvae typically survive temperatures up to 35-40°C (Mudenda et al. 2012; Udonsi and Atata 1987; Yaro et al. 2021). This may be because the hotter coastal plains of Jamaica were also drier, less densely vegetated, and more exposed to sunlight, leading to hookworm larvae dying from desiccation in hot, dry soils at temperatures which were themselves insufficient to kill them. In 1927 Washburn attributed his observation that ‘more people are infected with hookworms in mountainous districts than in the dry sandy plains near

the coast' to desiccation.[20] Temperature scales inversely with elevation; the colder, wetter mountains appear to have been more hospitable to hookworm. Vegetation has been found important in other studies as leaves shade soil thereby protecting hookworm larvae from desiccation (Ajjampur et al. 2021; Mudenda et al. 2012; Wardell et al. 2017). Greater exposure to L3 among rural small settlers and agricultural labourers was also likely important.

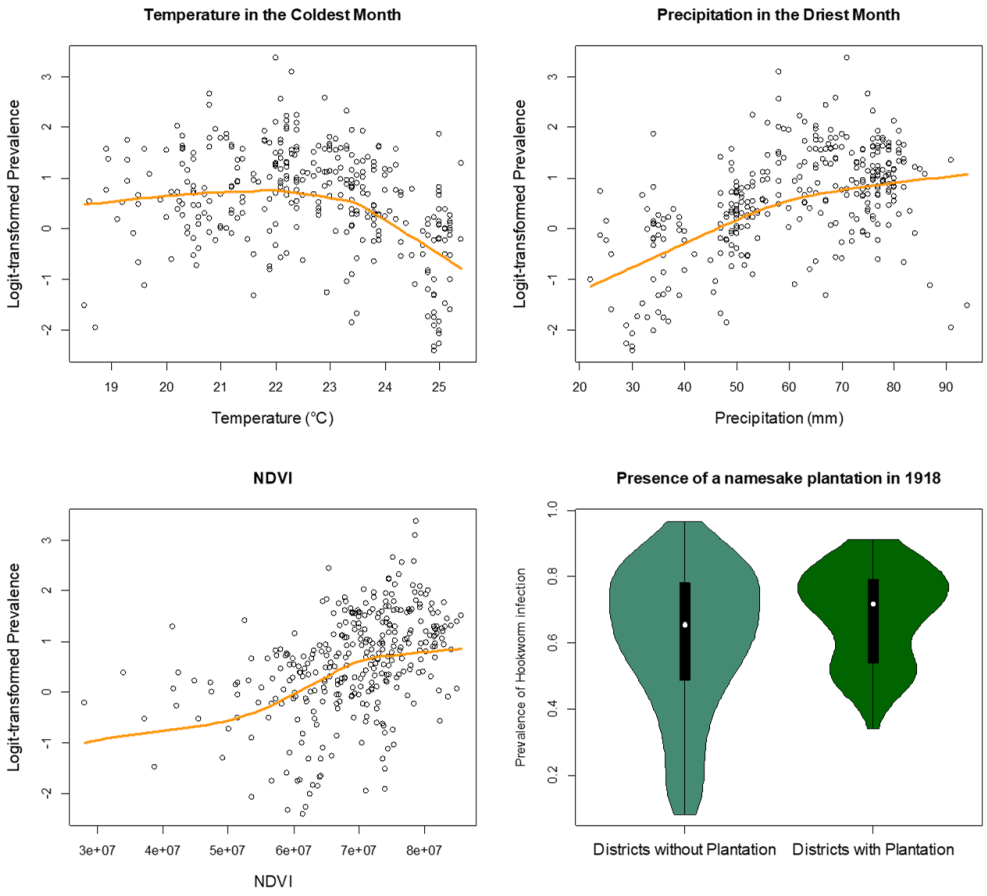

Figure 2.3: Logit-transformed prevalence of hookworm infection against mean temperature, mean precipitation, and NDVI, and violin plots showing prevalence of infection across districts with and without a namesake plantation, Jamaica, 1919-1936.
Lines represent a Loess smoothing of model predictions for each district.

Hookworm was more prevalent in districts with a namesake plantation, even after accounting for temperature, rainfall and vegetation. Ironically for those who defined civilization by plantation labour, the labour-hindering hookworm was more prevalent around plantations. These results support Palmer's hypothesis insofar as they suggest that working conditions in

[20] 'Facts about Hookworm Disease' *Jamaica Public Health* 1:7 (1927).

plantations spread hookworm infection. This model assesses how likely people were to be infected, but Palmer's argument hinges on the worm burden (how intensely people are infected). Nevertheless, mean intensity of infection typically increases with prevalence, though this relationship is non-linear (Anderson and May 1992). However, worm burdens typically also vary greatly between individuals, as is explored in the following section.

Worm Burden

This section examines the limited available evidence about burdens of hookworm in early 20th-century Jamaica, focusing mainly on quantitative evidence, but also discussing some of the qualitative evidence provided by the JHC. In most cases the JHC only recorded whether hookworm was present or absent in an individual, but there is some limited data available on burdens of hookworm during this period.

Worm counts on samples of 20-30 people were carried out in 1915, 1924 and 1931 (Figure 2.4). Two of these involved groups of people living together (orphans and prisoners), with a third carried out on hookworm-positive patients drawn from the general public. In each case, hookworm is markedly overdispersed, with most patients carrying only small numbers of worms (typically <100), and a small number of individuals carrying much larger burdens. The dispersal parameter *k* is used in epidemiology to describe the degree of parasite aggregation (Anderson and May 1992). A *k* close to zero indicates many parasites infecting few individuals, while a parasite population becomes more randomly dispersed as *k* approaches infinity. It was possible to calculate both *k* and the mean worm burden for the orphanage and prison samples as these included uninfected individuals; *k* was calculated by fitting a negative binomial generalised linear model with no explanatory variables (*glm.nb* in the *MASS* R package).

The mean intensities of infection were 46.6 for the prisoners and 68 among the orphans. k=0.862 (95% CL 0.362-1.36) among the orphans and k=0.491 (95% CL 0.267-0.714) among the prisoners. These k-values lie within the expected range of 0.1-10 for both hookworm and human macroparasites more generally, indicating strong overdispersion (Anderson and May 1992), but the

mean worm burdens are higher than those reported from studies reviewed by Brooker *et al.*, which all report mean burdens <20 (Brooker et al. 2004).

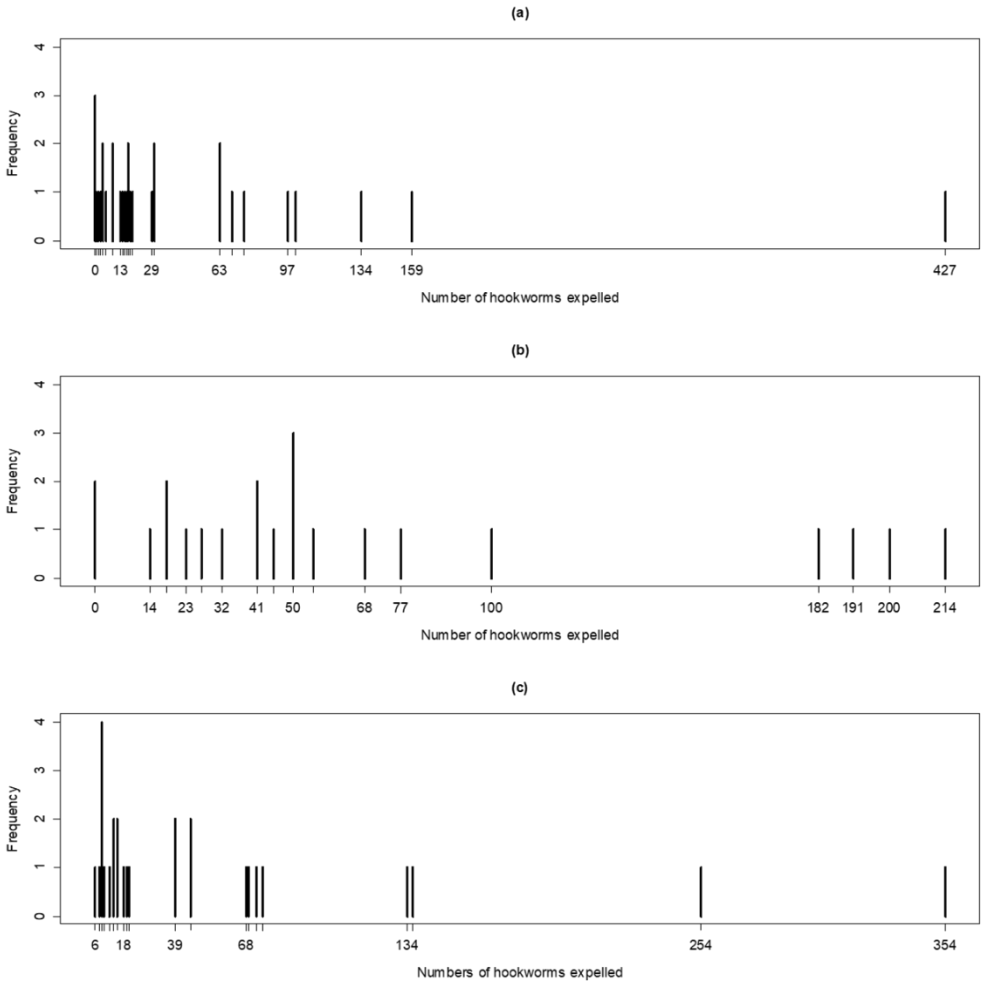

Figure 2.4: Numbers of hookworm expelled by treatment of: 31 prisoners (1915, a, k=0.491), 22 boys in Cross Keys Orphanage (1931, b, k=0.862) and 27 residents of Richmond (1924, c).
Data from Annual Medical Reports, NA CO/141/79 Sup. *Jam. Gaz.* 34:14 (7th Sep. 1916); CO/141/88 Sup. *Jam. Gaz.* 48:7 (23rd Apr. 1925); CO/141/94 Sup. *Jam. Gaz* 54:21. (12th Nov. 1931). 1915 study on prisoners in the General Penitentiary used treatment of three days of a 'low diet' with thymol (60 'grains' in two doses) followed by chenopodium (50 'minims' in three doses) against the same dosages of both in reverse order. For the purposes of this study, the two groups were amalgamated. The 1924 study in Richmond used one dose of thymol followed by one dose of chenopodium only on infected individuals; the 1931 study does not explain its treatment methodology.

It can be assumed that all the residents of the orphanage lived together and shared very similar living conditions, but they still hosted very different burdens of hookworm. The number of months a resident had lived in the orphanage was not correlated with their burden (Spearman's Correlation, S=1411, rho=-0.238, p=0.327). Similarly, prisoners lived and worked in close proximity, but one unfortunate prisoner nevertheless hosted 427 worms,

while most had <20. As it is not known how long they had been imprisoned, it is possible that the majority of their worm burden was acquired before their imprisonment, but this itself demonstrates the risks of attributing burden to the socioecological conditions of a particular place when people could and did move between locations. The pathogenicity of hookworm is influenced by socioeconomic and socioecological factors, but individuals living in much the same conditions experienced hookworm very differently. A similarly high variation in burden despite similar environment has been reported from other studies of human helminths, and is likely to result from the aggregated distribution of infective stages in the environment, combined with inter-individual variation in genetic and behavioural susceptibility to infection (Quinnell et al. 2010; Wong et al. 1991).

This overdispersion and variation in disease is also qualitatively attested in medical reports. In 1931, Washburn noted that in Cross Keys, 'very few patients exhibited symptoms or signs of hookworm disease: the vast majority are carriers of, rather than sufferers from the disease'.[21] Before the JHC, in 1914, the District Medical Officer for Moneague remarked that many of those infected with hookworm 'not feeling sick in any way other than the general lassitude and weakness from anaemia…are unwilling to go 10 miles to hospital' for treatment'.[22] At the same time, a number of people did suffer terrible illness arising from hookworm. In 1915, while attempting to secure support for an eradication programme, Howard informed the CO that 'the severe types of the disease are quite common, deaths having been reported from several Districts'.[23]

While hookworm infection for many Jamaicans passed unnoticed, for the smaller number of individuals who carried large burdens, hookworm infection would have had a significant impact on their quality of life. This further helped persuade doctors and colonial officials that it had to be

[21] NA CO/141/94 'Hookworm Control Through Sanitation and Treatment', Sup. *Jam. Gaz.* 54:21 (12th November 1931).
[22] NA CO/141/77 'Annual Report of the Island Medical Department', Sup. *Jam. Gaz.* 37:21 (8th October 1914).
[23] NA CO/137/711 H.H. Howard to Colonial Secretary, Feb 8th 1915.

eradicated. Even in similar socioecological circumstances, however, hookworm burdens, and therefore pathology, varied significantly.

Discussion

This paper has demonstrated that the prevalence of hookworm in interwar Jamaica was influenced by the environment (rainfall, temperature and vegetation), but also by socioeconomic institutions in the form of plantations. As John McNeill has most famously shown, the rise of sugar plantations transformed the ecology of the Caribbean, providing new opportunities for species such as *Aedes* and *Anopheles* mosquitoes, and consequently for parasites such as malarial *Plasmodia* and the yellow fever *Flavivirus* (McNeill 2010). At least one species of hookworm, *N. americanus,* is thought to have been introduced to the Americas via transatlantic slavery (Hawdon and Johnson 1996). Plantations, drawing labourers into close proximity with limited sanitation remained significant sources of hookworm infection into the 20th century.

Palmer (2010) has argued that while hookworm infection has been historically ubiquitous in tropical and warm temperate areas, hookworm disease (i.e., high-burden infections) became vastly more prevalent in the second half of the 19th century due to workers working in close proximity amidst 'ideal ecologies for the reproduction of the parasite in mines, railroad beds, and plantation soils'. Jamie Lorimer has extended this argument, dubbing hookworm a 'pathobiont', which, depending on socioecological context, can be harmful, harmless, or even beneficial (assuming that hookworm's modulation of their host's immune system protects against allergic and autoimmune disease) (Lorimer 2020). These arguments are partially supported by this study, which indicates that plantations did indeed promote the spread of hookworm infection. However, socioecological conditions were not the sole determinant of burden, which, as is typical of macroparasites, varied significantly even between individuals living together or in the same area. This resulted in varying levels of sickness, with some individuals seriously ill and others asymptomatic; hookworm varied according to both individual and socioecological factors. This paper supports the contention that plantations increased hookworm infections, but

complicates it by demonstrating that individuals living in very similar conditions still hosted highly varied burdens of hookworm. Though hookworm remains a significant health problem worldwide, in Jamaica it was placed on the path of extinction because it was seen as a threat to labouring capacity; but the conditions of labour also shaped the distribution of hookworm. Plantations both spread and problematized hookworm, driving efforts to bring it to extinction.

Black scholars have long seen in the plantation a geographic prototype (McKittrick 2011) shaping Black lives in the Americas, and in recent years the plantation has also become emblematic of capitalist modernity and multispecies exploitation in the environmental humanities (these literatures are usefully reviewed by Chao et al. (2023) and Davis et al. (2019)). 'Plantationocene' has even been posited as an alternative to 'Anthropocene' (Haraway 2015), though it is unclear whether this refers to a geological or historical era. Within the Caribbean, the plantation is often regarded as the defining institution of the region's history (Burnard and Garrigus 2016; Watts 1987) and scholars continue to grapple with its long-term effects on Caribbean societies (e.g. Beckford (1972); Patterson (2023)).

The post-emancipation plantation of the early 20th Century seldom features in these literatures, which generally focus on the slave plantation or the contemporary plantation. In this study, we find that 20th-century plantations had an ambivalent relationship with hookworm. Hookworm profited from the plantation, which aided its reproduction and transmission, but it was also expelled and killed by doctors anxious to render their patients fit for plantation work. Plantation work, that is, facilitated both hookworm's entry into and forced exit from human bodies. Sophie Chao has noted in her study of West Papuan oil palm plantations that monoculture allows parasites of the crop to thrive (Chao 2021); here we find that the plantation, in regimenting and concentrating human bodies alongside vegetal ones, made human bodies vulnerable to parasites as well. In West Papua parasites of the oil palm have become symbols of resistance to the colonization embodied by the plantation (Chao 2021). Hookworm, however, made its home not in the invading crop plant, but in the bodies of workers. In this light, hookworm infection could be considered another form of racialised violence inflicted upon Black and South

Asian workers by the light-skinned colonial elites, who promoted plantation work they themselves would never perform. This was also then multispecies violence, with hookworm both as instrument and ultimately victim, killed when the time came for infections to be treated. As Katherine McKittrick has argued, however, scholars should, when naming the anti-black violence of the plantation, avoid naturalising it (McKittrick 2011; 2013). Hookworm shows this clearly: infection was widespread but not universal, it was not inevitable and it was treatable. The plantation did not condemn everyone to hookworm disease and experiences of hookworm varied widely.

We do not view the plantation as the singular space where people contracted hookworm; our data show that hookworm could be encountered across Jamaica, and was influenced by environmental, as well as human, factors. Rather, the plantation, in concentrating human bodies, amplified hookworm transmission within their ambit, further spatializing infection. At the same time, the plantation, requiring the kind of alienated paid labour colonial elites promoted, sat at the heart of the ideological desire to drive hookworm extinct in order to create a more productive labour force. This, for us, epitomises the ambivalent complexities of extinction: scholars and public alike desire a neat 'extinction story' (Rose et al. 2017) with a tragic 'endling' (Jørgensen 2017) and a clear moral lesson (Heise 2016), but history is rarely so tidy. Instead, we find extinction is historically contingent, driven by particular social, economic and ecological configurations, which may, as in this case, begin an extinction but disappear before the extinction is completed.

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Conflict of Interest Statement

The authors have no conflicting interests to declare.

Chapter 3 Experiences and understandings of hookworm in Jamaica, 1919-1936

Abstract

This chapter explores how different individuals and groups in early 20th century Jamaica experienced and understood hookworm infection. Quantitative analysis of the prevalence of hookworm infection drawn from parasitology is integrated with qualitative archival research. Several different archival sources are used, principally letters sent by ordinary patients to the Jamaica Hookworm Commission (JHC, 1919-1936), but also medical reports produced by the JHC and local district medical officers; as well as the *Journal of the Jamaica Agricultural Society*. It is found that hookworm infection was more prevalent in adults than children, reflecting cumulative exposure to infective hookworm larvae (L3) over time. Similarly, hookworm was more prevalent than men than women, with an interaction between gender and location. This suggests that men were more frequently exposed to L3 than women. While more elite sources such as plantation managers saw hookworm as a threat to work, ordinary Jamaicans were more likely to view it as an obstacle to subsistence. Similarly, while many infected Jamaicans were asymptomatic, others noted a variety of symptoms, most commonly drowsiness. This contrast between the severely ill and the asymptomatic or mildly ill contributed towards the medical profession viewing hookworm as a slow-burn, insidious disease which slowly sapped the strength of both the individual and social bodies.

Introduction

In this chapter I explore the varying ways in which different individuals and groups within Jamaica experienced and understood infection with hookworm in the first decades of the 20th century. Drawing from both qualitative written accounts and quantitative data collected at the time, I discuss how differently different people experienced their infections, and how these were interpreted in various ways by patients and physicians. Having previously shown that hookworm was perceived by the medical profession and colonial elites as a threat to work and productivity, I

demonstrate in this chapter that lower-class labourers likewise interpreted their infections through the lens of work, but were chiefly concerned with subsistence and survival, rather than productivity. The burden of hookworms individuals carried – the intensity of their infections – varied widely, resulting in some individuals being seriously ill while others were effectively asymptomatic. The experiences of those severely ill individuals are explored here, as is the ways those experiences were interpreted by medical practitioners. Medical doctors reconciled the mild infections of many with the severe illness they also encountered by defining hookworm as a slow, insidious infection which gradually sapped the blood, health and working capacity of both individual and colony. I emphasise, however, that though there were commonalities of experience and understanding across Jamaican society, there was also considerable variation between both individuals and social classes. Different people experienced and understood the same parasite differently.

This chapter is primarily social history of disease, extending this approach into what is generally an under-studied period in Jamaican history between the Morant Bay Rebellion of 1865 and the Labour Rebellion of 1938.[1] I use government medical reports and the reports of the Jamaica Hookworm Commission (JHC, 1919-1936), supplemented with the *Journal of the Jamaica Agricultural Society*, to explore how different actors within Jamaica conceptualised and understood hookworm. While at a national level the Jamaica Agricultural Society was subsidised by the colonial government

[1] For histories covering this period see P. Bryan, *The Jamaican People 1880-1902: Race, Class and Social Control* (Kingston: University of the West Indies Press, 2000); B. L. Moore and M. A. Johnson, *They do as They Please: The Jamaican struggle for cultural freedom after Morant Bay* (Kingston: University of the West Indies Press, 2011); B. L. Moore and M. A. Johnson, *Neither led nor driven: contesting British cultural imperialism in Jamaica, 1865-1920* (Kingston: University of the West Indies Press, 2004); V. Shepherd, *Transients to Settlers: The Experience of Indians in Jamaica 1845-1950* (Leeds: Peepal Tree, 1994); R. Smith, *Jamaican Volunteers in the First World War: Race, masculinity and the development of national consciousness* (Manchester: Manchester University Press, 2004); H. Altink, *Destined for a Life of Service: Defining African-Jamaican Womanhood, 1865-1938* (Manchester: Manchester University Press, 2011); H. Altink, *Public Secrets: Race and Colour in Colonial and Independent Jamaica* (Liverpool: Liverpool University Press, 2019); J. de Barros, *Reproducing the British Caribbean: Sex, Gender, and Population Politics after Slavery* (Chapel Hill: University of North Carolina Press, 2014).

to the tune of around £1000 annually, and was almost a branch of government (the Governor and Colonial Secretary were *ex officio* members of the board), the various local branches seem to have been the preserve of well-off farmers and lesser gentry, with some smallholders involved.[2] The *Journal* therefore indicates how the rhetoric and agendas of medical authorities percolated through society.

My key sources, however, are letters sent by ordinary Jamaicans to the JHC, thanking the Commission for treatment. These were selected for inclusion in JHC reports, and therefore almost universally portray the commission in a positive light. Nevertheless, they preserve the words of ordinary Jamaicans narrating their own infections, and offer valuable insights into their experiences. Only one letter criticising the JHC survives, which illustrates the complexities of using these letters as a source. It was reproduced for its comic value – its author Abijah Thomas contended that, having previously been famously 'mild and of a sweet disposition', treatment for hookworm made him so 'fierce' that he boxed down a neighbour, Jephata Smith, who had cussed at him.[3] By publishing this, however, the JHC and its head Benjamin Washburn also advertised the idea that treatment for hookworm will make the patient energetic, even 'fierce'. Washburn was a canny propagandist who curated reports to impress the reader with the successes of the JHC. But to do this, he often used the words of other people, and the words of ordinary Jamaicans are not less valuable because of the uses they were put to by others.

Who had hookworm?

Hookworm is a blood-feeding nematode worm which infected around 6 in 10 Jamaicans; the prevalence of infection, however, varied considerably across the island.[4] Wetter and more densely vegetated districts, and those sharing a name with plantations tended to have a higher prevalence of

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[2] *Journal of the Jamaica Agricultural Society* [henceforth JJAS] 32/6 (1928) p.348.
[3] M. Jones, *Public Health in Jamaica, 1850-1940: Neglect, Philanthropy and Development* (Kingston: University of the West Indies, 2013) p.125.
[4] J.D. Roberts et al 'Parasites and Plantations: Disease, Environment and Society in efforts to induce Extinction of Hookworm in Jamaica, 1919-1936', *Cambridge PRISMS: Extinction* 3 (2025) https://doi.org/10.1017/ext.2024.15.

hookworm.[5] Rates of hookworm infection, however, did not only vary between locations, but also between age and gender groups.

Data on hookworm prevalence aggregated by age are available for 8 districts of Jamaica surveyed between 1925 and 1935. Hookworm predominantly affected adults, with prevalence rising steeply through childhood before plateauing in early adulthood (Figure 3.1). This pattern is typical: prevalence and intensity of hookworm infection have been consistently found to increase with age, with prevalence plateauing after 20-30 years.[6] This reflects a complex balance between rates of exposure, parasite establishment and parasite mortality, all of which may vary with age.[7] Hookworms, possessing a 2-3 year lifespan and self-protective immunomodulation, are only slowly cleared from the body by the host immune system.[8] Individuals regularly exposed to hookworm larvae would have been infected by small numbers of hookworms over the course of daily life, and in most cases these infections would not have fully cleared until the hookworm campaign arrived in their local area.

Prevalence of hookworm infection plateaued around early adulthood, but in Montego Bay prevalence dropped sharply after 30 years of age, with more modest declines observable in other districts. This may reflect rural-urban migration: it is possible that younger people acquired infections in rural areas and then subsequently moved to the town, where their infections were cleared either naturally or through treatment and reinfection was less likely.

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[5] Ibid.

[6] J. C. Dunn et al., 'A cross-sectional survey of soil-transmitted helminthiases in two Myanmar villages receiving mass drug administration: epidemiology of infection with a focus on adults', *Parasites and Vectors* 10/1 (2017); R. J. Quinnell et al., 'Genetic and household determinants of predisposition to human hookworm infection in a Brazilian community', *Journal of Infectious Diseases* 202/6 (2010) pp.954-961; S. Witek-McManus et al., 'Epidemiology of soil-transmitted helminths following sustained implementation of routine preventive chemotherapy: Demographics and baseline results of a cluster randomised trial in southern Malawi', *PLoS Neglected Tropical Diseases* 15/5 (2021) pp.e0009292; I. Praharaj et al., 'Temporal trends of intestinal parasites in patients attending a tertiary care hospital in south India: A seven-year retrospective analysis', *Indian Journal of Medical Research* 146(2017) pp.111-120; E. F. G. A. Avokpaho et al., 'Factors associated with soil-transmitted helminths infection in Benin: findings from the DeWorm3 study', *PLoS Neglected Tropical Diseases* 15/8 (2021) pp.e0009646.

[7] S. Brooker, J. Bethony, and P. J. Hotez, 'Human Hookworm Infection in the 21st Century', *Adv Parasitol* 58 (2004).

[8] Ibid.

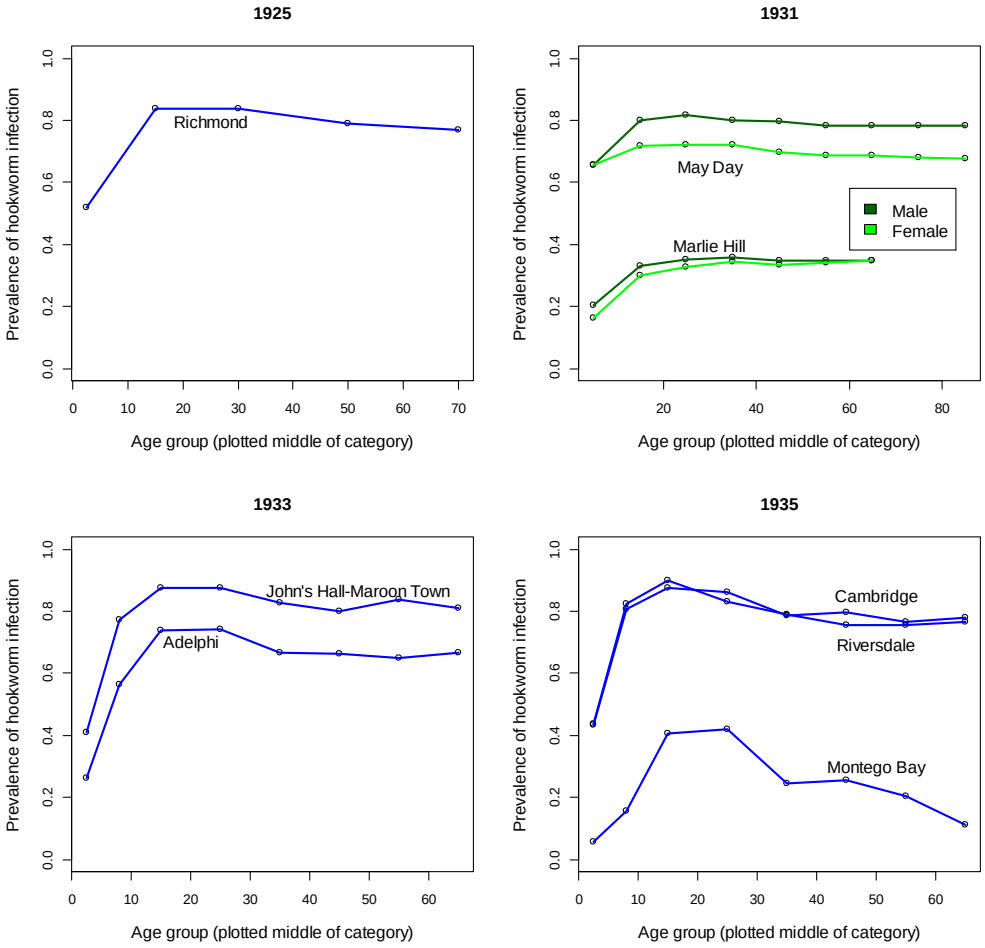

Figure 3.1: Age-prevalence profiles of hookworm in 8 districts of Jamaica, 1925-1935.
Data from Annual Reports of the Island Medical Department, NA CO/141/88,93,94 & UWI Medical Library.

Prevalence data aggregated by gender was available for 6 districts. Hookworm was significantly less prevalent in women than men, independent of the district they were tested in (Cochran Mantel-Haenszel test, common odds ratio=0.726, 95%CL 0.696-0.757, X^2=218, $p<2.2x10^{-16}$). This variation in gendered risk is also concordant with the behaviour of 21st-century hookworm populations.[9] However, there was a significant interaction between district and gender (Chi-squared test, X^2=39.6,

[9] Dunn et al., 'A Cross-Sectional Survey of Soil-Transmitted Helminthiases in Two Myanmar Villages Receiving Mass Drug Administration'; Praharaj et al., 'Temporal trends of intestinal parasites in patients attending a tertiary care hospital in south India'; S. S. R. Ajjampur et al., 'Epidemiology of soil transmitted helminths and risk analysis of hookworm infections in the community: Results from the DeWorm3 Trial in southern India', *PLoS Neglected Tropical Diseases* 15/4 (2021) pp.e0009338.; Avokpaho et al., 'Factors Associated with Soil-Transmitted Helminths Infection in Benin'; Witek-McManus et al., 'Epidemiology of Soil-Transmitted Helminths Following Sustained Implementation of Routine Preventive Chemotherapy'.

$p=1.83x10^{-7}$), suggesting that whatever factors mediated the difference between genders also varied between districts. Indeed, while hookworm was more prevalent in men than women in all districts, differences in prevalence between genders varied between districts (Figure 3.2).

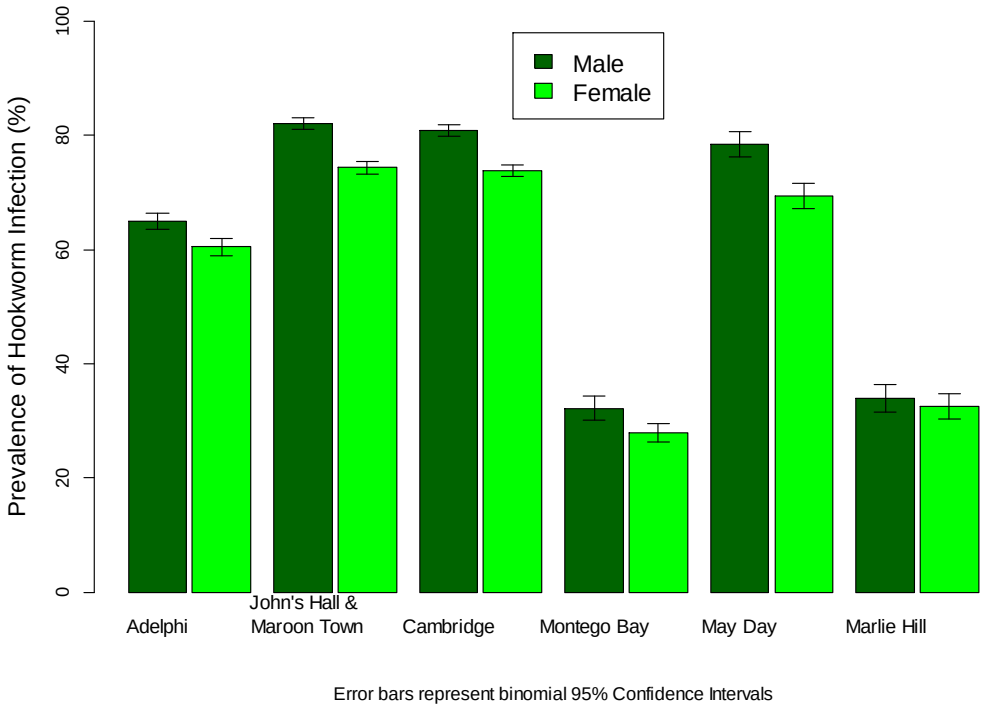

Figure 3.2: Prevalence of hookworm infection by gender in 6 districts of Jamaica, 1930-1935.
Data from Annual Medical Reports NA CO/141/93,94 & UWI Medical Library.

Genetically- and hormonally-mediated differences in immunological function and responses to parasites between sexes are widely reported, with males generally having lower immune function; progesterone and oestrogen appear to elevate immune responses and testosterone to lower it.[10] It is possible that generally elevated levels of testosterone in men inhibited immune responses against hookworm, but given that the strength of this gender disparity varies between locations, this cannot have been the sole factor.[11] Differential exposure to infective (L3) hookworm larvae likely played a greater role in shaping the observed disparities.

The amount of time spent in contact with the soil, and thus exposure to L3, likely varied between genders. While the Victorian ideal of the women as

[10] S. L. Klein and K. L. Flanagan, 'Sex differences in immune responses', *Nature Reviews Immunology* 16 (2016) pp.626-638.
[11] Brooker, Bethony and Hotez,'Hookworm Infection'

the ‘Angel of the House’ had been imported to Jamaica from Britain, for many Jamaican women this was unaffordable, old-fashioned or otherwise undesirable, and many women entered the workforce in the aftermath of the First World War.[12] Henrice Altink reports that in 1921, 44.7% of working women were engaged in personal service, a further 20.3% in millinery, and 24.4% in agriculture.[13] Of the general population, 55.3% worked in agriculture, suggesting that agricultural work was more commonly performed by men.[14] Working-class women were more likely to work in agriculture, service or millinery or in higgling (small-scale trade in agricultural produce), while middle-class women sought jobs in nursing, teaching, handicrafts and clerical work.[15] Despite male and middle-class disapproval, working-class women also worked in stereotypically masculine occupations such as plantation labour (e.g. Sarah Youngsom, see below) and docking, though they were paid less than men doing the same work.[16] Altink also notes that many working-class women who did own land owned such small plots that other work was necessary to supplement their incomes.[17] The JHC worked mainly in rural areas, where agricultural work was concentrated and less service work was available. Agricultural or plantation work carrying increased risk of hookworm infection was performed by both men and women, but more commonly by men, resulting in differential exposure to infective (L3) hookworm larvae and a significant (but not overwhelming) disparity in hookworm infection rates.

As can been seen in Figure 3.2, prevalence often varied more between districts than between genders, and both men and women commonly experienced infection. There is no indication in the available material that men and women understood or experienced hookworm in particularly different ways, though given that the overwhelming majority of the archival

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[12] H. Altink, *Destined for a Life of Service: Defining African-Jamaican Womanhood, 1865-1938* (Manchester: Manchester University Press, 2011) Ch.4; P. Bryan, *The Jamaican People 1880-1902: Race, Class and Social Control* (Kingston: University of the West Indies Press, 2000) Ch.6.
[13] Altink, *Destined for a Life of Service* p.108.
[14] G. Eisner, *Jamaica. 1830-1930: A Study in Economic Growth* (Manchester: Manchester University Press, 1961) p.163.
[15] Altink, *Destined for a Life of Service* pp.108-115.
[16] Ibid.
[17] Ibid. p.135.

material was penned by men, little can be said with confidence. Broadly and generally speaking, while Afro-Jamaican men valued economic independence, Afro-Jamaican women tended to desire to be good mothers.[18] Both of these required making enough money to get by and support dependents – something which heavy hookworm burdens could interfere with, as is explored in the following section.

Hookworm as an obstacle to subsistence

Hookworm was intimately connected with work. Not only was exposure to infection influenced by work (particularly plantation or agricultural labour), but hookworm was also understood by managers, doctors and the colonial elite as a threat to economic productivity.[19] Estate manager A. Whittingham, for instance, noted that

> The treatment given to the laobourers [sic] affected with hookworms on this estate has given good results; in two cases especially, where the individuals could do but little work, to-day they are earning more wages and showing improved appearances.[20]

Similarly, master of the Clarendon poorhouse J.L. Manhertz claimed that

> Following the Hookworm treatment I noticed a great change in the general condition of the inmates and quite a few have been discharged, feeling strong and well as they expressed a desire to go home and support themselves.[21]

'Good results' were defined as an increase in labouring capacity. This also hints at why hookworm's position as a threat to labouring ability was important to workers – it directly affected a labourer's wages, and their ability to 'support themselves' and their families. And indeed, letters from labourers thanking the JHC for treatment shows a similar emphasis on the

[18] Ibid Ch.1; R. Smith, *Jamaican Volunteers in the First World War: Race, masculinity and the development of national consciousness* (Manchester: Manchester University Press, 2004) pp.153-162.
[19] As discussed in Roberts et al, 'People, Parasites and Plantations'.
[20] UK National Archives, Kew [henceforth NA] CO/141/85 'Report of the Jamaica Hookworm Campaign for 1921' Sup. *Jam. Gaz.* 45:21 (19th October 1922).
[21] NA CO/137/742 B.E. Washburn to Dr Hunt (Superintending Medical Officer) 6th Sept. 1920.

ability to work. However, their focus is different: these individuals are not concerned with profit or productivity, but subsistence and survival.

Henry Peirce, for example, reported that prior to treatment for hookworm, he was confined to the poorhouse and 'not able to do much work', while Sarah Youngsom described how 'before I took the treatments I could not work now I can go to my work as a field labourer and can do my task at 3/6 [three shillings sixpence] and 4/- by midday, coming home feeling hearty and strong'.[22] Robert Lewis likewise attested that he and his family 'could scarcely work for our living' before treatment but, post-treatment, 'can do a hard day work now'.[23] This need to work for survival is also emphasised by Simeon Walker, who poetically claimed that 'My Home consist of 7 persons and after the treatment they have Developed into 14 persons with strength and energy also working ability to earn money…'[24] William Murray celebrated that he was able to 'work harder and with greater ease making more money' and William Learman claimed that prior to treatment 'I could not do any work…No scince I am a cured man can do my work without being tired or fatigue'.[25] Peirce likewise boasted that he is 'now working with Sanitary cart go on some months, make 17/6 weekly', but John Marshall was more domestically inclined, celebrating that he 'can now move about and do anything in the home'.[26]

In 1929, meanwhile, the Brown's Hall (St Catherine) branch of the Jamaica Agricultural Society hosted a Mr Mossman who

> addressed the meeting on Hygiene and its relationship to Agriculture…he showed how physical fitness is necessary to good work. He mentioned Hookworm, Venereal Diseases, and Tuberculosis as the three chief enemies which undermine the physical fitness and sap the vitality of the people of this island.[27]

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[22] NA CO/137/742 B.E. Washburn to Dr Hunt (Superintending Medical Officer) 6th Sept. 1920.
[23] NA CO/141/85 Report of the Jamaica Hookworm Campaign for 1921' Sup. *Jam. Gaz.* 45:21 (19th October 1922).
[24] NA CO/137/781/1 Jamaica Hookworm Commission Monthly Reports (1926-7).
[25] NA CO/141/85 Report of the Jamaica Hookworm Campaign for 1921' Sup. *Jam. Gaz.* 45:21 (19th October 1922); CO/137/742 B.E. Washburn to Dr Hunt (Superintending Medical Officer) 6th Sept. 1920.
[26] Ibid.; NA CO/137/781/1. Jamaica Hookworm Commission Monthly Reports (1926-7).
[27] W. Stanley Jones, 'Branch Notes' *JJAS* 33/9 (September 1929) p.333.

Again, hookworm was presented as a threat to 'good work' and to agriculture. Similarly, in 1926 a correspondent of the society, declaiming against rats, compared these rodents to 'the hookworm which causes loss of energy'.[28] The notion that hookworm stopped you working and drained your energy was widespread.

Hookworm was seen as an economic threat across society. But that meant something very different to colonial administrators and plantation managers, concerned with the profits of their business and the colony in general, than it meant to ordinary labourers and farmers. For these people, hookworm was experienced as an obstacle preventing them from performing the work required to make ends meet. Experiences of hookworm, however, were far from universal, and varied considerably between different individuals.

Heterogeneity of experience and hookworm as an insidious threat

Letters from those treated by the JHC attest to considerable, if varied, suffering. Murray, for instance, described heart palpitations and giddiness, while Peirce wrote that hookworm had confined him to the poor house, but treatment had made him 'helthey and strong in my body'.[29] Robert Lewis, meanwhile, asserted that he and his family 'were horribly crippled' by hookworm, and Marshall seemed to imply that he was bedbound before treatment.[30] John Rogers likewise vividly described the disease arising from what is explicitly identified as a heavy burden of hookworms:

> …severe pain around my waist for years, it grew worst and worst until my back became crooked, also a great burning in the stomach and great fleam on my chest…my ribs felt as if they were boring through at nights, so that I could not lie on my bed but took refuge in my hammock at nights. Last of all my body refused all bed…answer came, you have hookworm not simple, but you have it great…I took my stick and crambled to the office. Just over a mile from home and I had to sit three times to rest on the way before I reached. I took in all five treatment…Now all my sufferings are gone.[31]

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[28] *JJAS* 30/5 (May 1926) p.180.
[29] NA CO/141/85 Report of the Jamaica Hookworm Campaign for 1921' Sup. *Jam. Gaz.* 45:21 (19th October 1922).
[30] Ibid.; NA CO/137/781/1 Jamaica Hookworm Commission Monthly Reports (1926-7).
[31] NA CO/141/85 'Report of the Jamaica Hookworm Commission for the Month of November' *Jam. Gaz.* 45:74 (14th Dec. 1922).

This has been quoted at length as a description of the considerable suffering and disability caused by a heavy burden ('you have it great') of hookworms. Rogers suffered not only from severe abdominal pain and intense heartburn but was left able to only walk short distances with the aid of a stick. These symptoms, however, are also suggestive of *Ascaris lumbricoides* infection, and it may be that Rogers hosted more than one species of parasite.

More often, hookworm was attributed as the cause of a nonspecific 'bad feeling', in Marshall's phrase, or 'drowsiness', as James Bailey describes it.[32] Learman, for instance, described 'being sleepy and continual giddeness'.[33] James Tucker similarly reported 'all Different Bad feelings Darkness of eye Headach gueediness and Several Felling which is not good.'[34] Though these characterisations of the symptoms of hookworm disease may be clinically non-specific, the severity of said symptoms should not be underestimated. In an agricultural society where day labour and piecework were the main source of income for many, bodily strength, as these letters attest, was crucial for survival.

That hookworm infection was often experienced as a debilitating loss of energy and working capacity is further underlined by the ways in which treatment was experienced as revitalising. As discussed above, Walker celebrated that the 'strength and energy' of his family had doubled, as had their 'enormous appetite', while Bailey dubbed himself 'a changed man'.[35] Despite the bad taste of the medication, Marshall reflected that he 'was almost sorry when the report come than I am cure. I feeling so well that I would not mind taking another treatingment.'[36] Some even reported that they felt younger: 45-year-old Learman, for instance, declared that 'scince I have taken the medicin I feel man of 25', while 51-year-old Peirce of Spanish Town claimed that he now 'boast on all the young men of the

[32] Ibid.
[33] NA CO/137/742 B.E. Washburn to Dr Hunt (Superintending Medical Officer) 6th Sept. 1920.
[34] It is not entirely clear whether this last phrase refers to falling or bad feeling; NA CO/141/85 'Report of the Jamaica Hookworm Commission for May, 1922' *Jam. Gaz.* 45:3.5 (22nd Jun. 1922).
[35] NA CO/137/781/1 Jamaica Hookworm Commission Monthly Reports (1926-7).
[36] Ibid.

town'.[37] Pierce further noted in a postscript that he 'Weighs more and peoples say look better and good looking; say should now get married, but St. Paul says, Art thou lose from a wife seek not a wife.'[38]

However for the majority of individuals, who had low-burden infections, hookworm passed unnoticed, and unremarked.[39] For many people hookworm was mild or imperceptible, but for others, such as Rogers, hookworm caused intense suffering. This variation was difficult to for doctors to interpret, but they came to reconcile their experiences of hookworm as both unnoticed and deadly as evidence that hookworm slowly and invisibly weakened their hosts. This, for them, explained how the worm could cause intense suffering in some cases and no symptoms whatsoever in others. They were aware that the reason for these variations was differences in the number (burden) of worms carried but did not fully understand the implications of the fact that most people only carried a small number of worms, with a smaller number carrying much larger burdens.[40] Instead, the invisible insidiousness and weakening effect of hookworms were consistently emphasised – in part because it justified the JHC policy of treating everyone who was infected. In one report, Washburn insisted, under the heading 'Slight infections are Dangerous', that 'though a patient does not suffer from all of the symptoms still if he has the worms in his body they are always taking his blood, they are slowly weakening him…'[41]

Hookworm was seen as an economic threat in part because it was seen as an insidious weakening force. RF director for the West Indies Hector Howard, for instance, contended that hookworm in Jamaica was 'very materially increasing the occurrence and death rate of other diseases', a theme also taken up by the District Medical Officer (DMO) for Stony Hill, who

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[37] NA CO/137/742 B.E. Washburn to Dr Hunt (Superintending Medical Officer) 6th Sept. 1920; CO/141/85 Report of the Jamaica Hookworm Campaign for 1921' Sup. *Jam. Gaz.* 45:21 (19th October 1922).
[38] NA CO/141/85 Report of the Jamaica Hookworm Campaign for 1921' Sup. *Jam. Gaz.* 45:21 (19th October 1922).
[39] Roberts et al., 'Parasites and Plantations'.
[40] J. Farley, *To Cast Out Disease: A History of the International Health Division of the Rockefeller Foundation (1913-1951)* (Oxford: Oxford University Press, 2004) p.76.
[41] NA CO/141/85 'Report of the Jamaica Hookworm Campaign for 1921', Sup. *Jam. Gaz.* 45:32 (1922).

asserted that ‘either by itself or by reason of its weakening affect, hookworm disease is the cause of more illness in this district that all other diseases put together’.[42] Washburn similarly remarked that ‘many a person is made susceptible to contagious diseases and becomes ill with colds influenza and other illnesses because the body is not strong enough to resist their germs’.[43] Pierce also connected his ‘suffering with malaria fever’ to hookworm, noting that ‘I get cure of the hookworms. And from then I am free from the fever’.[44] Coinfections with hookworm and malarial *Plasmodia* can lead to severe anaemia, but it seems unlikely that clearing a hookworm infection would also cure malarial fevers.[45] The immunomodulatory capacities of hookworm are now well-known and these may have made hosts more vulnerable to other infectious diseases.[46] It is more likely, however, that this effect, if real, is a consequence of anaemia. Regardless, hookworm was seen in the minds of medical practitioners as a great weakener, weakening both individual and society.

The JHC report for 1921 waxed apocalyptic:

> As a handmaiden of poverty, a handicap of youth, an associate of crime and degeneracy, a destroyer of energy and vitality, it stands in the very forefront of diseases. Its effects express themselves in stunted physical and mental growth, blighted health and efficiency, retarded economic progress, and general degeneracy and decay. Labour is impaired, home standards are lowered, mental development is inhibited and

[42] NA CO/141/77 ‘Annual Report of the Island Medical Department’, Sup. *Jam. Gaz.* 37:21 (8th October 1914).
[43] NA CO/141/85 ‘Report of the Jamaica Hookworm Campaign for 1921’, Sup. *Jam Gaz* 45:32 (1922).
[44] NA CO/141/85 Report of the Jamaica Hookworm Campaign for 1921’ Sup. *Jam. Gaz.* 45:21 (19th October 1922).
[45] A. Loukas et al., 'Hookworm infection', *Nat Rev Dis Primers* 2/16088 (2016) pp.16088; E. Vaumourin et al., 'The importance of multiparasitism: examining the consequences of coinfections for human and animal health', *Parasites and Vectors* 8/545 (2015); J. L. A. Webb, 'Syndemic anemia in British Malaya: An early global health encounter with hookworm and malaria co-infections in plantation workers', *Social Science and Medicine* (2020).
[46] Loukas et al., ‘Hookworm Infection’; Brooker, Bethony & Hotez, ‘Human Hookworm Infection’; P. R. Chapman et al., 'Experimental human hookworm infection: a narrative historical review', *PLoS Negl Trop Dis* 15/12 (2021) pp.e0009908; A. O. Shalash et al., ‘Hookworm Infection’ *J Allergy Clin Immunol* 148/6 (2021).

> there is a tendency for the body machine to wear out before its time.[47]

The economic view of hookworm is here on full display, with labourers characterised very explicitly as 'machines', who, if not maintained, will 'wear out before…time'. The mention of crime likely refers to a peculiarly Jamaican linking of hookworm to 'praedial larceny' (crop theft) which surfaces intermittently in the archive.[48] Elsewhere in the same report, it is speculated that

> …when a boy gets hookworm disease and is made weak and dosent [sic] feel like working that it is easier for him to forget himself and steal. So there may be a direct relationship between hookworm disease and crime.[49]

Again, hookworm is presented as an economic threat, bringing monetary loss through both productivity metaphorically lost and crops literally lost to theft. This linking of hookworm to crime also implies that hookworm is a threat to moral normativity, and underlines that Washburn's moral framework valued 'efficiency…economic progress…labour… [and] home standards'. John Ettling has argued that the moral framework of John D. Rockefeller and his associates, blending capitalist notions of progress, efficiency and value for money with evangelical ideas of sin, work and personal redemption had a profound influence in the RF's decision to focus on hookworm.[50] E. Richard Brown also characterises hookworm campaigns as devices to produce more productive labour and additional consumers of American goods.[51] Here it can be seen that a similar linking of work, economics and personal morality was also present in Washburn's mind, and shaped his view of hookworm as a major threat not only to productivity, but also to personal morality and social progress. As Patrick Bryan discusses, the offense of praedial larceny had a classed and racialised aspect, being a

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[47] NA CO/141/85 B.E. Washburn, 'Report of the Jamaica Hookworm Campaign for 1921', Sup. *Jam. Gaz.* 45:32 (1922).
[48] E.g. NA CO/141/81 'Annual Report of the Island Medical Department', Sup. *Jam. Gaz.* 41:14 (30th November 1918). Praedial Larceny also features regularly in the *Journal of the Jamaican Agricultural Society*.
[49]NA CO/141/85 'Report of the Jamaica Hookworm Campaign for 1921', Sup. *Jam. Gaz.* 45:32 (1922).
[50] Ettling, *The Germ of Laziness* pp.49-121.
[51] E. R. Brown, *Rockefeller Medicine Men: Medicine and Capitalism in America* (Berkley: 1979).

crime for which the black working class were prosecuted to safeguard the interests of the planter class.[52] In this context, the linking of hookworm to praedial larceny draws the parasite into this complex web of morality, class and race. Hookworm became, in the eyes of the planter and medical classes, a parasite which weakened the morality of the individual, their class and their race.

Despite their conviction that hookworm disease was a scourge of civilisation, physicians had to contend with the fact that most of those they knew or suspected to be infected did not feel ill or display any particularly dramatic symptoms. As discussed above, their attempts to square this circle emphasised hookworm's invisible insidiousness, framing hookworm as a slow-burn disease. In the 1914 medical reports, for instance, the DMO for Adelphi bemoans that 'the insidious progress of this disease and the absence of acute painful symptoms…result in in but a very small proportion of cases finding their way to the Doctor'.[53] And the DMO for Stony Hill complained that

> The public have no idea of the widespread extent of the infection, no idea of the loss of working power – general and occasional – that it causes, of the steady sapping of the strength from a mild infection lasting for years…of the wonderful benefit following adequate treatment…[54]

The section of the 1921 report immediately before the 'handmaiden of poverty' rant again frames hookworm as slow, deadly and insidious:

> Hookworm disease does not run a spectacular course and kill or cripple its victims as does typhoid fever, pneumonia, or dysentery; and for this reason it is not generally regarded as a serious individual or community health problem. But the disease does its work slowly and insidiously by undermining physical and mental health and destroying economic efficiency and social development.[55]

Hookworm was consistently characterised as an invisible, insidious weakener, slowly sapping away the strength of both the individual and the

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[52] Bryan, *The Jamaican People* pp.22-6.
[53] NA CO/141/77 'Annual Report of the Island Medical Department', Sup. *Jam. Gaz.* 37:21 (8th October 1914).
[54] Ibid.
[55] NA CO/141/85 'Report of the Jamaica Hookworm Campaign for 1921', Sup. *Jam. Gaz.* 45:32 (1922).

colony. The fact that hookworm fed on blood emphasised this – hookworm was seen to be slowly bleeding the colony and the individual, bringing literal death by a thousand cuts. The individual and collective bodies were thus conflated – hookworm was sucking the blood and sapping the strength of both. As the *Journal of the Jamaican Agricultural Society* put it in 1924: 'this parasite saps the energy of man, woman and child'.[56] And again in 1926: 'There are two chief things that sap the life of people, young to old, viz., Malaria in the lowlands and Hookworm everywhere'.[57]

Hookworm in Jamaica followed a typical macroparasite dispersion pattern: some individuals had heavy burdens, but most were lightly infected. This allowed hookworm to be seen as both a deadly, dramatic disease and an invisible, insidious threat. Medical practitioners resolved this tension by describing hookworm as a slow, insidious disease, slowly and invisibly sapping the strength of the individual and collective bodies, slowly weakening them until its dire effects became visible.

Conclusion

Hookworm was understood across Jamaican society in different ways. For the colonial elite, it was a threat to profit and productivity, while for labourers it was more often a threat to survival and subsistence. Hookworm was understood to sap the strength of colony and individual alike, but while doctors made it an insidious economic and moral menace, ordinary hosts were more likely to experience hookworm infection as drowsiness. Some, however, like John Rodgers, experienced much more severe symptoms. Hookworm was more prevalent amongst adults than children, and amongst men than women, but the prevalence of hookworm varied between different areas, and the intensity of infection between individuals even in the same area.

Parasites are not just parasites. Jamie Lorimer has argued that hookworm in particular is contextual, being harmful in some socioecological contexts and

[56] 'Hookworm – Chenopodium Semi-Contract' *JJAS* 28/8 (September 1924) p.320.
[57] 'Health', *JJAS* 30/3 (March 1926) p.34.

harmless in others.[58] He extends this to the figure of the hookworm, and the different roles it plays in various imaginaries.[59] This study has demonstrated that experiences of infection varied considerably between individuals, while the ways hookworm was understood varied across society. Hookworm, that is, varies with individual as well as socioecological context. Similarly, the meaning of hookworm varied across society: plantation managers saw it as a threat to work, doctors as an insidious force weakening individual and society, and ordinary labourers as an obstacle to survival. Even among ordinary people however, one person could experience hookworm infection as drowsiness and giddiness, while another person could find themselves completely disabled by it.

[58] J. Lorimer, *The Probiotic Planet: Using Life to Manage Life* (London: University of Minnesota Press, 2020).
[59] Ibid.

Chapter 4 The Impact of Multiple Infections and Community Knowledge on Engagement with a Historical Deworming Programme: Hookworm and *Ascaris* in Jamaica, 1913-1936

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Abstract

Community engagement with public health efforts often depends on existing knowledge of a health issue. Here qualitative analysis of archival material from the Jamaica Hookworm Commission (1919-1936) and quantitative analysis of prevalence data are used to assess knowledge of and ecological interactions between different helminths during a historical hookworm eradication campaign. Archival sources demonstrate that Jamaicans were familiar with *Ascaris lumbricoides.* Surveys revealed a high prevalence of hookworm (*Necator americanus* & *Ancylostoma duodenale*; 62%), *Ascaris* (30%) and *Trichuris trichiuria* (32%) in communities targeted for hookworm control. Community prevalence of *Trichuris* was positively associated with prevalence of *Ascaris* and hookworm. At an individual level, data from hospital patients and soldiers showed significant associations between all three species. The co-occurrence of hookworm and *Ascaris,* alongside folk treatment of *Ascaris* with the same plant used by the Hookworm Commission (*Chenopodium ambrisoides*) to treat hookworm, made biomedical claims about hookworm credible and biomedical treatment more acceptable. Expulsions of *Ascaris* following treatment also provided dramatic proof of the effectiveness of treatment, further facilitating engagement. Knowledge of *Ascaris* and other helminths directly shaped engagement with hookworm treatment, demonstrating how folk medical knowledge, grounded in the biology of the worms, aided a biomedical public health programme.

Data availability statement

Data are available on request. The datasets were derived from public records held in the UK National Archives (Kew) and the University of the West Indies Medical Library

Author contributions

Conceptualisation: JDR, AMD, LW, and RJQ; Statistical design: JDR, RJQ, and AMD; Archival research, data collection and curation: JDR; Investigation: JDR, AMD, LW, and RJQ; Writing – original draft: JDR; Writing – reviewing, critiquing, and editing: JDR, AMD; LW, and RJQ.

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Conflicts of Interests

We have no conflicts of interest to declare.

Ethical Approval

We have confirmed with the University of Leeds that this research does not require ethical approval, as it does not involve living human participants; the personal data of a living human participant or different pieces of information, which collected together can lead to the identification of a particular person; human tissue; potential for adverse environmental impact; or animals. All data were gathered from public records, contained no individual-level or

identifying information, and pertained to deceased individuals who cannot be identified from these data.

Data availability statement

Data are available on request. The datasets were derived from public records held in the UK National Archives (Kew) and the University of the West Indies Medical Library

The Impact of Multiple Infections and Community Knowledge on Engagement with a Historical Deworming Programme: Hookworm and *Ascaris* in Jamaica, 1913-1936.

1. Introduction

Public health efforts rely not only on scientific knowledge, but also on the engagement of individuals and communities (1-3). Engagement with health programmes can depend on an individual's knowledge of a health issue and how far they consider it a threat; likewise they may assess the credibility of claims made by medical practitioners based on what they already know of the illness. (1, 4) Adherence to treatment is likewise influenced by knowledge of the relevant treatment or drugs. (5, 6) Community knowledge is a product of experience and education in multiple knowledge systems, which may be folk, biomedical or syncretic. This paper explores an historical example of folk medical knowledge grounded in experiences of a widespread disease (in this case Ascariasis) and its influence on engagement with biomedical health education and treatment targeting a different disease (hookworm).

The early decades of the 20th century saw burgeoning medical awareness of hookworm (*Ancylostoma duodenale* and *Necator americanus*); hookworm control campaigns, often carried out in collaboration between the Rockefeller Foundation (RF) and national, colonial and local governments were instated across the world during this period (7-9). We present quantitative analysis of historical data on soil-transmitted helminth infections and qualitative analysis of Jamaican folk knowledge and its effects on the success of the Jamaica Hookworm Commission (JHC, 1919-1936) deworming programme. This was a co-operative programme between the RF (an independent American philanthropic foundation) and the Jamaican colonial government,

spearheaded by the charismatic RF doctor Benjamin Earl Washburn. Washburn's focus on simple, easy-to-implement interventions and gift for public engagement, institution-building and health propaganda have been credited with helping Jamaicans to take control of their own health, leading to sustained gains in life expectancy in a period of widespread poverty and colonial neglect. (10, 11) Washburn's focus on health education and interest in the culture of his patients was unusual among medical professionals of his era, contributing to the longevity of the JHC. (10) Hookworm is not a readily visible parasite; it needs to be created in the minds of its hosts before it can be treated, making community knowledge and engagement crucial. (12) Folk medicine was a primary source of treatment for many Jamaicans, particularly among the rural peasantry, as biomedical practitioners were expensive, distant or inaccessible. (13) The peasantry were subsistence farmers occupying small plots of land; their medical knowledge was rooted in a synthesis of African, European, Taíno, South Asian and Chinese traditions. (14)

In the present, Knowledge, Actions and Practices surveys are used to assess community knowledge of public health concerns. (15-17) However, these are usually primarily concerned with whether community knowledge is complete and correct by biomedical standards. Here we follow on from literature engaging with the content of community knowledge to consider how this can form aids or obstacles to biomedical public health programmes, applying this approach to the past. (18, 19)

In this paper we aim firstly to assess the prevalence of single and multiple intestinal nematode infections in early 20th century Jamaica; secondly to test whether different helminth species were associated; thirdly to assess what Jamaicans of this period knew about soil-transmitted helminthiases; and finally to assess how epidemiological associations and knowledge affected attitudes towards hookworm treatment. Our approach is interdisciplinary, incorporating both historical and parasitological methods. We use JHC and other records to assess pre-existing Jamaican folk (this term is used following Payne-Jackson and Alleyne) knowledge and treatment of parasitic helminths. (14) We analyse data on the prevalence of hookworm, *Ascaris lumbricoides* and *Trichuris trichiuria* from JHC records as well as data on multiple

infections derived from both hospital patients and volunteer soldiers. We use these to understand information on folk knowledge and treatment of helminths in light of their prevalence and relationships.

2. Methods

2.1 Data sources

Data from government archives were extracted by searching physical documents from the Colonial Office archives in the UK National Archives (NA; Kew, England) and from the University of the West Indies (UWI) Medical Library (Mona, Jamaica). The main sources were monthly or yearly reports prepared by the JHC, the Island Medical Department and the National Bacteriological Laboratory. Reports up to 1931 were collected in annual supplements to the *Jamaica Gazette* (NA, file CO/141); reports beyond this date were provided by UWI. Reports forwarded to the Colonial Office and the Colonial Advisory Medical and Sanitary Committee were also used (in NA CO/137 Jamaica: Original Correspondence). These files report surveys carried out by the JHC across Jamaica and case numbers from the island's public hospitals.

We have used the *Journal of the Jamaica Agricultural Society*, accessed in the Natural History Museum Library (London, England), as a primary source of information on community knowledge and folk medicine. The health education journal *Jamaica Public Health* (1926-1973, published by the Jamaican government in collaboration with the RF) was also used, accessed in the National Library of Jamaica (Kingston, Jamaica). These sources were unindexed, and were searched for references to helminth infections on an article-by-article basis.

2.2 Parasitology data

District surveys: Pre-treatment surveys of hookworm prevalence were carried out by the JHC between 1919 and 1936 using the 'intensive method' of Howard. (20) These aimed to test the entire population of a 'district' of around 500 people for hookworm as part of an 'area' served by a central field office. We used data from 81 districts across 7 areas (in the parishes of Manchester, St Andrew, St Mary, St Catherine and St James) surveyed between 1927 and 1933 in which the prevalence of *Ascaris* and *Trichuris* infection was also

reported. Individuals of all ages and genders were tested, but surveys reported only the total number of people tested and infected for each parasite in each district at a single point in time, and not how many individuals had multiple infections. Testing used salt flotation and centrifugation of faecal samples.

Hospital data: data are available on numbers of patients at the 19 Public General Hospitals located in towns across the island tested for helminth infections and the numbers of individuals infected with hookworm, *Ascaris* and *Trichuris* alone or in each possible combination. It was not stated whether or not individuals were only tested where infection was suspected, nor which method of faecal examination was used; samples were processed by the National Bacteriological Laboratory and the data reported in the annual medical reports 1913-1928. Data were sometimes aggregated by hospital, and sometimes by month; missing figures and printing errors were encountered, but it was possible to impute the correct value from the totals provided.

Army recruits: data are also available for tests carried out on 1063 volunteer recruits of the Jamaica Contingent of the British West Indies Regiment (BWIR) prior to embarkation to Britain to join the First World War in 1915 (NA CO/141/79 'Report of the Island Medical Department', Sup. *Jam. Gaz.* 39:14 (1916)).

No sources used in this paper report on burden hence we only present analysis of prevalence.

2.3 Statistical analysis

To test for community-level associations between helminth species in the surveyed districts, a generalised least squares model (assuming normality; *gls* from the *nlme* R package) with an exponential spatial correlation coefficient was fitted to maximise log-likelihood against the logit-transformed prevalence of the first species, with only the logit-transformed prevalence of the other species as an explanatory variable. Districts were assigned a point location (latitude-longitude coordinates) based on either historical maps or Google Maps.

The historical maps consulted were located in the David Rumsey Collection (E. Stanford, *Jamaica,* 1901); and NA CO/137/742; CO/700/JAMAICA37; CO/700/JAMAICA44; CO/1047/513; CO/700/JAMAICA50; CO

700/JAMAICA52; MFQ 1/885; WO/252/1065; WO/78/2424; and WO/78/567.

To test the hypothesis that individuals were coinfected with multiple helminths more often than would occur by chance independently of year, the Cochran Mantel-Haenszel test was used. Fisher's Exact Test was used on the subgroup of BWIR recruits.

3. Results

3.1. Prevalence of Soil-transmitted Helminth infections

Prevalence figures were consistent across data sources (Table 4.1). Around 6 in 10 Jamaicans (62% in JHC surveys, 63% in laboratory figures and 60% of BWIR volunteers) were infected with hookworm. Around 3 in 10 were infected with *Ascaris* (30% in JHC surveys, 34% in laboratory figures and 28% of BWIR volunteers). A similar number were infected with *Trichuris* (32% in JHC surveys, 38% in laboratory figures and 34% of BWIR volunteers). Other helminth parasites were recorded infrequently. The JHC reports for 1929 (in NA CO/141/93 Sup. *Jam. Gaz.* 54:17) and 1933 (UWI) provide prevalence data for the common human parasite *Strongyloides*, while the report for 1925 (NA CO/141/88 Sup. *Jam. Gaz.* 48:7) noted *Strongyloides intestinalis* infection: for this reason we have assumed that the prevalence data reported under a column headed 'Strongylus' in the 1928 report (NA CO/141/91 Sup. *Jam Gaz.* 51:5) represents *Strongyloides* infection reported under a spelling error.

Table 4.1: Prevalence of Infection with Parasitic Helminths in Jamaica, 1913-1931. Several species were referred to in these documents by generic names which are no longer used, including *Trichocephalus* for *Trichuris*, and *Oxyuris* for *Enterobius*. Here we use the present-day names.

Parasite	Prevalence				
	Hookworm Commission Surveys, 1927-1933	National Bacteriological Laboratory, 1913-1928	BWIR Volunteers, 1915	Hospital Admissions	
				1916	1917
Hookworm	62.1% (n=41,758)	62.7% (n=30,607)	60.1% (n=1,063)	1665 cases (listed under *A. duodenale*)	1192 cases (listed under *A. duodenale*)
Ascaris	30.2% (n=41,758)	34.2% (n=30,607)	27.8% (n=1,063)	273 cases	206 cases
Trichuris	32.1% (n=41,758)	37.9% (n=30,607)	33.6% (n=1,063)	-	-
Strongyloides (including data from 31 districts reported under *Strongylus*)	0.193% (n=18,171) Reported on in 46 districts	-	-	-	-
Enterobius	0.0111% (n=13,570) Reported on in 30 districts	-	-	6 cases	2 cases
'Filarial Disease'	-	-	-	1 case	1 case
'Hookworm disease'	-	-	-	434 cases	220 cases
Tapeworm (*Taenia*)	'two or three cases' in 1929; 'one case' in 1930	-	-	-	-

3.2 Epidemiological associations between helminth species

At a community level, the prevalence of hookworm infection was positively associated with the prevalence of *Trichuris* infection (t=2.56, p=0.0124) but not of *Ascaris* infection (t=0.965, p=0.337, Figure 4.1). However, the prevalence of *Ascaris* infection was associated with the prevalence of *Trichuris* infection (t=12.1, p<0.0001, Figure 4.1).

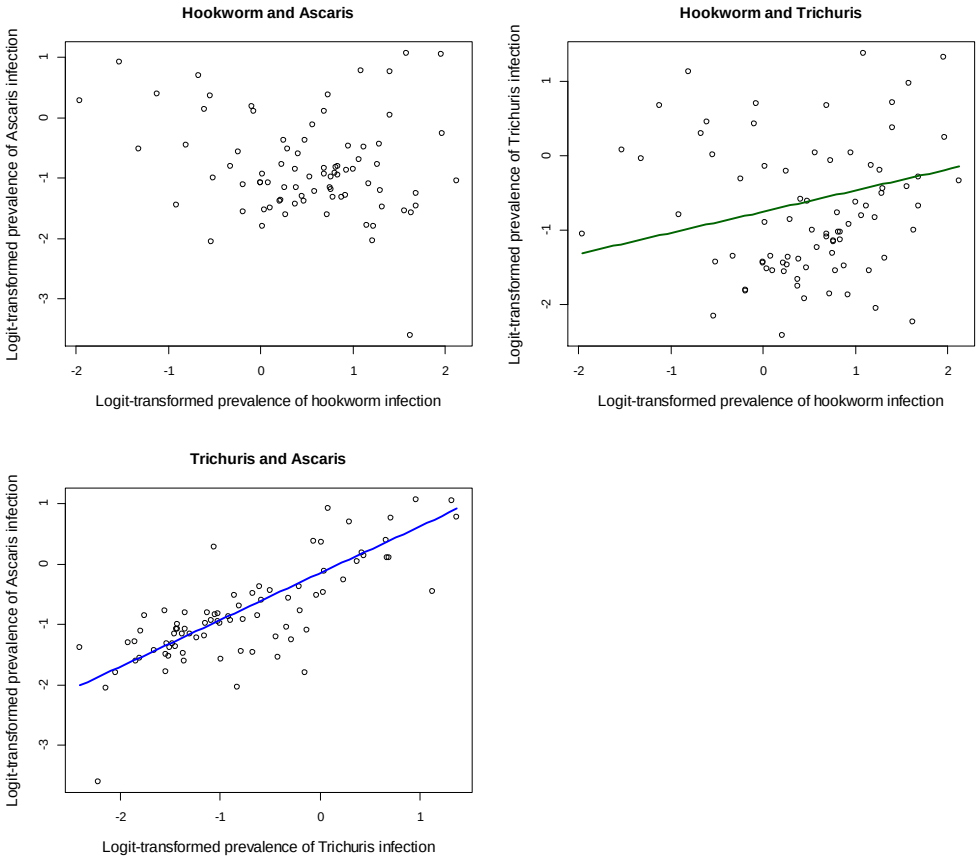

Figure 4.1: Logit-transformed prevalence of Hookworm, *Ascaris* and *Trichuris* infection in 81 districts of Jamaica plotted against each other, 1927-1933. Lines show Loess smoothing of model predictions for each district.

To test for associations at an individual level, data from Jamaica's National Bacteriological Laboratory were used. These gave the numbers of individuals testing positive for *Ascaris*, *Trichuris* and hookworm alone and in each possible combination (Figure 4.2). Hookworm, *Ascaris* and *Trichuris* were associated on an individual level (Table 4.2). Hookworm was associated with both *Ascaris* and *Trichuris*, but the latter two species were even more closely associated with each other.

Table 4.2: Associations between infection with hookworm, *Ascaris* and *Trichuris* in faecal samples from Jamaican Public General Hospitals tested by the Jamaican national Bacteriological Laboratory.
Conchran Mantel-Haenszel test used for hospital patients and Fisher's Exact Test used for BWIR volunteers. Data from NA CO/141/78-92, Annual Medical Reports, Sup. *Jam. Gaz.* 36:18-52:18 (1913-1929).

Group	Odds Ratio: Hookworm infection as a risk factor for *Ascaris* infection	95% Confidence Intervals	Odds Ratio: Hookworm infection as a risk factor for *Trichuris* infection	95% Confidence Intervals	Odds Ratio: *Ascaris* infection as a risk factor for *Trichuris* infection	95% Confidence Intervals
Hospital Patients	2.24	2.12-2.37	2.00	1.90-2.10	7.22	6.88-7.59
BWIR Soldiers	3.18	2.33-4.35	2.02	1.54-2.65	2.12	1.60-2.79

Infections among BWIR volunteers (Table 4.2, Figure 4.3) show a similar pattern to that among hospital patients (Figure 4.2). In the volunteers, hookworm infection was similarly positively associated with *Ascaris* and *Trichuris* infection; *Ascaris* and *Trichuris* were also positively associated (Table 4.2).

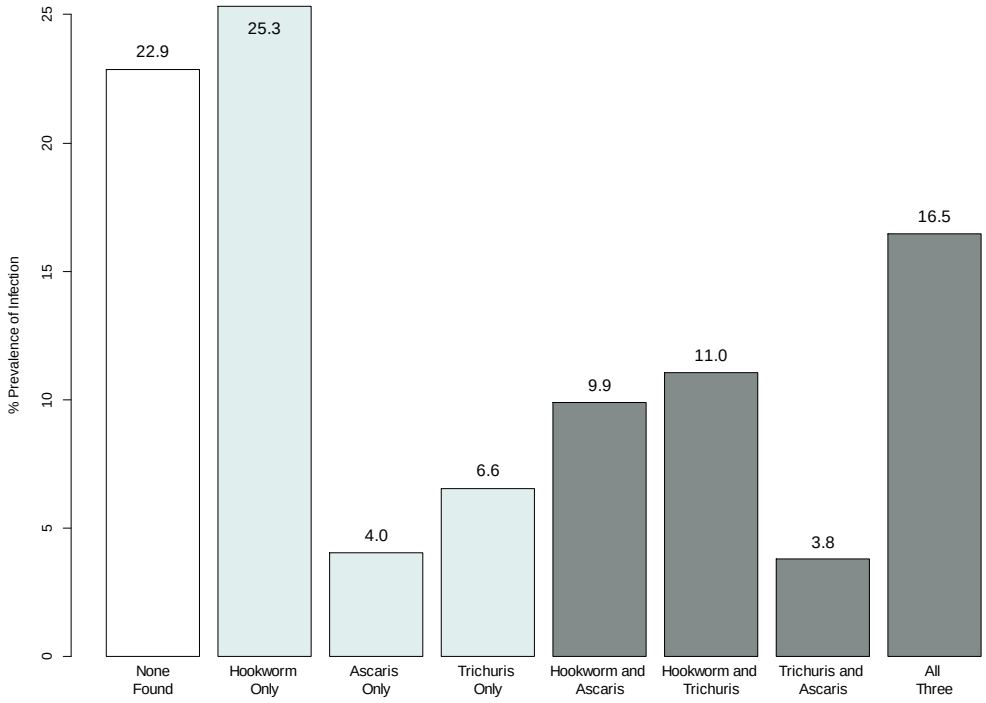

Figure 4.2: Percentages of 30607 people found infected with STH in Jamaican Public General Hospitals, 1913-1928.
Data from NA CO/141/78-92, Annual Medical Reports, Sup. *Jam. Gaz*. 36:18-52:18 (1913-1929).

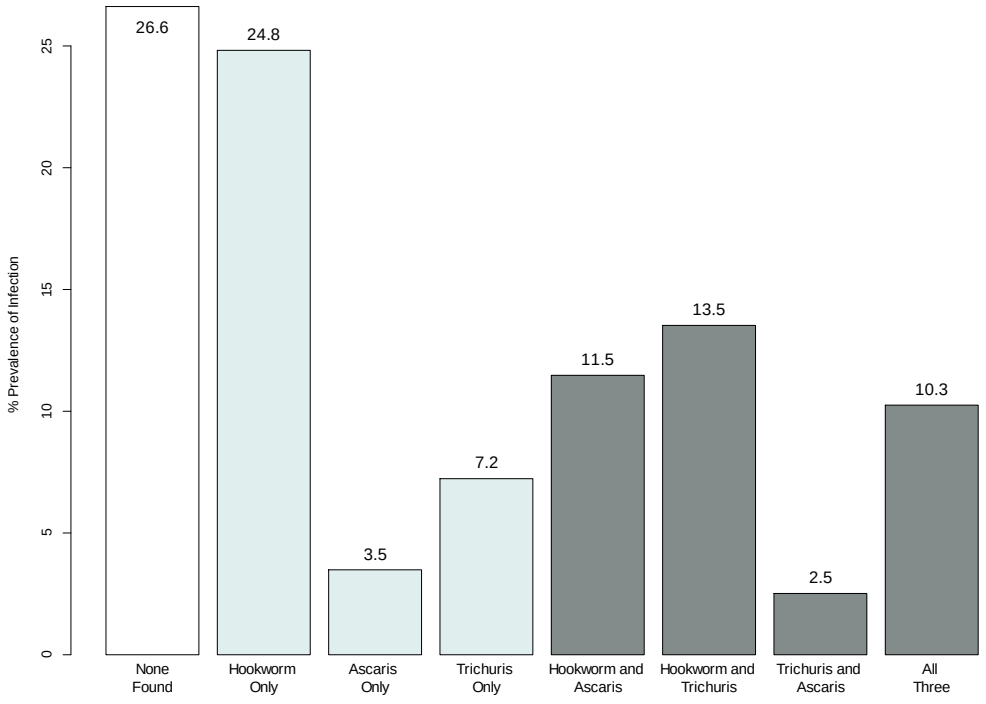

Figure 4.3: Percentages of 1063 Jamaican volunteer soldiers of the BWIR found infected with STH, 1915.
Data from NA CO/141/79 'Report of the Island Medical Department', Sup. *Jam Gaz.* 39:14 (7th September 1916).

3.3 Community knowledge of helminths & anthelmintics

Hookworm, *Ascaris* and *Trichuris* were widespread in early 20th century Jamaica. However, medical attention focused on hookworm, which was seen as one of the principal threats to public health, alongside malaria and tuberculosis. (10) Hookworm features frequently in government reports, health education literature and occasionally in the *Journal of the Jamaica Agricultural Society* (*JJAS*). References to other helminths are harder to find: between 1926 and 1936, *Jamaica Public Health* published only one article focusing on 'roundworms' (*Ascaris*). Five articles in *JJAS*, discussed below, referred to medicinal plants effective against hookworm and provide useful information about knowledge of other helminths. While JHC reports reported numbers of cases of other helminthiases, they seldom provided any qualitative information about these.

Four themes were identified in this literature. (1) Early 20th-century Jamaicans were familiar with parasitic helminths, principally *Ascaris*. This lent credibility to JHC assertions about hookworm, which was less familiar. (2) Medicinal plants, including *Chenopodium ambrisoides* (known in Jamaica as semi-contract), were used to treat these worms. This helped make the use of chenopodium oil as an anthelmintic by the JHC acceptable. (3) The large, well-known, and highly visible *Ascaris*, when expelled by treatment with chenopodium, provided dramatic and visible proof of the effectiveness of JHC medication. (4) This was sometimes used by the JHC to promote hookworm treatment.

3.3.1 Familiarity with *Ascaris* and other helminths

Jamaicans were sufficiently familiar with *Ascaris* to have given it at least two common names, and understood it to affect the gastrointestinal tract, as shown in a 1928 *Jamaica Public Health* article titled 'Roundworms'*:*

> "The scientific name of the worm is Ascaris lumbricoides, but in Jamaica it is commonly known as the "stomach" or "greedy" worm." (*Jamaica Public Health* 3:12 (December 1928) pp.5-6.)

Familiarity with helminth parasites of livestock and their treatment is also evident. As early as 1915, *JJAS* advertised the usefulness of tansy (*Tanacetum vulgare*) against 'the dreaded Hook Worm', noting that 'Tansy tea has always been locally used as a specific for worms in horses', though apparently

previously not in humans (*JJAS* 19 (1915) p.402). While hookworm was by this point worrying medical authorities, no evidence was encountered that either hookworm or *Trichuris* were specifically known or distinguished from other intestinal worms by folk medicine the way *Ascaris* was, though they may have been recognised within a general category of 'worms'.

3.3.2 Folk usage of *Chenopodium ambrisoides*

C. ambrisoides was widely used as an anthelmintic in early 20th century Jamaican folk medicine. *JJAS* reported:

> "With reference to our paragraph in the October JOURNAL that a strong infusion of Tansy has been found to be useful in eradicating Hook Worm, a medical man writes that a decoction of Bitterwood is better, but the plant called locally Wormweed (*chenopodium* [sic] *ambrisoides*) promises to be the best remedy of all; better even than Thymol…Wormweed is commonly known and used for ordinary intestinal worms." (*JJAS* 19 (1915) p.477).

In 1924, *JJAS* reported that *C. ambrisoides*

> "has long been used as a "bush tea" by wise old women…We know of a case where a family running with their barefeet, – as most children do when at home, – but getting a dose of this particular bush tea every Saturday, were, on test, found to be free of the pest [hookworm], whereas the father who always wore boots and who never bothered about "bush tea" was found highly infested." (*JJAS* 28/9 (1924) p.320).

The *JJAS* returned to their advocacy of bush tea on the grounds that weekly use of 'such homeopathic doses prevented infection of Hookworm' in 1926 (*JJAS* 30/3 (1926) p.84). They had previously, in the 1924 article discussed above, urged their readers to

> "Get some Chenopodium or Semi-contract in a corner of your garden along with other herbs, like Mint. We can supply seed." (*JJAS* 28/9 (1924) p.320).

The enthusiasm of the Jamaica Agricultural Society for *C. ambrisoides* was based not only on its endorsement by biomedicine, but also on its status as a widespread, effective and time-honoured folk remedy.

3.3.3 Expulsion of *Ascaris* demonstrated anthelmintic effectiveness

The dramatic effect of chenopodium on *Ascaris* provided a valuable advertisement for hookworm treatment. The medical report for 1929 remarks that:

> "These [*Ascaris*, *Trichuris* and *Enterobius*] and two or three cases of tape-worm infection, have responded well to the Chenopodium and Thymol, the efficiency of which is often judged by the native from the number of "greedy" worms (ascaris) expelled." (NA CO/141/93 'Annual Medical and Sanitary Report for the Year 1929' Sup. *Jam. Gaz.* 53:2 (17th April 1930)).

This anecdote is presented as a curiosity, but it is more useful to see it as an entirely sensible metric of anthelmintic action. *Ascaris* (150-350mm long) are much larger than hookworms (7-13mm), and consequently far easier to see when expelled. (21, 22) This report also demonstrates that many Jamaicans knew *Ascaris* to be a threat to their health, and took the opportunity offered by the JHC to remove it.

On the other side of the Caribbean in St Lucia, Dr Stanley Branch similarly noted that chenopodium's 'efficacy as a lumbricoid expellant has I think helped to persuade' patients to take treatment (Rockefeller Archive Center, RG 5/3.457H/190/2344 St. Lucia - Hookworm, Quarterly, Semi-annual and Annual Reports, 1917). 'Lumbricoid' refers to *Ascaris lumbricoides.*

3.3.4 Use of *Ascaris* to promote health efforts

The JHC eventually recognised that *Ascaris* could be used to promote hookworm treatment. *Jamaica Public Health* regularly featured, alongside instructional articles and health advice, stories penned by Washburn in which his child protagonists learned to 'keep well' and instructed their parents in what they learned. (10) In one of these, published in 1930, folk healer Aunt Eliza was only persuaded to take hookworm medication (which she notes 'smell like semi-contrac' tea') after Mrs Francis reports that, post-treatment,

> "My daughter, Retinella, is passing, such big, tall, round worms and they are all alive. It must be good for her and I am glad that the dispenser has come here and truly glad for the medicine." (*Jamaica Public Health* 5 (1930) pp.30-31).

Following this, Aunt Eliza 'swallowing her medicine', says 'me wan' fi see de worms', concluding that 'Di hookworm medicine fi good'. This is an idealised account authored by a propagandist, but it shows that Washburn recognised that the spectacle of *Ascaris* expulsion could be a valuable advertisement for hookworm medicine, and a means to persuade reluctant patients of its efficacy.

4 Discussion

4.1 Coinfections

Ascaris, Trichuris and hookworm were all prevalent in this period, with other intestinal parasites being recorded less frequently. However, these data, being based on faecal examinations, likely underestimate the prevalence of *Strongyloides* and *Enterobius* (pinworm). (23, 24) Those infected with hookworm were around twice as likely to be infected with either *Trichuris* or *Ascaris* as those without any parasite infections. *Ascaris* and *Trichuris* were even more closely associated: infection with *Ascaris* or *Trichuris* was associated with a sevenfold increase in the risk of infection with the other species. Similar results were obtained for both hospital patients and BWIR volunteers, who were required to be healthy adult men, mostly in their twenties, suggesting that the three helminths were associated regardless of the health of the host. (25, 26).

Positive associations between hookworm and other parasites, including *Ascaris* and *Trichuris*, are commonly reported. (27-30) *Ascaris, Trichuris* and hookworm share similar modes of transmission, in that their transmission phase is found in soil that has been contaminated with human faeces. This results in overlapping risk factors: all three are positively associated with warmer, wetter and more vegetated areas and negatively associated with improved sanitation. (31-36) Identical modes of transmission and very similar age-prevalence profiles result in *Ascaris* and *Trichuris* being strongly associated and commonly found together. (22) Likewise, individuals who are immunologically vulnerable to one helminth can also be expected to be vulnerable to others. It is also likely that immunomodulation of the host immune response plays a role in the positive associations between these helminth parasites. (22) Hookworms in particular downregulate host production of a variety of immunoproteins and lymphocytes while upregulating T-cell apoptosis and T-regulatory cell populations, while *Ascaris* and *Trichuris* are known to block dendritic cell function, thereby reducing T-cell activity. (37-39) However, the particularly strong association in this study and others between *Ascaris* and *Trichuris* suggests that transmission may be of primary importance in coinfections.

4.2 Knowledge of Helminths

We have shown that familiarity with *Ascaris* and other intestinal parasitic helminths of humans and livestock lent credibility to claims about hookworms: the *JJAS* encouraged its readers to use herbal treatments for hookworm (tansy and *C. ambrisoides*) on the basis of their pre-existing use as treatments for other helminths. Use of *C. ambrisoides* to treat *Ascaris* and other 'ordinary intestinal worms' was widespread. The expulsion of *Ascaris* similarly provided vivid visual proof of the effectiveness of chenopodium oil and other drugs used by the JHC.

JJAS reported folk usage of *C. ambrisoides* as an anthelmintic in Jamaica between 1915 and 1926, with the implication that this was longstanding. Use of *C. ambrisoides* to treat pinworm in children in Central American folk medicine during this period is reported by Palmer, while its use as a vermifuge has likewise been reported in present-day Jamaican folk medicine by Payne-Jackson and Alleyne. (14, 40) The RF and colonial authorities were primarily concerned with hookworm, but ordinary Jamaicans used the hookworm campaign to improve their own health outside of the bounds set by the colonial government; they saw *Ascaris* as a threat to their health and took the opportunity presented by the hookworm campaign to remove it, as demonstrated by positive responses to *Ascaris* expulsion. The framing of *Ascaris* as 'greedy' further underlines that Jamaicans understood that *Ascaris* was devouring the food they had eaten and thereby depriving them of nourishment. Hookworm was not the only worm they cared about.

Ascaris expulsion following treatment also functioned as 'theatre of proof' for the JHC, dramatically demonstrating the effectiveness of their medicine. (41) Palmer, in his study of Guatemala, Nicaragua, Costa Rica, Panama, British Guiana (Guyana) and Trinidad and Tobago claims that chenopodium's dramatic effects on *Ascaris* made it favoured over other drugs by RF doctors, suggesting a similar use of *Ascaris* elsewhere the circum-Caribbean to what we have shown here. (40, 42)

Existing knowledge of *Ascaris* similarly made biomedical claims about another dangerous intestinal worm (hookworm) credible. Hookworms are

invisible to the host; people infected with them, even where symptoms were acute, often had no idea of their presence, especially as their primary symptom (anaemia) is neither distinctive nor obviously related to the digestive system. The existence of hookworms is not self-evident. (12) By contrast, the larger and more migratory *Ascaris* was far more visible and familiar to Jamaicans, who already regarded it as a medical threat requiring treatment. While hookworm was unfamiliar, the knowledge that intestinal worms caused illness was widespread.

Noting that notions of worms causing illness are near-universal across medical knowledge systems, Palmer has argued that RF doctors were able to use this non-biomedical knowledge to promote their own epistemologies of hookworms causing disease. (42) This 'worm theory' created an epistemic middle ground facilitating exchanges of medical knowledge. Payne-Jackson and Alleyne have shown that worms are directly linked to stomach problems in present-day Jamaican folk medical epistemologies; here we have shown widespread knowledge of the dangers of *Ascaris* and other 'ordinary intestinal worms' in the early 20th century. (14) Palmer's discussion of 'worm theory' accords well with our results, as well as with Stuart's account of RF doctor Sylvester Lambert's encounter with a Papuan medical knowledge system which blamed worms in the belly for illness – which for Lambert highlighted the uncomfortable similarities between himself and those he viewed as 'witch-doctors'. (43) We go beyond Palmer in showing that this extended to treatment: just as familiarity with *Ascaris* made hookworm programmes credible, familiarity with *C. ambrisoides* made treatment with chenopodium oil acceptable. Furthermore, we show that 'worm theory' was underpinned by the ecological relationships between worms: the fact that *Ascaris* was widespread, familiar and positively associated with hookworm enabled Washburn and the JHC to use it to promote 'worm theory'. Had *Ascaris* been less widespread, or not associated with hookworm, the JHC's task might have been significantly more difficult.

4.3 Conclusion

Hookworm, *Ascaris* and *Trichuris* were widespread across early 20th century Jamaica, and *Ascaris* was familiar to Jamaicans as the 'stomach' or 'greedy worm'. Those infected with one of these parasites were at increased risk of

infection with another; around as many Jamaicans were infected with both hookworm and the more visible and familiar *Ascaris* (26.4%; Figure 2) as were infected with hookworm alone (25.3%; Figure 2) while far fewer were infected with *Ascaris* but not hookworm (7.8%, Figure 2). Familiarity with *Ascaris* lent credibility to JHC claims about hookworm, as did pre-existing folk usage of one of the same anthelmintics used by the JHC. Simultaneously, expulsion of *Ascaris* provided further proof of the effectiveness of JHC medication, helping to drive public engagement with hookworm treatment. Ecological relationships existed between hookworm, *Ascaris* and *Trichuris*, as the three species commonly co-occurred and coinfected people. This enabled an epistemic relationship to emerge, as knowledge of *Ascaris* and other helminths shaped knowledge of hookworm. This epistemic relationship was exploited by public health workers concerned with hookworm. Knowledge of *Ascaris*, known to be a threat to health and treated with *C. ambrisoides*, helped persuade Jamaicans to engage with the JHC, and also persuaded them of the effectiveness of JHC treatment; folk medical knowledge can be a valuable aid to biomedical health education. It can be useful for medical and public health workers to engage with how folk knowledge can aid health programmes, as researchers in the present are already doing. (19, 44)

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Chapter 5 The Advance Agent of Health: Health Education, Hygienic Modernity, and Anticipated Extinctions of Hookworm and Folk Medicine in Jamaica, 1919-1936

Abstract

Eradication programmes strive to create futures in which diseases and parasites have gone extinct. In this chapter, health education efforts undertaken as part of a programme to eradicate hookworm from Jamaica between 1919 and 1936 are examined. I explore the ways in which the extinction of hookworm was imagined as both a product of hygienic modernity and a means to enact it, drawing from reports prepared by the Jamaica Hookworm Commission (JHC) and its associated health education magazine *Jamaica Public Health*, alongside the *Journal of the Jamaica Agricultural Society*. Doctors expected that as the JHC cured people of hookworm and persuaded them to adopt healthy 'modern ways of living', Jamaicans would begin to practise biomedical disease prevention at both and individual and a social level, resulting in the ultimate extinction of hookworm. Likewise, it was anticipated that as hygienic modernity and modern medicine advanced, it would supplant and eliminate folk medicine. Hookworm was understood as an educational tool, an 'advance agent of health' which would aid the JHC in modernising Jamaica. This would be advanced through hookworm treatment, which was promoted through spectacle, humour, shame and the recruiting of local authority figures. Many Jamaicans, particularly from the middle classes, embraced this programme, which aligned with their own emphasis on self-discipline and moral 'improvement' of the labouring classes. The extinction of hookworm was anticipated as both cause and consequence of the creation of a hygienic modernity for Jamaica.

Introduction

Health programmes – and particularly eradication programmes – offer a useful perspective on extinction, in that they imagine, celebrate, and strive to enact futures where parasites and diseases are extinct. The extinction of a parasite is understood not as a depletion of the natural world, but as a

triumph of human progress. The dissonance between medical and conservation views on extinction is particularly apparent when the parasite targeted for extinction is itself an animal, such as hookworm. This chapter explores health education efforts surrounding the Jamaica Hookworm Commission (JHC, 1919-1936) in this light. I show that hookworm played a key role in JHC and Bureau of Health Education head Benjamin Earl Washburn's imagining of future trajectories of Jamaica. An American veteran of Rockefeller Foundation hookworm programmes, Washburn understood hookworm as a useful tool of health education, an 'Advance Agent of Health' which could be deployed to teach Jamaicans how to 'live well'. As Jamaicans learned to live well and Jamaica entered a new era of hygienic modernity, he thought, hookworm would naturally fade away. Similarly, he anticipated a parallel extinction of folk medicine, believing that as modern biomedicine advanced, folk medicine would be superseded, and likewise fade away. I am interested here not in actual extinctions – which did not occur – but in Washburn's anticipated extinctions, the extinctions he felt must inevitably come to pass as Jamaica advanced, and how these related to his vision of a modern Jamaica. As Dolly Jørgensen has shown, the anticipation of extinction is central to both conservation biology and extinction studies.[1] Here I show that the anticipation of extinction has also been central to public health, though medicine aimed to induce, rather than avert, extinction.

Washburn and his allies envisaged and sought to create a hygienic modernity, a healthier future for Jamaica where modern biomedicine, hygiene and public health were universally practised, and hookworm and other diseases would consequently be extinct. The extinction of hookworm was imagined as both a product of this modern future and as a means to bring it about. Treatment for hookworm, it was thought, would make people more mindful of health, and more likely to adopt preventative measures which would both protect them from hookworm and improve their health in general. Health was thought to make people better citizens, and good citizens were expected to create healthy progressive communities.

[1] D. Jørgensen, 'Extinction and the End of Futures', *History and Theory* 61/2 (2022) pp.181-368.

Progressive communities were then anticipated to create a modern, healthy, hookworm-free Jamaica. Inducing the extinction of hookworm was a means to enact this hygienic modernity and create a modern, healthy nation. For this reason, Washburn was able to build a broad alliance with the Jamaican middle classes, who, as Darcy Heuring has demonstrated, increasingly viewed health in nation-building terms during this period.[2]

These middle classes became more prominent and more nationalistic as the 1930s progressed. Though nationalism typically envisaged self-government within the British Empire, perhaps within a West Indian federation holding the same dominion status enjoyed by Canada, rather than complete independence, many Jamaicans were increasingly dissatisfied with Crown Colony government and the rule of local elites.[3] The middle classes, largely composed of light-skinned Afro-Jamaicans of mixed heritage, sought more influence at the expense of the predominantly white elite and what remained of the planter classes, while also seeking to spread their values to the working classes and peasantry in order to create a Jamaican nation along British lines.[4] As Heuring points out, the middle classes rejected white cultural hegemony but found themselves operating within its frameworks and aiming to spread English values to the lower classes.[5]

I discuss firstly JHC use of hookworm as a tool of health education, before briefly outlining 'the rules of health' the JHC and its allies promoted and the means by which they attempted to persuade Jamaicans to adopt these rules. Following this, I turn to Washburn's anticipation of the extinction of folk medicine, before addressing the politics of health education in this late-colonial context. Throughout, I use JHC reports from the UK National Archives and the University of the West Indies Medical Library, as well as

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[2] D.H. Heuring, *Health and the Politics of 'Improvement' in British Colonial Jamaica, 1914-1945* (2011: DPhil Dissertation, Northwestern University, Illinois).
[3] Ibid., K. Post, *Arise Ye Starvelings: The Jamaica Labour Rebellion of 1938 and its Aftermath* (The Hague: Martinus Nijhoff, 1978) Ch. 7; E. D. Duke, 'The Diasporic Dimensions of British Caribbean Federation in the Early Twentieth Century', *New West Indian Guide* 83/3&4 (2009) pp.219-248.
[4] See B. L. Moore and M. A. Johnson, *They do as They Please* (Kingston: University of the West Indies Press, 2011), especially Ch.5.
[5] Heuring, *Health and the Politics of 'Improvement'* p.17; see also Moore & Johnson, *They do as they please.*

the *Journal of the Jamaica Agricultural Society*. My key source, however, is Washburn's health education journal, *Jamaica Public Health*, published by the Bureau of Health Education from 1926 well into the 1970s, and accessed in the National Library of Jamaica. I draw from and extend the work of Heuring and Margaret Jones, who, alongside James Riley, are the only historians to have provided in-depth explorations of health in Jamaica in this period.[6]

Jamaican folk medicine is a sophisticated medical knowledge system, drawing from African, European, Taíno and Asian traditions. An overview is provided Arvilla Payne-Jackson and Mervyn Alleyne, who make use of a tripartite aetiological taxonomy of natural, spiritual and occult causes of illness.[7] Illness can result from, for example, problems with the blood (natural), encounters with duppies (spiritual), chastisement by God (spiritual) or the spiritual action of an enemy (occult). Treatment could consequently encompass a wide range of natural (e.g. herbal bush-teas and bush-baths), spiritual (e.g. prayer and faith healing) and occult (e.g. ritual) treatments. Both cause and treatment often blend natural, spiritual and occult elements; many herbs have spiritual properties as well as natural ones, for example, and may be used in conjunction with psalm-reading or consecrated water.

In the early 20th century, access to biomedicine was extremely limited in Jamaica.[8] There were few biomedically-trained doctors on the island, and these typically charged unaffordable fees.[9] Paupers were entitled to free treatment from District Medical Officers and public hospitals, and those earning less than 12 shillings a week could apply for a 'ticket' entitling them to free or discounted treatment, but the costs and difficulties of travel still

[6] M. Jones, *Public Health in Jamaica, 1850-1940: Neglect, Philanthropy and Development* (Kingston: University of the West Indies, 2013); J. C. Riley, *Poverty and Life Expectancy: The Jamaica Paradox* (Cambridge: Cambridge University Press, 2005).
[7] A. Payne-Jackson and M. C. Alleyne, *Jamaican Folk Medicine: A Source of Healing* (Kingston: University of the West Indies Press, 2004).
[8] Jones, *Public Health*, Ch.1-3; see also Riley, *Poverty and Life Expectancy* Ch.2.
[9] Heuring, *Health and the Politics of 'Improvement*' pp.65-66.

put biomedical treatment beyond the reach of many.[10] In part in consequence, Jamaicans mainly relied on folk medicine, both self-administered and provided by a range of church, occult and naturalistic practitioners.[11] This was a situation the JHC and its sister organisation the Bureau of Health Education (launched 1926), both joint operations between the American Rockefeller Foundation (RF) and the colonial government, sought to change. The RF had long viewed hookworm programmes as a means to cheaply improve individual health and extend health systems, thereby improving economic productivity.[12] Through biomedical treatment, the JHC sought to extend biomedical knowledge of health through Jamaica, a mission which the Bureau was founded to extend. For Washburn, this spread of biomedical knowledge was key to creating a modern, hygienic and healthy future for Jamaica. He anticipated a hygienic modernity, and sought to enact this through the eradication of hookworm.

Hookworm: The Advance Agent of Health

The RF's use of hookworm as a 'wedge', which could be used to build up public health systems that would outlast the initial hookworm campaign, has been much remarked-upon.[13] John Farley connects this to director Wickliffe Rose's vision for the Foundation, and notes that it was a vison shared by International Health Board director for the West Indies Hector Howard.[14] This vision was also embraced by Washburn, whose efforts against hookworm in Jamaica gradually acquired elements of child dental (from 1926), health education (1926), medical training (1928), anti-malarial

[10] Heuring, *Health and the Politics of 'Improvement'* pp.58-66; Jones, *Public Health* Ch.3.
[11] Heuring, *Health and the Politics of 'Improvement'* pp.58-66; Payne-Jackson & Alleyne *Jamaican Folk Medicine* Ch.5.
[12] J. Ettling, *The Germ of Laziness: Rockefeller Philanthropy and Public Health in the New South* (London: Harvard University Press, 1981); J. Farley, *To Cast Out Disease: A History of the International Health Division of the Rockefeller Foundation (1913-1951)* (Oxford: Oxford University Press, 2004); E. R. Brown, *Rockefeller Medicine Men: Medicine and Capitalism in America* (Berkley: 1979).
[13] See, for example: C. Elman et al., 'Extending Public Health: The Rockefeller Sanitary Commission and Hookworm in the American South', *American Journal of Public Health* 104/1 (2014) pp.47-58.; A.-E. Birn and A. Solórzano, 'Public health policy paradoxes: science and politics in the Rockefeller Foundation's hookworm campaign in Mexico in the 1920s', *Social Science and Medicine* 49(1999) pp.1197-1213; Farley, *To Cast Out Disease* pp.61-74.
[14] Farley, *To Cast Out Disease* pp.61-74.

(1928), anti-tuberculosis (1929) and anti-yaws (1932) work as it blossomed into a programme of 'Cooperative Health Work' between the RF and the Jamaican government.[15] Washburn's reports frequently emphasise 'the development of public health' and 'developments in sanitation' arising out of the hookworm campaign.[16] Jones even considers the RF 'instrumental in improving the health services of the colony'.[17] Building up health systems was a crucial part of Washburn's efforts to enact his vision of a hygienically modern Jamaica.

What has been less noted by historians is the enthusiasm shown in Whitehall for this use of hookworm. The Colonial Advisory Medical and Sanitary (CAMS) committee were effusive in their praise of Washburn – so effusive, in fact, that Colonial Office officials complained that

> The C.A.M.S. C'tee have complimented Dr Washburn three times in the last two years. In this connexion it may perhaps be relevant to observe that Dr. Washburn is (a) an American by birth, and (b) a journalist by training…there may be others elsewhere in the Empire who are doing equally good work without the attendant "publicity".[18]

Regardless of the Colonial Office's general suspicion of Americans (presumably deriving from increasing US global power and regional interventionism), the CAMS committee shared with the RF a vision of a hookworm campaign which would build up public health systems. In April 1928, for instance, Dr Horn commented that 'It is very satisfying to note the different lines of Public Health activity in Jamaica – largely due to Dr.

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[15] UK National Archives (Kew) [henceforth NA] CO/137/781/1 Jamaica Hookworm Commission Monthly Reports (1925-7); CO/137/786/4 Jamaica Hookworm Commission Monthly Reports (1928-9); CO/141/91 'Report of Co-operative Health Work in Jamaica during 1927' Sup. *Jam. Gaz.* 51:5 (26th Apr. 1928); CO/141/92 B.E. Washburn 'Report of the Co-operative Health Work Conducted in Jamaica During 1928', Sup. *Jam. Gaz.* 52:7 (13th July 1929); CO/141/93 'Annual Medical and Sanitary Report for the Year 1929' Sup. *Jam. Gaz.* 53:2 (17th Apr. 1930), University of the West Indies Medical Library [Henceforth UWI], 'Medical Department' Report for the year ended 31st December 1935' (1936).

[16] NA CO/141/91 'Report of Co-operative Health Work in Jamaica during 1927' Sup. *Jam. Gaz.* 51:5 (26th Apr. 1928); CO/141/92 B.E. Washburn, 'Report of the Co-operative Health Work Conducted in Jamaica During 1928', Sup. *Jam. Gaz.* 52:7 (13th July 1929); CO/141/87 'Report of the Jamaica Hookworm Commission', Sup. *Jam. Gaz.* 47:2 (1st March 1924).

[17] Though not without caveat: Jones, *Public Health* p.154.

[18] NA CO/137/782/4 'Hookworm Reports' (1927-9).

Washburn', while in December 1927 Sir James Fowler approvingly noted that 'it is clear that public health matters are receiving increased attention in Jamaica and that progress is being made'.[19] In November 1928, Dr Balfour noted that 'the hookworm campaign is serving as an incentive to the sanitary campaign' (that is, the sanitation programmes which ran ahead of and in parallel with the treatment programmes), while Fowler celebrated the 'many indications that the sanitary conscience of Jamaica has been awakened. I attribute much of this to Dr. Washburn'.[20] Horn further dubbed Washburn, 'a "live wire"'.[21] Enthusiasm for using hookworm to advance public health, and to 'awaken' a 'sanitary conscience' was hardly confined to the RF; Jones also notes praise for Washburn in the *British Medical Journal*.[22]

In Jamaica, meanwhile, both Howard and Washburn were keen to make hookworm an educational tool, and hookworm campaigns 'advance agents of health departments' in Washburn's phrase.[23] Their reasoning was rooted in the biology of the parasite. Hookworm was 'a simple disease' with an uncomplicated and scientifically well-understood lifecycle which, Washburn believed, 'can be explained and demonstrated to anyone'.[24] Unlike other prevalent 'bowel diseases', such as typhoid fever, hookworm disease was caused by a readily-comprehensible parasite. A worm living in your gut sucking your blood is not a complex aetiology, and could be demonstrated dramatically with film (RF propaganda film *Unhooking the Hookworm* was a perennial favourite of the JHC) and bottled specimens.[25] The control methods emphasised (build a pit latrine) were easy to understand and carry out, and would, the RF believed, have a positive

[19] NA CO/137/786/4 Jamaica Hookworm Commission Monthly Reports (1928-9).
[20] NA CO/137/781/1 Jamaica Hookworm Commission Monthly Reports (1926-7).
[21] Ibid.
[22] Jones, *Public Health* p.127.
[23] NA CO/141/91 B.E. Washburn, 'Report of the Co-operative Health Work in Jamaica during 1927', Sup. *Jam. Gaz.* 51:5 (26th April 1928).
[24] NA CO/141/92 B.E. Washburn 'Report of the Co-operative Health Work Conducted in Jamaica During 1928', Sup. *Jam. Gaz.* 52:7 (13th July 1929)
[25] NA CO/141/85 'Report of the Jamaica Hookworm Campaign for 1921' *Jam. Gaz.* 45:2 (12th Jan. 1922).

knock-on effect on other bowel diseases and health generally.[26] Hookworm became not only an 'agent of health departments', but, as the 1925 JHC report has it, 'an advance agent of health' itself.[27]

Shirish Kavadi describes a very similar, if largely unsuccessful, attempt to use hookworm as a tool of sanitary education in Madras, India, and notes that the RF focused on hookworm 'not because it was a dreaded disease, but because its control methods were easiest to demonstrate'.[28] Though hookworm held a significantly more dreaded position in the Jamaican medical profession's pandemonium of disease, this interpretation is useful. Washburn and Howard consistently emphasised the 'educational value' of the treatment campaign. 'The object of the Jamaica Hookworm Campaign', Washburn repeatedly noted,

> is to co-operate with the Government Medical Service in demonstrating the importance of hookworm and the other soil pollution (bowel) diseases…hookworm disease being taken as a type of this class of disease…to teach people the necessity for using the latrines which had been erected…[29]

He aimed to

> utilize the work of controlling hookworm disease as a demonstration of the value of public health work…to stimulate improvement in sanitary conditions throughout the Colony…to employ the hookworm campaigns as a means of educating the people as to the value of disease prevention.[30]

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[26] NA CO/141/87 'Report of the Jamaica Hookworm Commission', Sup. *Jam. Gaz.* 47:2 (1st March 1924); c.f. CO/141/91 B.E. Washburn, 'Report of the Co-operative Health Work in Jamaica during 1927', Sup. *Jam. Gaz.* 51:5 (26th April 1928).
[27] NA CO/141/89 'Report of Overseer of Works, Hookworm Campaign, Year Ending 31st December, 1925' Sup. *Jam. Gaz.* 69:24 (14th Oct. 1926).
[28] S.N. Kavadi, ''Parasites lost and Parasites Regained': Rockefeller Foundation's Anti-Hookworm Campaign in Madras Presidency', *Economic and Political Weekly* 42/2 (2007) pp.130-137.
[29] NA CO/141/84 'Report of the Jamaica Hookworm Campaign for 1920' Sup. *Jam. Gaz.* 44:22 (15th December 1921); CO/141/86 'Report of the Jamaica Hookworm Commission for 1922', Sup. *Jam. Gaz.* 46:25 (4th October 1923); CO/141/88 B.E. Washburn, 'Report of the Jamaica Hookworm Commission for 1924' Sup. *Jam. Gaz.* 48:7 (23rd April 1925).
[30] NA CO/141/84 'Report of the Jamaica Hookworm Campaign for 1920' Sup. *Jam. Gaz.* 44:22 (15th December 1921); CO/141/86 'Report of the Jamaica Hookworm Commission for 1922', Sup. *Jam. Gaz.* 46:25 (4th October 1923); CO/141/88 B.E. Washburn, 'Report of the Jamaica Hookworm Commission for 1924' Sup. *Jam. Gaz.* 48:7 (23rd April 1925).

'All the hookworm campaigns' he enthused 'have been conducted from an educational standpoint having for their object the spread of health education, especially teaching the necessity and value of sanitation'.[31] Hookworm was not just, as historians typically emphasise, a political wedge to build up health systems; it was also an educational wedge to build up health consciousness – what Washburn referred to as 'a sanitary sense' or a 'public health conscience'.[32] 'The object', it was claimed,

> is to take hookworm as an example of a preventable disease and, through the different phases of the campaign, to impress upon the people the desireability [sic] and necessity of practicing disease prevention in their homes and of teaching them, by demonstration, the benefits of keeping well.[33]

Hookworm, Washburn wrote, provided an 'object lesson in sanitation', which could be used to 'teach…the basic facts underlying the spread of disease due to soil pollution'.[34] He aimed to use hookworm to advance his own vision of hygienic modernity and create a modern and disease-free future for Jamaica. This hygienic modernity centred on the personal; part of the aim was the creation of modern hygienic citizens who were knowledgeable about health and modified their behaviour accordingly. A narrative of disease, rooted in hookworm's biology, provided a scaffold for the construction of a code of what the JHC felt to be correct sanitary behaviour: a set of Rules of Health.

The Rules of Health

Washburn and the Bureau of Health Education launched *Jamaica Public Health* in August 1926, in order to 'acquaint the layman with the facts of

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[31] NA CO/141/91 B.E. Washburn, 'Report of the Co-operative Health Work in Jamaica during 1927', Sup. *Jam. Gaz.* 51:5 (26th April 1928).
[32] NA CO/141/84 'Report of the Jamaica Hookworm Campaign for 1920' Sup. *Jam. Gaz.* 44:22 (15th December 1921); CO/141/92 B.E. Washburn 'Report of the Co-operative Health Work Conducted in Jamaica During 1928', Sup. *Jam. Gaz.* 52:7 (13th July 1929); c.f. CO/141/87 'Report of the Jamaica Hookworm Commission', Sup. *Jam. Gaz.* 47:2 (1st March 1924); Farley, *To Cast Out Disease* pp.61-87; Birn & Solórzano 'Public health policy paradoxes'.
[33] NA CO/141/85 'Report of the Jamaica Hookworm Campaign for 1921' Sup. *Jam. Gaz.* 45:21 (19th October 1922).
[34] NA CO/141/87 'Report of the Jamaica Hookworm Commission', Sup. *Jam. Gaz.* 47:2 (1st March 1924).

public health as they apply to the island'.[35] The Bureau, it was explained, 'is a further development of the work of the Jamaica Hookworm Commission', expanding their educational purpose to an island-wide health education effort.[36] *Jamaica Public Health* featured a mix of instructive articles advising Jamaicans on disease prevention, healthy living and child welfare, alongside short stories, plays, songs, crosswords, poems and humorous articles. Jones has examined Washburn's stories and plays in detail, explaining how the child protagonists, Thomas Ezekiel Brown and his cousin Retinella Francis, improved their family's and community's health through their actions and outwitted the healer Aunt Eliza Bush-Tea, who symbolised folk medicine.[37] I will here focus on the question of how Washburn and his Bureau attempted to persuade Jamaicans to engage with public health and hookworm, and on his belief, expressed through his stories, that biomedicine would inevitably displace and drive extinct folk medicine. Jones has analysed Washburn's stories and plays; I particularly focus here on his songs, not for their artistic merit, but because they offer concise distillations of Washburn's message. These were set to well-known tunes and intended to be sung by children and therefore display the key points he wanted children to imbibe.

The songs printed in *Jamaica Public Health* uniformly emphasise self-discipline, and the need to obey 'the rules of health'. The simile of a game was used: 'To keep good health is like a game – we must observe the rules, these should be taught to every child before he leaves our schools…'[38] As one song set to *Auld Lang Syne* explains:

> Should Rules of Health Week be forgot
> And never brought to mind?
> No, we should use them every day,
> And good health we shall find
>
> Shall we by germs be overcome
> And sickness be our lot?
> These things will surely be our fate,

[35] *Jamaica Public Health* [henceforth *JPH*] 1:1 (August 1926).
[36] Ibid.
[37] Jones, *Public Health* pp.126-136.
[38] 'Recitations – The Game of Health' *JPH* 7:9 (September 1932); c.f. 'The Game of Health' *JPH* 2:8 (October 1927).

If health rules are forgot[39]

While another, set to the Jamaican song *Run Mongoose* (*Sly Mongoose*) runs:

If you want to keep Good Health
You don't have to own great wealth
All you need is just to heed
The rules of health

Breathe fresh air
At night as well as day
Eat good food
Take exercise and play

We all should keep our bodies clean,
So our minds'll be bright and keen
Then will we always enjoy the best of health

The rules of health are very plain
But neglect will end in pain
To be of help they must be kept
Then health we'll gain[40]

This emphasis on following the rules has an authoritarian flavour, but the JHC and Bureau had no ability to enforce these rules. The rules of health were theoretically enforced by hookworm, *Salmonella typhi* and *Mycobacterium tuberculosis*, alongside any number of other parasites, but this could hardly be ensured. Washburn aimed to persuade teachers to enforce rules in schools, and eventually enabled sanitary inspectors to enforce the construction and maintenance of latrines through legal sanctions (mostly fines), but the 'rules of health' governing individual private conduct could only be enforced through suasion and social punishment. Washburn was engaged in an attempt to restructure social norms and create modern hygienic Jamaican subjects; hygienic citizens who would create a hygienically modern Jamaica. This naturally raises the questions of how he attempted to persuade Jamaicans to engage with and partake in this process, and how hookworm figured in these attempts.

[39] *JPH* 9:8 (August 1934).
[40] *JPH* 7:9 (September 1932).

Events and Methods of Persuasion

The JHC used a variety of strategies to persuade Jamaicans to adhere to the rules of health. Chief among these were the use of humour, local events, and the co-option of other networks and sources of authority. These were supplemented by attempts to make hookworm seem shameful, analogies, and an emphasis on the value of treatment.

Shame was sometimes used to enforce the rules of health. Henrice Altink has described the role of shame in regulating the behaviour of lower-class Afro-Jamaican women during this period; this was a power health education efforts attempted to tap into.[41] In one health play authored by Ethel F. Passingham, Mr Smart, as his name suggests the embodiment of right thinking, declares that

> The doctor examined some of the dirt from our yard, and I felt downright ashamed. It was full of them dirty hookworms.[42]

Likewise, in one of Washburn's stories, Mr Smith opines 'I kind of thought it was a disgrace to have hookworms'.[43] Here hookworm functions as a source of shame, a social punishment for insanitary behaviour which would encourage following the rules of home sanitation. Another emotion used was disgust. The JHC, as Smart says, wanted to make hookworms seem 'dirty'. To this end, they consistently used terminology designed to evoke dirt and create disgust: 'soil *pollution*', 'bowel *filth*', '*dirty* soil' and '*filthy dirt*' (my italics).[44]

Probably a more effective strategy was humour. Jones has noted Washburn's strategy of 'gentle ridicule' of folk medicine in his health stories, but the use of humour and spectacle to carry health messages extended beyond this.[45] G.S. Escoffery, for instance, devised a public

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[41] H. Altink, *Destined for a Life of Service: Defining African-Jamaican Womanhood, 1865-1938* (Manchester: Manchester University Press, 2011) pp.13-14.
[42] E.F. Passingham, 'The Hookworm Hunters', *JPH* 4 (1930).
[43] Jones *Public Health* p.131.
[44] E.g. 'Jamaica's Greatest Menace' *JPH* 1:6 (January 1927); 'Facts about hookworm disease' *JPH* 1:7 (February 1927); 'Hookworm Disease' *JPH* 3:5 (May 1928); 'The Hookworm Campaigns' *JPH* 6:4 (April 1931); 'Facts about Hookworm Disease' *JPH* 7:8 (August 1932).
[45] Jones, *Public Health* pp.126ff.

bulletin board, updated weekly wherever his JHC unit was based, with 'Notes, Posters and Placards on health topics'.[46] Regular turnover of these created a public spectacle which, it is claimed, 'attracted attention from schoolchildren and adults who stop to read and discuss the facts presented'.[47] These placards tapped into a widespread love of word games, and used humour to promote discussion of their message.[48] One, entitled 'criticism and reply', deflected criticism of the JHC in limerick form:

> Said doubting old Thomas of Porus
> "Our fathers and mothers before us
> Knew none of these terms,
> About hookworms and germs
> To avoid which you beg and implore us"
>
> "You must not forget, men of Porus
> That the people who lived here before us
> By some of these germs,
> As well as hookworms,
> Were sent to the heavenly chorus"[49]

The JHC message – that 'hookworms and germs' were a deadly threat – was packaged into a memorable punchline. Another strategy employed by Escoffery which likewise appears designed to provoke discussion was to reinterpret Jamaican proverbs to carry his own health messages. These emphasised the rules of health, and inserted unfamiliar knowledge into a familiar setting. A Jamaican proverb was stated, with Escoffery's reinterpretation of it (in italics) below:

> Cotton tree fall down, ram goat walk 'pon it
>
> *When your body is weakened by malaria or Hookworm, that's the time Consumption can catch you*
>
> Dawg who hab shine teet' laff after butcher
>
> *Keep the rules of health and laugh at catching diseases*
>
> Puss no deh, ratta tek house
>
> *Without a sanitary fly-tight latrine, germs will easily get to your food*

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[46] 'The Hookworm Commission's Plan of Health Action' *JPH* 3:10 (October 1928).
[47] Ibid.
[48] See Moore & Johnson, *They Do as they Please* pp.213-4.
[49] 'The Hookworm Commission's Plan of Health Action' *JPH* 3:10 (October 1928).

> Jackall say him wooda run race but world no lebel
>
> *Don't make vain excuses; observe all the Rules of Health. Take advantage of the treatment for hookworm disease*.[50]

While reminiscent of scriptural exegesis, these messages are also arguments by analogy: consumption (tuberculosis) is like a goat walking all over a fallen tree, germs are like rats and a sanitary latrine is like a housecat. Analogies relating the unknown to the familiar were also used to describe hookworm. One 1928 article in *Jamaica Public Health* describes hookworms as 'about as thick as a pin or a coarse sewing thread'; which hatch from eggs 'very much like a fowl's egg' and 'shed their skins twice, much like a snake or lizard'.[51] Hookworm was unfamiliar: analogies made an abstract concept relevant by bringing it into relation with familiar objects. In a 1932 health story by J.M. Hall, Willie Brown draws comparisons between racehorses and humans after Aunt Eliza admires the fine condition of the horses:

> You see how healthy and strong they are, that is because they are made to obey their Rules of Health whether they like it or not. If we would take as much care of our diet, exercise, rest and personal cleanliness; keep our homes and sleeping room clean, bright and airy; and have a periodical examination by our doctor even though we feel well, it is certain that we should avoid a lot of sickness…[52]

As Escoffery's bulletin board shows, local events were a mainstay of the JHC. These events included lectures with or without the magic lantern, microscope demonstrations, film screenings and treatment itself. Lectures delivered by the doctor in charge, or other member of the local team such as a clerk, nurse, or microscopist were a major feature of the JHC campaigns, but it is difficult to analyse these as JHC reports are at best vague, and often totally silent, about their contents.[53] However, in a 1921 article for an internal RF bulletin, Washburn describes a 'demonstration' in Gimme-Me-Bit:

> The microscopists borrow tables from a nearby home and set up their "scopes"; the clerk hangs the charts on the side of the house

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[50] Ibid.
[51] 'Hookworm Disease', *JPH* 3:5 (May 1928).
[52] J.M. Hall 'Aunt Eliza goes to the Races Part II' *JPH* 7:7 (July 1932).
[53] E.g. UWI, 'Medical Department: Report for the year ended 31st December, 1933'.

> and gets out the bottles of intestinal parasites along with other exhibit material. I, as medical director, give an explanatory talk, and the microscopists begin their demonstrations. [54]

These local events were calculated to be memorable. The aim was that everyone would remember the day the hookworm campaign came to town, and, it was hoped, the JHC's message about healthy living. The drama of the microscope demonstrations and the bottled worms enhanced their status as object lessons. Washburn had witnessed the travelling-show-style hookworm dispensaries of the US campaign and knew the power of group spectacle and drama to promote an anti-hookworm message.[55] Eric Stein has adapted Bruno Latour's concept of 'theatre of proof' to describe the use of film by the JHC's Javanese counterparts.[56] This is an apt description: the JHC, a sort of travelling health circus, consistently used theatrical flourishes to hold the attention of its audience.

A photograph of a microscope demonstration is included in Washburn's article (Figure 5.1). This shows a crowd of people arranged around a microscope stood on what appears to be a small table or stool, or else a box. A woman peers down the microscope, while the rest of the crowd face the camera. (Their distance from the microscope can be explained by the fact that this mirrored microscope needed sunlight to function). These demonstrations were intended to draw a crowd, to link the memory of a novel, exciting and above all memorable communal event to the memory of the knowledge about hookworm and disease prevention transmitted.

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[54] B.E. Washburn 'A day with the Jamaica Hookworm Campaign' *Bulletin of the International Health Board* 1:4 (April 1921).
[55] Ettling, *Germ of Laziness* pp.161-2. Washburn's recollections provide the basis for Ettling's argument that the travelling dispensaries mirrored religious revivals.
[56] E. A. Stein, 'Colonial Theatres of Proof: Representation and Laughter in 1930s Rockefeller Foundation Hygiene Cinema in Java', *Health and History* 8/2 (2006) pp.14-44.

A DEMONSTRATION

Figure 5.1: A microscope demonstration in Gimme-Me-Bit.
From B.E. Washburn 'A day with the Jamaica Hookworm Campaign' *Bulletin of the International Health Board* 1:4 (April 1921).

Visual storytelling was a mainstay of JHC theatre of proof, as Washburn related:

> The story of hookworm disease and the results of treatment are explained by means of charts and an album of Jamaica photographs. The microscope is used and hookworm ova and larvae are show to impress upon the people the necessity of latrine maintenance. General lectures, illustrated with magic lantern slides and moving pictures, are given in each area by the medical director.[57]

This was once again calculated to be memorable and easy for the audience to relate to their own lives. The use of 'Jamaica photographs' rather than American or Guyanese ones emphasised the relevance of hookworm to the Jamaican audience.

Other aspects of theatre were intended to build trust and authority. Washburn described a ritual called 'sounding':

> The nurse in charge of the district then assembles the infected persons, and the doctor "sounds" each and prescribes his treatment. "Sounding" – listening to the heart with the stethoscope is held in great favour by the patients. It gives them more confidence in the treatment, and it certainly makes them more willing to take the medicines.[58]

The main function of sounding was to build the authority of the doctor, to make him seem like a trustworthy medical professional. Treatment

[57] UWI, 'Medical Department: Report for the year ended 31st December, 1933'.
[58] Washburn 'A day with the Jamaica Hookworm Campaign'.

depended primarily upon the results provided by the microscopist, rather than the sound of the patient's heart (though Washburn elsewhere claimed to be able to assess the severity of infection through sounding and prescribe accordingly).[59] Sounding was primarily theatre: a doctor playing the part of a doctor, using an iconic medical instrument to project an image of himself as a good doctor. Washburn had also witnessed sounding in the US hookworm campaign.[60]

While the JHC created and exploited local events, they also promoted empire-wide events such as Empire Health Week, celebrated annually in October. This was instituted in Britain in 1912, and imported to Jamaica in 1923.[61] *Jamaica Public Health* always made sure to provide instructions and material on how to celebrate Health Week, with plays, songs, and catechisms for children to perform, as well as suggestions for how teachers, ministers and families could make a successful event of Health Week.[62] The aims and imperial reach of Health Week were made clear in its anthem:

> Hurrah! Hurrah! For Health Week
> Which comes 'round every year;
> And we shall make an effort,
> Its lessons to make clear
> From sickness unto good health
> It's this should be our aim
> Till every ill is vanquished
> And health by all is claimed
>
> Hurrah! Hurrah! For Health Week
> Throughout our great Empire;
> Let each one do his duty
> And good health he'll acquire
> Clean up our homes and sanitate,
> This is the road to health
> And when disease is conquered
> 'Twill be on the road to health[63]

Another way the JHC promoted its message and built authority was by co-opting local authority figures such as teachers, ministers and agricultural

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[59] NA CO/141/83 'Report of the Jamaica Hookworm Campaign' *Jamaica Gazette* (11th November 1920) p.246.
[60] Ettling, *The Germ of Laziness* p.161.
[61] *JPH* 1:2 (September 1926); *JPH* 3:9 (September 1928).
[62] E.g. *JPH* 1:2 (September 1926); *JPH* 2:7 (September 1927); *JPH* 3:9 (September 1928).
[63] *JPH* 3:9 (September 1928).

instructors; Washburn was particularly keen to use schools to promote health education.[64] To give a handful of the many examples in JHC reports: in 1921 Rev. J.N. Swaby of Harewood Anglican Church organised lectures at which the JHC spoke on hookworm and sanitation; the same year a schoolmaster at Newstead School, Alex Smith, helped facilitate testing of his pupils; the same monthly report also thanks Amy Paine as 'it was through her efforts that the people of [Clifton Lodge] district have been examined'; in March 1922 public meetings were presided over by a variety of figures including G.L. Young and A.A. Melhado, Member of the Legislative Council and Chairman of the Parochial Board respectively for St Catherine; the same month Washburn and Blanche Jeffrey-Smith, Headmistress of the Cathedral High School (Spanish Town) tested pupils to 'form an estimate of the mental retardation produced in school children by hookworm disease'.[65] Washburn was adept at recruiting influential figures from both the middle classes and the elite.

Ministers were particularly useful in delegitimising spiritual aetiologies and promoting biomedical ones: one play has a 'minister' declare 'To say a disease is caused by God is a flimsy excuse man makes for failing to do his part in the game of life.'[66] The minister draws an analogy between a typhoid epidemic and a motor-car accident, asserting that both are due to 'criminal negligence'.[67]

Existing institutions were used to spread the message. This included schools and churches, but also the Jamaica Agricultural Society (JAS). Minutes of local JAS branch meetings show JAS figures promoting JHC work: at a meeting held by the Albion Mountains branch on 6th March 1924, a professional JAS agricultural instructor 'urged co-operation with the

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[64] *JPH* 6:8 (September 1931); *JPH* 11:7 (September 1927)*;* 'Rural Schools Should be Health Centres' *JPH* 3:12 (December 1928); c.f. Jones, *Public Health* pp.127-8.
[65] NA CO/141/84 'Report on the Jamaica Hookworm Campaign for August, 1921' *Jam. Gaz.* 44 (22nd September 1921) p.750; CO/181/84 'Report of the Jamaica Hookworm Campaign for April, 1921' *Jam. Gaz.* 44:25 (12th May 1921) p.390; CO/141/85 'Report of the Hookworm Commission for March, 1922', *Jam. Gaz.* 45:22 (20th April 1922) pp.269-270.
[66] 'The Better Way', *JPH* 7:9 (September 1932).
[67] Ibid.

authorities re the stamping out of hookworm.'[68] On the 17th June 1925 the president of the Richmond branch 'spoke of the good results of the Hookworm campaign.'[69] On the 7th October of the same year president of the Wakefield branch J.E.E. Armstrong 'lectured on Hookworm and house fly and made extensive observations. He strongly recommended absolute cleanness and ventilation'.[70] On the 12th August at Brown's Hall, instructor H. Leo Mossman 'addressed the meeting on Hygiene in its relationship to Agriculture…he mentioned Hookworm, Venereal Diseases and Tuberculosis as the three chief enemies' and 'gave some sound advice as to their prevention'.[71] On the 30th of the same month Mossman delivered probably the same lecture to a branch based in Benbow-Bonnet.[72] In July 1921, Washburn himself reported that the Ham Walk branch 'manifested much interest in the Hookworm Campaign and Sanitation' and had petitioned the Parochial Board to appoint a sanitary inspector.[73]

The *Journal of the Jamaica Agricultural Society* in March 1926 reprinted a section of a JHC report discussing 'The Relation of Hookworm Infection to the Types of Soil', prefacing it with various remarks, including its regular promotion of *Chenopodium ambrisoides* and an endorsement of the JHC: 'The Hookworm Campaign is doing inestimable good but it cannot be carried on everywhere at once and then people should understand that they can become re-infected'.[74] The following year, they recommended that 'Vegetables should be at all times thoroughly washed' to prevent 'hookworm, typhoid fever, dysentery, etc.'[75] Finally, their prize holdings competition, where small settlers (smallholding farmers) were judged on the quality of their farms, awarded marks for 'General Sanitary Arrangements'.[76] In 1928 the judge noted that

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[68] *Journal of the Jamaica Agricultural Society* [Henceforth *JJAS*] 28:4 (April 1924) p.140.
[69] *JJAS* 29:7 (July 1925) p.201.
[70] *JJAS* 29:11 (November 1925) p.479.
[71] *JJAS* 33:9 (September 1929) p.333.
[72] Ibid. p.334.
[73] NA CO/141/84 *Jam Gaz.* 44:41 (21st July 1921) pp.575-6
[74] 'Health' *JJAS* 30:3 (March 1926) p.84.
[75] 'Cabbage Worms', *JJAS* 30:4 (April 1926) p.122.
[76] 'Prize Holdings Competition for 1925-26' *JJAS* 29:11 (1925).

> Excellent work has been done in connection with the sanitation of the Holding in general, and in connection with the sanitary conveniences in particular, these in most instances are up to date and should be a great asset to the health of the community in the future.[77]

Washburn and the JHC had clearly built good relations with the JAS, which could be a powerful local force in rural areas. The Glengoffe branch, apparently responding to remarks by one T.J. Cawley that the JAS served no useful purpose, in 1928 even took credit for the work of the JHC:

> ..this community [of Glengoffe], one of the most progressive and prosperous of the Island and made up chiefly of small settlers is largely indebted to the work of the Jamaica Agricultural Society…That the Jamaica Agricultural Society has been instrumental in bringing about the improvement of the district is evidenced by the appointment of a District Medical Officer, the building of the Glengoffe market, the sanitation of the district and the operations of the Jamaica Hookworm Commission, the general improvement of our Parochial Roads and the provision for the establishment of a Police Station.
>
> There is in the district a thriving People's Co-operative Bank which is the child of the local Branch Society; and last, but by no means least, the large production of bananas and other staple crops, is the fruit of the Society's Labours.[78]

The JAS and the JHC were allied in efforts to 'improve' rural Jamaica, and this branch at least viewed the JHC as a valuable product of this improvement.

Treatment was also intended as a demonstration of, in Washburn's phrase 'the benefits of keeping well'. [79] As F. Gordon Somers put in in an article for *Jamaica Public Health,* treatment

> Paves the way for the appreciation, adoption and maintenance of the more permanent measures of education and sanitation which aim at preventing recurrences…you demonstrate the advantages an individual gains from being free of infection. Healthy citizens make a progressive community.[80]

To induce people to take treatment, and experience for themselves 'the benefits of keeping well', the benefits of treatment to the individual were

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[77] 'Prize Holdings Competition' *JJAS* 31:7 (July 1927) p.277.
[78] 'Work of Society', *JJAS* 32:8 (August 1928) pp.347-8.
[79] NA CO/141/85 'Report of the Jamaica Hookworm Campaign for 1921' Sup. *Jam. Gaz.* 45:21 (19th October 1922).
[80] F. Gordon Somers, 'Hookworm Control in Jamaica', *JPH* 10:3 (1933).

consistently emphasised. 'The object of the treatment campaign has been educational as well as curative', Washburn sternly informed the Colony's Superintending Medical Officer in 1920.[81] Letters from patients and employers testifying to increased health and labouring/earning power after treatment were reproduced in JHC reports in order to promote treatment. These often included endorsements by the patient, recommending hookworm medicine to their peers: Henry Peirce for instance, stated that he 'can speak and recommend hookworm pills of their goodness'.[82] William Learman similarly wrote that he 'can comend hookworm medicin throughout the world'.[83] 'In no other disease are the results of treatment so marked or so striking', claimed a 1928 article in *Jamaica Public Health*.[84] The fact that most infections were light was acknowledged, but the perceived weakening effects of hookworm were emphasised to promote the benefits of treatment.[85]

Treatment served to both improve individual health and advance education and sanitation: the act of killing hookworms was understood to advance hygienic modernity and enact progress towards a healthy, modern Jamaica. In this modern Jamaica, Washburn thought, biomedicine and hygiene would have eliminated both hookworm and folk medicine. He saw his educational efforts against both as intertwined, believing that as folk medicine faded away with the advent of modern medicine and hygiene, so too would hookworm. He thus anticipated the extinction of both as signs of an advancing hygienic modernity.

Hookworm, Modernity & Aunt Eliza Bush-Tea

This section will argue that the extinction of folk medicine, as anticipated in Washburn's texts, was portrayed as an inevitable consequence of education and modernisation, and therefore parallels the anticipated extinction of

[81] NA CO/137/742 B.E. Washburn to Dr Hunt (Superintending Medical Officer), 6th September 1920.
[82] NA CO/141/85 Report of the Jamaica Hookworm Campaign for 1921' Sup. *Jam. Gaz.* 45:21 (19th October 1922).
[83] NA CO/137/742 B.E. Washburn to Dr Hunt (Superintending Medical Officer) 6th Sept. 1920.
[84] 'Hookworm Disease', *JPH* 3:5 (May 1928).
[85] Ibid.; 'Facts about Hookworm Disease' *JPH* 7:8 (August 1932).

hookworm. Neither hookworm nor folk medicine are today extinct: I am interested here in the anticipation of extinction by public health practitioners. As Jones shows, Washburn originally portrayed Aunt Eliza Bush-Tea, his fictional embodiment of Jamaican folk medicine, as a menace to be outwitted by his heroes, but softened his criticism over time.[86] Though Eliza was depicted as dangerously inept in the early (mid-1920s) stories, she was portrayed increasingly sympathetically into the 1930s. Jones uses Washburn's later recollections to argue that this was strategy rather than genuine sympathy: he explicitly noted the value of making Eliza 'a good character, instead of a bad one as they mostly are'.[87]

In all Washburn's stories, Aunt Eliza is depicted as retrograde, old-fashioned and outmoded, in contrast to the modern, 'new-fangled' biomedicine. Washburn's self-consciously modern hygiene attempted to project itself as essential to social and economic progress. As the Medical Officer of Health puts in an early (1926) story:

> You boys and girls are having many advantages which your parents didn't have when they went to school. If you will only apply the things you are taught in school and learn modern ways of living and caring for your bodies you will grow up to be healthy and intelligent men and women who will be free from the handicap of disease; and you will be able to do effective work. Good health and the ability to work will make you good citizens.[88]

Washburn's anticipation of a hygienic, modern future enacted through health education is apparent here. Health education, Washburn anticipated, would advance 'modern ways of living' and the creation of hard-working 'good citizens'. Hygienic modernity was enacted by both health education efforts and ordinary citizens in their daily lives. Aunt Eliza, by contrast, regularly bemoaned that the children, educated in modern disease prevention, no longer valued her knowledge, and anticipated her own obsolesce:

> Your picknies [children] have got so smart that they won't listen to old and experienced folks…[89]

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[86] Jones, *Public Health in Jamaica* pp.132-6.
[87] Ibid. p.127.
[88] 'The Medical Officer of Health Visits the School' *JPH* 1:3 (October 1926).
[89] *JPH* 2:3 (May 1927).

> If folks come to follow all these new fangled idears they won't be needing this old woman.[90]
>
> Look 'ere, young man, none of yu forwardness…Nobody fi ask yu wh' yu tink and yu mus' respec' the elder people dem like meself, as dem kno' more dan yu…wah' good fi me den good fi me now.[91]

Washburn consistently presented biomedicine as superseding folk medicine. As his public attitude softened towards folk medicine into the 1930s, he increasingly depicted Aunt Eliza as recognising and welcoming her obsolescence:

> Times 'ave change – new days, new ways. My doctorin' was good 'nough fer old days but peoples live different now…we's all better since de Hookworm Campaign. I did t'ink it foolishness at first but I know we better off since we sanitate an' since so many people build good houses and good latrines…[92]

This likely reflects increased confidence on Washburn's part, buoyed by a decade of expanding public health work originating with the JHC, that biomedicine would emerge hegemonic in a modern Jamaica. He consistently anticipated of the extinction of folk medicine as part of his vision of hygienic modernity for Jamaica, to be enacted through health education and hookworm treatment.

Hookworm and *Ascaris lumbricoides* (roundworm), however, contributed to Washburn's more sympathetic portrayal of folk medicine. *Chenopodium ambrisoides*, known as semi-contract or wormweed in Jamaica, was regularly used as a bush-tea to treat *Ascaris* infections and stomach complaints in folk medicine, and the fact that the JHC also used this plant to treat hookworm and other helminthiases bolstered their credibility in the eyes of Jamaicans. It took Washburn several years to realise the propaganda potential of this (or perhaps even to notice it at all), but once he did, he deployed *Chenopodium* as proof of biomedicine superseding an effective, but outmoded folk medicine. In the 1931 story 'The Illness of Aunt Eliza Bush-Tea', Retinella Francis, now training as a public health nurse, used biomedical use of *Chenopodium* to persuade Aunt Eliza to seek treatment:

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[90] 'The Rules of the Health Game' *JPH* 2:7 (September 1927).
[91] 'Hookworm Medicine' *JPH* 4 (1930).
[92] 'Aunt Eliza Bush-Tea Discusses the Housing Situation' *JPH* 8:3 (March 1932). See also 'Better Health for Jamaica' *JPH* 6:9 (September 1931).

> "One of the doctors who lectured to us at the hospital told us a lot about them. He said that many of the bushes and herbs which grow in Jamaica are used, in various forms, in the medicines which we give our patients. The Hookworm Commission uses see-me-contract to cure their patients of hookworms – They call it chenopodium."
>
> "Mek me hear you say it ag'in," spoke up old Aunt Eliza, greatly interested. "I thought all doctors are ag'in us ole women."[93]

The respect that a doctor (an embodiment of biomedicine) has for her and for folk medicine makes Eliza reconsider her opposition to biomedicine:

> If de doctor believe in bush-tea his medicine may be good – anyway, I'd have more confidence in 'im than some o' those…doctors who say we folks don' know nothing 'an that there ain't no virtue in herbs.[94]

This may also be a subtle reproach to doctors who assumed the total superiority of biomedicine: respect for the views of the patient went a long way toward securing cooperation with treatment. In Washburn's portrayal, chenopodium proved that folk medicine had uses, flattering the sensibilities of Jamaicans who used folk medicine (as most did), while also showing that biomedicine could improve upon folk medicine and ultimately take its place. In a 1934 story, Aunt Eliza, visiting Kingston, seeks out 'de doctor what believe in herbs', who informs her that:

> Here in Jamaica we have growing a large number of medicinal plants such as chenopodium, digitalis, aloes, ipecac, guicaol, and squills…When teas are made from these the sick person gets the effect just as if the medicinal preparations were administered.[95]

Surprisingly, this puts folk medicine and biomedicine on equal footing, vindicating at least some of Eliza's prescriptions after previously depicting them as useless, ignorant and superstitious. Nevertheless, this has the effect of implying that anything folk medicine can do, biomedicine can also do, thus making biomedicine a valid replacement for folk medicine.

Indeed, when preparing to leave Jamaica in 1935, Washburn penned a final story in which Aunt Eliza died, symbolising the death of folk medicine. In eulogising Aunt Eliza, other characters presented her as effective and well-

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[93] 'The Illness of Aunt Eliza Bush-Tea' *JPH* 4:12 (December 1931).
[94] Ibid.
[95] 'Aunt Eliza Bush-Tea visits the Tuberculosis Dispensary', *JPH* 7:4 (April 1934).

meaning, but ultimately outmoded. Mrs Brown, for instance, argued that the Health Officer and District Medical Officer

> Both liked Aunt Eliza and say she helped them with the poor and ignorant and that she succeeded in some cases where they failed.[96]

This is a far cry from her original portrayal as a menace, and rather suggests a biomedicine attempting to be magnanimous in (anticipated) victory. The minister's eulogy for Eliza is a thinly-veiled celebration of the RF's modernisation of Jamaica:

> She was the last representative of a time that is past and gone. Schools and hospitals and public health work have revolutionized rural Jamaica; our people live in a new age and now know the facts about sickness; and preventative medicine and sanitation and good water supplies have made old-fashioned notions ridiculous. For that reason, treatment of disease by superstitious ritual is passing away forever. Aunt Eliza, however, was different to most of her kind: she progressed with the best of us. She recognised that better results followed modern medical treatment and good nursing…[97]

In a final sentimental twist, Washburn had Eliza leave £2000 to be used to educate her former opponents Thomas Ezekiel Brown and Retinella Francis in medicine and public health nursing respectively, symbolically passing the baton from one generation to the next, from folk medicine to biomedicine.

In the following issue, J.M. Hall, JHC alumnus and new head of the Bureau of Health Education, interpreted his predecessor's metanarrative:

> Aunt Eliza is a satire on the superstition, ignorance and unwillingness to learn of the older generation, while the childhood and development of Thomas Ezekiel Brown and Retinella Francis are symbolic of the progress in education, and especially health education, being made by a younger generation.
>
> The passing of Aunt Eliza with her quaint superstitions and fatalistic attitude to sickness symbolises, we hope, the death of obeah and ignorance and the birth of a new intelligence which will help the Government in its efforts to make our naturally healthy and beautiful Island still safer and happier.[98]

Washburn and Hall felt that the extinction of folk medicine was an inevitable consequence of the advance of hygienic modernity and 'modern medicine'. The reference to 'obeah and ignorance' and 'superstitious ritual'

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[96] 'The Death of Aunt Eliza Bush-Tea' *JPH* 10:12 (December 1935).
[97] Ibid.
[98] *JPH* 11 (1936).

– obeah being a difficult-to-define but generally pejorative term for African-derived forms of spiritual power and practice – underline that while biomedical doctors were prepared to accept herbs from folk medicine, they sought to eradicate spiritual aetiologies and treatments. Washburn's hygiene was not entirely biomedical – it placed the aetiological origins of illness more in personal behaviour than microbes – but it aimed to displace folk aetiologies and practises. While Washburn was prepared to make peace with herbs, he, as Jones notes, roundly and routinely mocked spiritual remedies as well as naturalistic ones using ingredients he disapproved of such as alum and sulphur.[99]

The anticipated extinction of folk medicine mirrored the anticipated extinction of hookworm. From being presented as a dire threat in 1919, hookworm gradually slid down the public health agenda through the late 1920s and early 1930s, as the government and RF turned their attention to tuberculosis, malaria, yaws, diet, and venereal disease.[100] Like folk medicine, doctors felt that hookworm would necessarily fade away as health progress was made and the island entered into hygienic modernity. A 1927 *Jamaica Public Health* article described how

> The great scourges like typhoid, yellow fever, hookworm, malaria and smallpox have been, in great measure, conquered, or, at least, the means of controlling them are known and at the disposal of citizens and government…[101]

Similarly, a 1934 health week song set to *Stand up, Stand up for Jesus* depicts hookworm and other illnesses as oppressive enemies who, while 'on the run', must still be mercilessly crushed.

Hurrah! Hurrah! for Health Week.
The best week of the year;
We're taught by song and story
That germs we need not fear.
From sickness and diseases
Jamaica must be freed.
Now raise a large health army
And join the fight indeed.

Take part, Take part in Health Week!
Its lessons learn you well!

[99] Jones, *Public Health* pp.126-136.
[100] C.f. Jones, *Public Health* pp.87-114,136-153.
[101] *JPH* 2:3 (May 1927).

Disease can be prevented,
To others you must tell.
Typhoid, malaria, hookworm,
We now have on the run.
Let no one stop the battle,
Till health by all is won.[102]

Perhaps unsurprisingly, given that they were based on Protestant battle hymns, health songs often deployed a public-health-as-war metaphor. This was intended to spur action, and also to create a sense of agency, whereby each individual, fighting their own war on disease, is able to shape their own life and that of the island as a whole. The prospect of defeat, however, is not contemplated: victory over hookworm is presented as inevitable, a task which is begun and can only be completed. The extinction of hookworm was anticipated as an inevitable outcome of the advance of hygienic modernity.

It is intriguing that the 1934 version of *Hurrah! Hurrah! For Health Week* drops the previous version's references to the Empire in favour of a focus on Jamaica. Another health song, set to *Onward Christian Soldiers*, similarly makes the war on disease a patriotic one:

Wake up, now, Jamaicans,
All should join the fight
To make our pretty island
A place of pure delight
We must sanitate
Till in health and plenty
All participate
Wake up then Jamaicans
Come and join the fight
To make our pretty island
A place of pure delight

We should make an effort
To keep our bodies strong
So that we'll be worthy
Of our island home;
It's a land of beauty
As one and all acclaim,
And each should do his duty
And thus increase its fame
Forward, then, Jamaicans,

[102] *JPH* 9:8 (August 1934).

Hasten to the fight
To make our pretty island
A place of pure delight[103]

Thus hookworm campaigns were, in an era of rising nationalism, a project of island-wide improvement. And this improvement, in the eyes of biomedical doctors and health education enthusiasts, necessarily meant the end of hookworm. It seems odd for the colonial government-run Bureau of Health Education to align itself with nationalist rhetoric of Jamaican improvement, but Washburn had been recruiting allies among Jamaica's politically energised and increasingly nationalist middle classes for years, as his efforts to recruit teachers, ministers, agricultural instructors and lawyers show. Moreover, his liberal progressivism and emphasis on individual and community improvement aligned well with the values of the Jamaican middle classes, as the next section will discuss.

The Politics of Health Education

The politics of health education were not straightforward. On the one hand the JHC represented a colonial programme, constructed in collaboration between the colonial government and a foreign philanthropy. On the other its need to recruit allies among Jamaicans, as well as alignments between Washburn's own liberal progressivism and the values of the Jamaican middle classes, led to a programme which was more aligned with middle-class interests in Kingston than those of Whitehall. Health education became absorbed into a larger programme of middle-class efforts to 'improve' the health, values and culture of lower-class Jamaicans.[104] This had a nationalist element, which produced an increasing emphasis on improving Jamaica as a country into the 1930s. But even as middle-classes worked to build a Jamaican nation, they still followed British prototypes and their own

[103] *JPH* 6:9 (September 1931).
[104] See Heuring, *Health and the Politics of 'Improvement'*; Moore & Johnson, *They do as they please*; B. L. Moore and M. A. Johnson, *Neither led nor driven: contesting British cultural imperialism in Jamaica, 1865-1920* (Kingston: University of the West Indies Press, 2004); H. Altink, *Destined for a Life of Service: Defining African-Jamaican Womanhood, 1865-1938* (Manchester: Manchester University Press, 2011).

British-emulating values, facilitating the formation of a durable alliance based on a shared outlook with the American Rockefeller Foundation.[105]

The emphasis on following 'the rules of health' underlines Washburn's understanding that health arose from self-discipline, a position which he shared with many among the Jamaican middle classes. Though a relatively liberal position, it could be argued that this merely offloaded the role of the coloniser as sanitary disciplinarian onto the individual. Sanitary subjects became sanitary citizens, who were expected to self-discipline without altering their political, economic or social status. As JHC doctor Dwight Sisco put it: 'when each person in Jamaica realizes that he personally, is responsible not only for his own health but also for that of his neighbours then will there be a sanitary conscience, for no person will willingly bring upon himself and neighbours the disaster of disease'.[106]

The JHC and the Bureau of Health Education are best understood not as an imposition of colonial discipline upon the entire population, but as part of a broader effort by the middle classes to 'improve' the labouring classes by teaching them self-discipline and 'good citizenship'. Self-control was a key value of the Jamaican middle classes who therefore sympathised with Washburn's emphasis on self-discipline.[107] The increasingly nationalist middle classes shared with Washburn the idea that good citizenship was something which needed to be created, in part to prepare Jamaica for self-government; through the 1920s and 1930s, middle-class nationalists came to understand the perceived 'backwardness' of the labouring classes as an obstacle to self-government.[108] Washburn's *Wake up now Jamaicans* should be seen in this light as both an attempt to channel Jamaican patriotism towards his goal of health improvement and an attempt to strengthen his alliance with a middle class which increasingly saw improvement in national, or nation-building, terms. Washburn's attempt to construct a

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[105] For a fascinating reflection on the perspectives and habitus of middle-class Jamaica in this period see S. Hall and B. Schwarz, *Familiar Stranger: A Life Between Two Islands* (Milton Keynes: Penguin, 2017) Ch.2.
[106] NA CO/141/85 'Report of the Jamaica Hookworm Commission for the Month of October, 1922' *Jam. Gaz.* 45:9 (16th November 1922) p.849.
[107] Heuring, *Health and the Politics of 'Improvement'* p.314.
[108] Ibid. pp.303,323

hygienic citizenship fit for a hygienically modern Jamaica aligned with the middle-class project to construct and impose upon the working classes a Jamaican citizenship fit for a politically and socially modern Jamaica. The middle classes often felt the working classes lacked a 'moral sense'; Washburn felt that they lacked a 'sanitary sense'.[109] Both Washburn and the middle classes felt that health consciousness was linked to broader morality (including reproductive morality), and that both were necessary to create a stronger Jamaican society.[110] Washburn's civilising mission aligned with the internal civilising mission of the Jamaican middle classes, directed both at the upper and working classes, both of whom they felt to have been morally corrupted by slavery.[111]

Washburn's alignment with Jamaican middle-class reformers is further demonstrated by his 1927 praise for the Upwards and Onwards Society of Montego Bay and its 'Self-Help Home'.[112] The Society, a church-based women's group, aimed to promote 'self-help' and middle-class femininity among the lower classes.[113] Washburn approved of this emphasis on self-help and self-improvement under middle-class supervision.

The progressivism of both Washburn and the middle classes was paternalistic: lower-class Afro-Jamaicans were expected to abandon their own tradition of medical knowledge in favour of a foreign or elite knowledge system, and in the process to view their previous selves as backward, insanitary and potentially diseased.[114] It is impossible to ignore the fact that in Washburn's stories and plays, only Aunt Eliza speaks Jamaican Patwa, in clear contrast to characters presented as educated and enlightened, who speak English; Brian Moore and Michelle Johnson note

[109] Heuring, *Health and the Politics of 'Improvement'* p.339
[110] Ibid. p.361.
[111] Moore & Johnson, *They do as They Please* pp.1-10.
[112] NA CO/137/782/4 'Hookworm Reports' (Disp. 35721, 1927).
[113] See Altink, *Destined for a Life of Service* pp.20,47,80,88,137 and Moore & Johnson, *Neither led nor driven* p.181.
[114] C.f., of course, W. Anderson, *Colonial Pathologies: American Tropical Medicine, Race, and Hygiene in the Philippines* (London: Duke University Press, 2006).

the hostility of culturally elite Jamaicans towards Jamaican Patwa, which they viewed as backward and unenlightened.[115]

This paternalistic approach and imposition of medical knowledge could be profoundly disempowering; but it also invited Jamaicans to take control of their own health, as James Riley argues, and to improve their own lives, albeit on the terms of the elite. Ordinary working-class Afro-Jamaicans became microscopists and sanitary inspectors, some eventually building a medical career out of JHC work.[116] In 1927 nurse E.W. Patterson resigned from the JHC in order to take up medical studies; His position was filled by his brother T.W. Patterson.[117] Steven Palmer has shown that hookworm campaigns provided a route into medical practice and the social mobility this represented for ordinary people across the circum-Caribbean.[118] This suited Washburn, as it allowed him to advance his own institution-building, in line with the broader Rockefeller programme. He boasted in 1934:

> Seven of the nine medical officers of health already given permanent appointments had service with the hookworm commission and more than 20 of the most successful sanitary inspectors had their first service with the commission.[119]

This represented both social mobility for the sanitary inspectors and a victory for Washburn's programme of extending and modernising Jamaican public health. This has parallels with the British missionaries of the previous century, who trained Afro-Jamaican preachers to take their place and extend their mission to Christianise and civilise the people; both involved outside actors attempting to reform the values and behaviours of Jamaicans, and recruiting local allies in order to leave behind them durable institutions continuing their work.[120]

It could be argued, as Riley does, that Washburn's focus on individual action empowered Jamaicans to take control of their own health.[121]

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[115] Moore & Johnson, *They do as they please* Ch.4.
[116] C.f. Palmer, *Launching Global Health* Ch.3&5.
[117] NA CO/141/91 I.J. Cruchley & G.S. Escoffery 'Report of Unit No. 1 of the Jamaica Hookworm Commission for the Year 1927', Sup. *Jam. Gaz.* 51:5 (1928).
[118] Palmer, *Launching Global Health* pp.111-114.
[119] 'The Jamaica Hookworm Commission' *JPH* 9:2 (February 1934).
[120] Moore & Johnson, *Neither led nor Driven* p.175; C. Hall, *Civilising Subjects: Metropole and Colony in the English Imagination 1830-1867* (Cambridge: Polity, 2002).
[121] Riley, *Poverty and Life Expectancy* pp.130-1.

However, this focus on individuals building their own latrines and practising their own disease prevention, as ever, underlines that the colonial government lacked the capacity and willingness to improve rural sanitation.

The broad anti-hookworm alliance across colonised/coloniser boundaries drew in elements of the colonial government, an American doctor employed by an American philanthropy, influential rural landholders, the middle classes and many working-class Jamaicans. This becomes slightly less surprising in light of Franz Fanon's observation that the nationalism of the colonised bourgeoisie often aimed more at substituting natives for foreigners in positions of power and authority than dismantling colonial systems of power.[122] Fanon argues that the interests of the nationalist middle classes were aligned with those of the coloniser in important ways, which goes some way to explaining these cross-boundary alliances: colonial government, American progressives and Jamaican landowners shared economic and ideological interests in producing a hygienic modernity and a hard-working, productive, healthy populace. There was significant common ground between a middle-class white American doctor and the Jamaican middle classes.

What, then, is the 21st-century health scientist to make of this? On the one hand, medicine and public health ought to empower people to take control of their own health and make informed decisions about their own bodies. As Riley argues, the promotion of simple measures which ordinary people could carry out in their own homes accomplished this. Yet this also involved a concerted effort to remove folk epistemologies within a health education which focused on imposing, rather than sharing, knowledge. This was a one-way process: JHC personnel did not expect to learn from ordinary Jamaicans, they expected ordinary Jamaicans to learn from them. Despite the support and engagement of a relatively wide section of Jamaican society, the epistemological power dynamics of colonialism remained in place. In order to progress, Jamaicans were urged to become hygienic and modern – and to do so in the same manner as Britain and America, adopting their suite of healthy ways of living.

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[122] F. Fanon, *The Wretched of the Earth* (New York: Grove Press, 2004).

Similarly, the focus was often on the individual. The positive side of this was the way it empowered individuals to take action to improve their health. However, it also individualised blame: individuals catching disease were encouraged to understand this as a consequence of them not following the 'rules of health'. But even health fanatics can fall ill through sheer bad luck – anyone could accidentally come into contact with soil containing hookworm larvae. Furthermore, this focus on the individual occludes social and economic determinants of health. Hookworm infection was more prevalent in the proximity of plantations: the extractive colonial economic system spread hookworm, and yet this key fact was concealed by a focus on individual risk mitigation. And so was the other key fact that the lack of money available for government investment in health was due in large part to the Imperial policy of colonial self-sufficiency (i.e. colonies could expect no financial support from the British government) as well as with the amount of money which travelled to Britain in the form of payments for goods, services and rents. Public health should empower individuals to take control of their own health, and that this includes encouraging people to question who falls ill and why.

Conclusions

Washburn and the JHC viewed hookworm as an educational tool, which could be used to advance sanitary progress and create good citizens. By following the 'rules of health', it was hoped, Jamaicans would become healthier, and drive hookworm to extinction. This anticipated extinction of hookworm paralleled a similar anticipated extinction of folk medicine, which, it was felt, would disappear as it was superseded by biomedicine. Extinction was understood to be part of an advance into hygienic modernity. Middle-class nationalists and colonial and American doctors therefore formed an alliance against hookworm. All imagined a future Jamaica in which hookworm had disappeared, resulting in a healthier and more progressive and engaged citizenry. Few statements encapsulate the mindset of the JHC and the Bureau of Health Education better than Somers' mantra 'Healthy citizens make a progressive community.'[123] Hookworm was viewed by the JHC as an advance agent of health, promoting both health

[123] F.G. Somers, 'Hookworm Control in Jamaica', *JPH* 10:3 (March 1935).

systems and health consciousness. And health was viewed as an advance agent of hygienic modernity, helping to create good, progressive citizens, who possessed a 'public health conscience' and behaved accordingly. The long-term goal was the extinction of hookworm, a process which was imagined to begin with its control. Control of hookworm would create a hygienic modernity by producing good, healthy citizens and progressive communities. The creation of this hygienic modernity would ultimately produce the extinction of hookworm.

One poem by JHC nurse Archie Lindo provides a fitting summary of these themes. It emphasises the dangers of hookworm, its status as a threat to labour, the benefits of treatment, the attempted displacement of traditional medicine by biomedicine, and the hygienic modernity of the JHC, all in 8 stanzas:

The man was trembling, weak, and sick
And leaned upon his walking-stick;
He could not work, he scarce could live
For life seemed only ill to give.

At times he could not even sleep
He'd mourn his fate, and sometimes weep,
His stomach ached with dreadful pain
All bush-teas did he drink in vain.

His neighbours wondered at his state
He'd stand forlornly at his gate
And watch the ever-passing crowd
To join which, he was not allowed.

One day there chanced to come his way
The Saving Factor of the day;
It was the Hookworm Commission
Which; good in other towns had done.

'Twas found he had Hookworm Disease
And, taking Capsules got release,
The medicines the Doctor gave
Soon saved him from an early grave.

For there was marked change in the man
New lease of life for him began
Cured were his pains by these good pills
And, vanished, all his other ills.

And now, no more pain does he feel

At nights his sleep is sound and real
He leans no more upon a stick,
Forgets that he was once so sick.

Now full of laughter, free from cares
He works with ease, gone are his tears
And, mingle with the passing crowd,
His praise of good done him, is loud.[124]

[124] A. Lindo, 'The Hookworm Cure', *JPH* 5 (1930).

Chapter 6 'Sickness is a Sin': Colonial Sanitary 'Progress' and the Failure to induce the Extinction of Hookworm in the Windward Islands Association, 1914-1924

Abstract

Extinction is typically considered a tragedy, and particularly a tragedy of modernity and technoscientific progress. However, extinction has often been an aim of state or non-state policy. This becomes particularly apparent when discussing parasites such as hookworm (*Ancylostoma duodenale* and *Necator americanus*). The extinction (eradication) of parasites has often been seen as a way to improve health, education and economic development. This chapter examines a joint attempt between the Rockefeller Foundation and the colonial government to induce the extinction of hookworm in St Lucia, St Vincent and Grenada (the Windward Islands Association) between 1914 and 1924. Hookworm, a blood-feeding nematode worm transmitted through soil contaminated with human faeces, was seen as an embodiment of backwardness, and a product of uncivilised environments and uncivilised behaviour. As such, colonial doctors and officials desired its extinction as a sign of social and civilizational progress. They attempted to civilise both the environment (through sanitation) and the population (through coercion and education) in order to eradicate hookworm. Extinction was not viewed as a tragedy, but as a desirable outcome of civilizational 'progress' and modernity. However, hookworm not only continued to exist, but also reinfected those previously cured of the infection. The failure to induce the extinction of hookworm, and its continued existence, was taken as a failure of the colonial state to adequately civilise environment and people: a failure of colonial modernity. The extinction of hookworm was an explicit aim of the colonial state, envisaged as a product of civilizational progress.

Introduction

Extinction is typically considered a tragedy and a loss to be mourned, and writings about extinction, as Ursula Heise has identified, consequently

commonly take the form of elegy.[1] But extinction has been seen in a positive light, particularly by medical practitioners and public health workers aiming to induce extinctions of diseases and parasites. The local, regional, or global extinction of a parasite, or at least of the disease it causes, has often been an aim or consequence of the health policies of states, philanthropies and intergovernmental bodies.[2] Though words such as 'eradication' (today defined as an irreversible reduction of global incidence and transmission of a disease to zero) and 'elimination' (today defined as the regional eradication of a disease) give the process a medical gloss and a positive connotation, these words denote local or global extinctions.[3] In the case of guinea worm, for example, eradication has driven an animal extinct across Asia and most of Africa, and may yet succeed in wiping it out entirely.[4] In this context, extinction becomes a sign of progress, of the successes of human endeavour: the triumph of modernity, rather than its tragedy. Nonetheless, parasites such as hookworm, despite being intimately entangled with humans, are often left out of the story of extinction.[5]

This chapter examines correspondence and reports from the UK Colonial Office and Rockefeller Foundation archives generated during attempts to eradicate hookworm in the colonial Windward Islands in the early 20th century. These attempts were carried out in collaboration between the Rockefeller Foundation (RF) and the colonial government, with the RF, an American philanthropy which was rapidly expanding after initial successes in the American South, aiming to use hookworm programmes to cheaply build up health systems abroad.[6] This paper aims to unpick how the actors

[1] U.K. Heise, *Imagining Extinction* (Chicago: University of Chicago Press, 2016); D.B. Rose, T. van Dooren & M. Chrulew (eds.) *Extinction Studies* (Colombia University Press, 2017); D. Jørgensen, 'Endling, the Power of the Last in an Extinction-Prone World', *Environmental Philosophy* 14/1 (2017) pp.119-138.
[2] N. Stepan, *Eradication: Ridding the World of Diseases Forever?* (London: Reaktion, 2011).
[3] Ibid. p.233.
[4] Ibid. pp.241-6; J. D. Roberts, 'Participating in eradication: how Guinea worm redefined eradication, and eradication redefined Guinea worm, 1985–2022', *Medical History* 67/2 (2023) pp.148-171.
[5] E. Giraud, E.H. Kershaw, R. Helliwell, G. Hollin, 'Abundance in the Anthropocene', *The Sociological Review Monographs* 67/2 (2019) pp.357-373; J. Lorimer, 'Hookworms Make Us Human' *Medical Anthropology Quarterly* 33/1 (2018) pp.60-79.
[6] J. Farley, *To Cast Out Disease: A History of the International Health Division of the Rockefeller Foundation (1913-1951)* (Oxford: Oxford University Press, 2004).

involved conceived of hookworm and its extinction. It is found that both doctors and colonial administrators viewed hookworm as an embodiment and sign of backwardness, and aimed to advance sanitary – and therefore civilizational – progress through eradicating hookworm. This was conceptualised as a two-way process: combatting hookworm was seen as a means to advance sanitary civilisation, but sanitary progress was also seen as something which would ultimately result in the eradication of hookworm. Hookworm was understood to be both a product of the environment and of human backwardness. Hookworm, however, persisted to exist despite colonial sanitation and treatment efforts. Hookworm's continued existence – its failure to go extinct – thus became a failure of colonial 'progress'. In an added layer of irony, the abundance of hookworm could in part be attributed to the nature of the colonial plantation economy.[7]

Though my focus is on extinction, I also offer an overview of hookworm control in the Windward Islands during this period, and shows that even where control methods – in this case treatment, sanitation and education – may themselves be adequate, the attitudes underlying these methods can severely undermine their effectiveness. Had efforts to improve sanitation, provide health education and treat those infected with hookworm been maintained over the longer term, they may have been successful, but the belief that hookworm infections signified backwardness and that reinfection indicated a failure of the colonial state to civilise its subjects led to efforts being abandoned before they could take full effect. Similarly, health education efforts would presumably have been more successful without the racist contempt in which these doctors held their patients and the hectoring tone which health education materials adopted.

Hookworms (*Necator americanus* and *Ancylostoma duodenale*) are blood-feeding nematode worms, and obligate parasites of humans. Adult hookworms live in the gut, and eggs passed in the faeces hatch in the soil, passing through two larval stages before reaching the infective third stage,

[7] J. Lorimer, *The Probiotic Planet: Using Life to Manage Life* (London: University of Minnesota Press, 2020) pp.133-159; S. P. Palmer, *Launching Global Health: The Caribbean Odyssey of the Rockefeller Foundation* (Ann Arbor: University of Michigan Press, 2010) pp.25-7.

which infects new hosts by penetrating their skin, typically through the feet, before travelling to the small intestine.[8] As such, hookworm infections can be prevented by disposing of faeces in ways which prevent eggs and larvae contaminating the ground. High-burden infections with large numbers of hookworms can cause iron-deficiency anaemia, while low-burden infections with a small number of worms are often asymptomatic.[9]

Geographically, the Windward Islands are the windward subset of the Lesser Antilles island chain on the eastern rim of the Caribbean Sea, from Dominica south to Grenada. However, the term was also used as a unit of British colonial government. By the early twentieth century, the Windward Islands Association consisted of St Lucia, St Vincent and Grenada (Figure 6.1) in addition to dependant islands such as the Grenadines. The three islands shared a single governor, but each had its own administrator and medical staff. The islands had entered into British control at various points in the 18th century, and by the 20th were inhabited by creole populations of mixed African, Kalinago and European descent ruled by a mixture of local white elites and officials imported from Britain.[10]

[8] A. Loukas et al., 'Hookworm infection', *Nat Rev Dis Primers* 2/16088 (2016) pp.16088; S. Brooker et al., 'Human hookworm infection in the 21st century', *Adv Parasitol* 58/(2004) pp.197-288.
[9] Loukas et al., 'Hookworm infection'.
[10] For the turbulent history of the 18th century Caribbean, see D. Watts, *The West Indies: Patterns of Development, Culture and Environmental Change since 1492* (Cambridge: Cambridge University Press, 1987) pp.240-258.

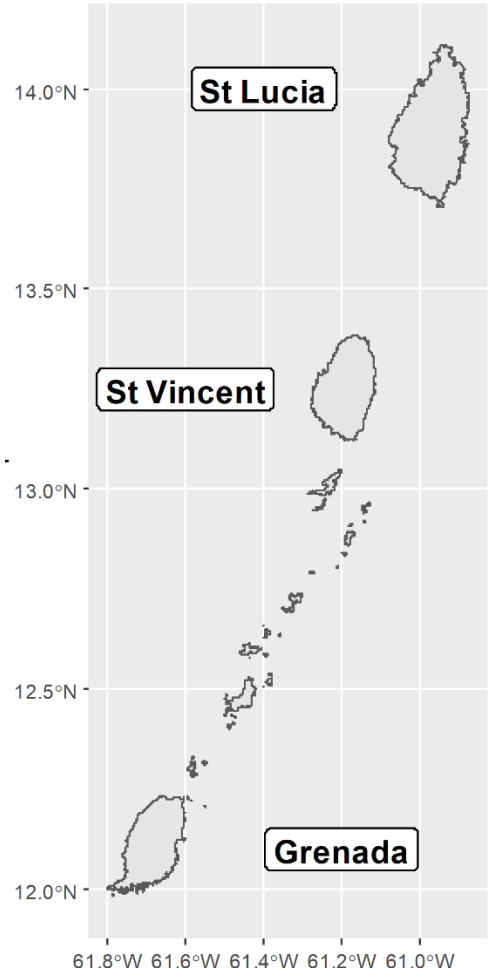

Figure 6.1: The Windward Islands Association.
Drawn using shapefiles from The Humanitarian Data Exchange (https://data.humdata.org) [10th August 2024].

Hookworm was widespread during this period. Hookworm surveys covering all of St Lucia reported infection prevalence of 64% (n=48,799, i.e. 48,799 people were tested) up to 1922, while data from Grenada and St Vincent show prevalences of 64% (n=22,946) and 55% (n=6,792) respectively.[11] Infection was more common in adults than children (Figure 6.2), following the typical distribution for this parasite.[12] As such, by 1913 the Windward Islands had caught the attention of the newly-founded RF, which viewed hookworm as both an easy target for eradication campaigns and a useful tool with which to persuade governments to extend health provision.[13]

[11] UK National Archives, Kew [henceforth NA] CO/231/327 'St Lucia: Ankylostomiasis Campaign 1923', (Dispatch [Disp.] 7403, 1924); CO/321/294 'Grenada: Ankylostomiasis Campaign', (Disp. 10266, 1917); CO/321/307 'St. Vincent: Hookworm Disease. Relief + Control', (Disp. 44065, 1919).
[12] Brooker et al., 'Human hookworm infection'.
[13] Farley, *To Cast Out Disease* pp.61-87.

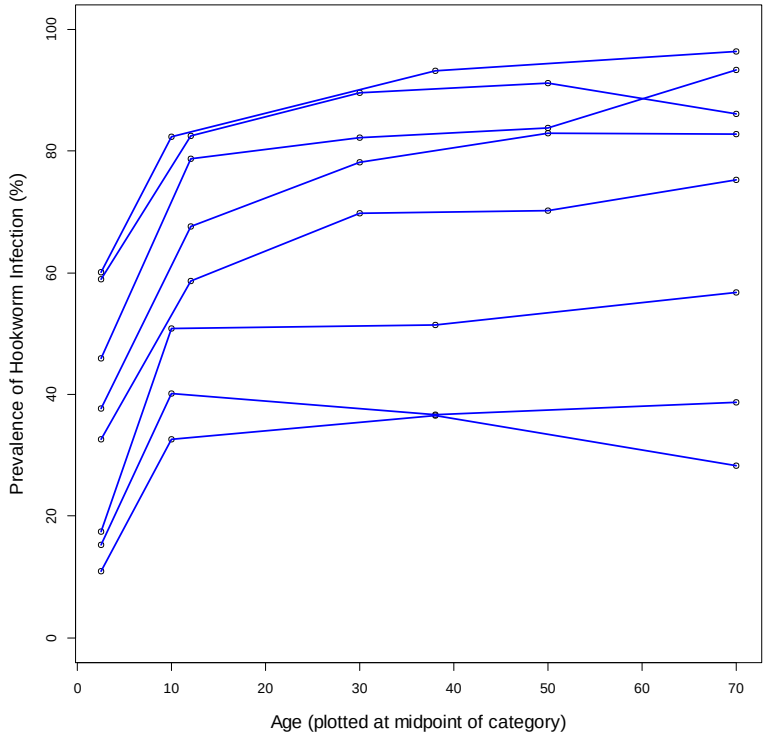

Figure 6.2: Prevalence of hookworm infection against age in eight areas of St Lucia, 1915-1923.
Data from reports of the St Lucia hookworm campaign in NA CO/321/294,325 and 327.

The next section of this paper will provide a brief narrative of the campaigns and the difficulties which the RF and the colonial government has in staffing them. Following this, I explore hookworm's place in the colonial imaginary as a signifier of an uncivilised environment and how its extinction was therefore desired as an indicator of progress, before finally turning to the ways in which failure to induce extinction were interpreted.

Background: Staffing the Eradication Campaigns

The timing of the hookworm eradication campaigns in the Windward Islands was not auspicious. RF director Wickliffe Rose had enlisted British Colonial Office support for hookworm campaigns in August 1913, and visited Antigua, St Lucia, St Vincent, Grenada, Trinidad and British Guiana the same autumn.[14] Appointments, arrangements and negotiations continued

[14] Farley, *To Cast out Disease* p.61; NA CO/323/623 W. Rose to Governor, Windward Is. 26 November 1913.

to be made through the spring of 1914.[15] By August 1914 the British Empire was at war.

Staffing the West Indian medical service had long been difficult, with low pay, high costs of living, limited promotion prospects and a lack of excitement hindering recruitment from the metropole.[16] Complicating things further, the Windward Islands government preferred to staff hookworm campaigns with their own medical officers rather than RF doctors. In the case of Stanley Branch of St Lucia, this was justified by his expertise in hookworm and knowledge of the French-inflected St Lucian Patois, but in the case of C.H. Durrant of St Vincent, even the Colonial Office seem to have been in the dark about the reasoning of the local Administrator.[17]

Following the outbreak of war, finding suitable candidates to stand in for medical officers seconded to the hookworm campaigns became even more difficult.[18] The RF offer to provide their own medical staff to relieve the hookworm doctors was seized upon, but required laws to be amended to allow doctors with previously unrecognised American qualifications to practise.[19] This caused some controversy, particularly among local physicians such as Grenadian Glasgow graduate Captain H.B. Morgan, who perceived that West Indian candidates were being discriminated against in favour of doctors with (he felt) inferior American qualifications.[20] Given the habit of the colonial government of noting the racial origins and skin tones

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[15] NA CO/321/284-5 Dispatches, Windward Islands; CO/323/623 Correspondence, Windward Islands.
[16] D. H. Heuring, *Health and the Politics of 'Improvement' in British Colonial Jamaica, 1914-1945* (PhD Thesis, Illinois: Northwestern University, 2011) pp.50-98.
[17] NA CO/323/623/49 St Lucia: Ankylostomiasis Campaign (Disp. 19248; 1914); CO/323/650/32 St Vincent: Ankylostomiasis Campaign (Disp. 3120, 1915); CO/323/652 St Vincent: Ankylostomiasis Campaign (Disp. 13752, 1915).
[18] NA CO/321/289 St Lucia: Appointment of Medical Officers (Disp. 3053, 1916).
[19] NA CO/323/650/32 St Vincent: Ankylostomiasis Campaign (Disp. 3120, 1915); CO/321/289 Grenada: Medical + Dentists Registration Bill Amendment (Disp.45639, 1917); CO/321/293 Medical Registration Amendment Ordinance (Disp.28552, 1916); CO/321/294 Grenada: Medical + Dental Registration Ord. (Disp. 29736, 1917).
[20] NA CO/321/298 Grenada: Ordinance 3 of 1917 Medical & Dentists Registration Amendt. (Disp. 34423, 1917); CO/321/294 Grenada: Medical + Dental Registration Ord. (Disp. 29736, 1917).

of their staff and candidates, and preference for English or light-skinned local candidates, Morgan was almost certainly correct.[21]

Nevertheless, ordinances allowing American doctors to practise were passed, and the hookworm eradication campaigns were underway by early 1915. But this was not the end of the staffing problems. Angus MacDonald, head of the campaign in Grenada, resigned in August 1916, resulting in the colonial government, unable to find a replacement during wartime, requesting a doctor from the RF.[22] Howard Colwell duly assumed control of the campaign. The USA entered the war in April 1917, resulting in many RF physicians, apparently including Colwell, enlisting in the American military.[23] The RF wound up several programmes due to the consequent shortage of doctors, including the Grenada hookworm campaign, which Rose officially closed in December 1918, but does not appear to have published any reports after December 1916.[24] In St Vincent, the hookworm campaign, then under the control of RF doctor Powell Gardener, was wound up in 1918, while Branch continued the hookworm campaign in St Lucia until 1924.[25]

‘An ideal forcing house of the Ankylostoma’: Hookworm as an indicator of an uncivilised environment and society

Doctors in the Windward Islands charged with eradicating hookworm viewed the parasite in a mixture of environmental, bacteriological, and civilizational ways. Hookworm was understood as a germ, but as a germ

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[21] E.g. CO/321/279 St Vincent: Medical Officer (Disp. 1133, 1915); CO/232/623/70 Grenada: Ankylostomiasis Investigation (Disp. 24659, 1914); CO/321/315 Grenada: Officials Not of European Parentage (Disp. 6230, 1921); CO/321/294 Grenada: Colonial Surgeon (Disp. 18843, 1917).
[22] NA CO/321/293 Resignation of Dr Macdonald from I.H.C. Work (Disp. 30024, 1916).
[23] A ‘Dr. Howard S. Colwell, now first lieutenant in the Medical Reserve Corps, United States Army’ appears in C. Nutt, *History of Worcester and its people* (New York: Lewis Historical Publishing Company, 1919), https://archive.org/stream/historyofworcest03nutt_0/historyofworcest03nutt_0_djvu.txt [12 Jan 2024].
[24] NA CO/321/302 Grenada: Ankylostomiasis Campaign (Disp. 63172, 1918).
[25] Rockefeller Archive Center, Sleepy Hollow, USA [henceforth RAC] RF/RG5/FA115/3.457H/191/2347 St Lucia – Hookworm, Monthly Reports (1921-1924); NA CO/321/307 P.B. Gardener ‘Report on Work for Relief and Control of Hookworm Disease in St. Vincent from May 1, 1915 to August 26, 1918.’ (Disp. 44065, 1919).

with a particular connection to environmental conditions, particularly those of tropical environments. At the same time, it was understood to emerge from poor personal hygiene and uncivilised behaviour. As Warwick Anderson has demonstrated in relation to hookworm in the Philippines, colonised populations were defined by the colonisers as dirty, barbaric and lacking in sanitary discipline.[26] This lack of civilisation by the twentieth century was principally understood by colonising powers in racial, genetic terms, but also had an environmental aspect, being thought to be at least in part a result of, in Branch's phrase, 'tropical inertia'.[27] MacDonald epitomises this complex synthesis of environmental and personal:

> Crudely speaking, Grenada may be said to be an ideal forcing house of the Ankylostoma.
>
> The high mean temperature; the narrow range [of temperatures]; the humidity; the nature of the soil over a large part of the Island; the type of cultivation, dense Cacao growth through whose leafy roof the sun's rays barely filter; and the habits of man make perfect conditions for the development and spread of Ankylostomiasis.[28]

Thus hookworm arose both from the tropical environment and the tropical 'habits of man'. Branch's reports in particular often included descriptions of his areas of operations which border on travel writing, describing both the topography and the people in often exotising terms.[29] MacDonald likewise blended geology, climate and agriculture in his explanations for hookworm prevalence:

> The red clay bears a high infection, while also a high infection is found in definite districts on light, ashy or sandy soil, over "tiff", conglomerate and tough basalt…the more moist windward side of the Island probably carries a higher infection…The densely cacao-shaded areas have a high percentage [of infection]; open cultivation

[26] W. Anderson, *Colonial Pathologies: American Tropical Medicine, Race, and Hygiene in the Philippines* (London: Duke University Press, 2006).
[27] RAC RF/RG5/FA115/3.457H/191/2348 S. Branch to W.B. Davidson-Houston 29th December 1924.
[28] NA CO/323/651 A. MacDonald, 'Report for the month of October, 1914' (Disp. 8135, 19th February 1915).
[29] RAC RF/RG5/3.457H/190/2342 S. Branch, 'No. 7100 Report on Work for the Relief and Control of Uncinariasis in Saint Lucia from November 20, 1914, to March 31, 1915' (February 1916) is a particularly good example.

> of recurrent or rotation crops (corn, peas, tannia, potato, etc.) in definite districts also bears a high infection.[30]

These are, in terms of present-day understandings of the life cycle and transmission of hookworm, plausible suggestions. Hookworm larvae live in the soil with the first two stages feeding on bacteria and debris, before moulting into the infective third stage, which infect humans through the skin.[31] Living in the soil, they are vulnerable to desiccation, making rainfall and soil moisture important determinants of larval survival and therefore adult infection.[32] High vegetation cover is commonly associated with increased hookworm prevalence, due to leaves shading the soil and protecting larvae from desiccation.[33] MacDonald's suggestion that rotation crops lead to more hookworm infection is also plausible: farming these would involve large amounts of skin contact with potentially contaminated soil, and farmers can be at higher risk of infection even today.[34] There is less present-day evidence for the role of geology in shaping hookworm distributions, however, though well-drained sandy loam and acidic soils are generally thought to favour hookworm.[35]

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[30] NA CO/323/653 'Grenada: International Health Commission (Ankylostomiasis Campaign): Report of the Medical Officer in Charge for the Quarter Ended 31st March 1915' (Disp. 21935, 23rd April 915).

[31] Brooker et al., 'Human hookworm infection'; Loukas et al., 'Hookworm infection'.

[32] N. B. Mudenda et al., 'Modelling the ecological niche of hookworm in Brazil based on climate', *Geospatial Health* 6/3 (2012) pp.S111-S123; S. S. R. Ajjampur et al., 'Epidemiology of soil transmitted helminths and risk analysis of hookworm infections in the community: Results from the DeWorm3 Trial in southern India', *PLoS Neglected Tropical Diseases* 15/4 (2021) pp.e0009338; R. Wardell et al., 'An environmental assessment and risk map of Ascaris lumbricoides and Necator americanus distributions in Manufahi District, Timor-Leste', *PLoS Neglected Tropical Diseases* 11/5 (2017) pp.e0005565.

[33] Mudenda et al., 'Modelling the ecological niche'; Wardell et al., 'An environmental assessment and risk map'; Ajjampur et al., 'Epidemiology of soil transmitted helminths'.

[34] E. F. G. A. Avokpaho et al., 'Factors associated with soil-transmitted helminths infection in Benin: findings from the DeWorm3 study', ibid.8 pp.e0009646.

[35] C. Elman et al., 'Extending Public Health: The Rockefeller Sanitary Commission and Hookworm in the American South', *American Journal of Public Health* 104/1 (2014) pp.47-58; A. L. Anderson and T. Allen, 'Mapping Historic Hookworm Disease Prevalence in the Southern US, Comparing Percent Prevalence with Percent Soil Drainage Type Using GIS', *Infectious Diseases: Research and Treatment* 2011/4 (2011) pp.1-9; Wardell et al., 'An environmental assessment and risk map'.

Nevertheless, the eradication campaigns consistently focused on the sanitary environment and the behaviour of their patients. MacDonald argued that 'the almost absolute absence of any latrine service throughout the Island is the root factor in the causation and spread of Ankylostomiasis'.[36] The problem was understood to be that due to the backwardness of colonised populations the very ground itself had become 'polluted'; civilised defecation and the control of 'soil pollution' was needed to civilise tropical soils and cleanse them of hookworm. Branch asserts of hookworm prevention in a leaflet he titled 'A Simple Sketch for the Layman' that the 'most important [preventative] is keeping the ground clean', detailing over half a page methods for safe disposal of night soil.[37] This emphasis on clean ground may be a response to the preference of St Lucians for chamber pots, which were sometimes emptied onto open ground; Branch complained that even after latrines had been built, many St Lucians simply used them to empty chamber pots into.[38] While this particular practise would protect against hookworm infection, Branch nevertheless saw it as disappointing resistance to his programme. A 'health leaflet' from Grenada similarly consists entirely of methods for faecal disposal.[39] A large bulk of the attempt to eradicate hookworm from the Windward Islands, moreover, consisted of government-sponsored latrine building, in addition to appointing sanitary inspectors and increasing the powers of officials (including police) to rectify insanitary conditions and issue fines: state-enforced hygiene.[40] This hygiene often had an island flavour: in St Lucia, hookworm-related innovations included latrines erected over the sea and a small sloop purchased to assist Castries' existing sewage boat and system of

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[36] Ibid.
[37] NA CO/232/650 'Ankylostomiasis Campaign' (Disp. 8158, 25th January 1915).
[38] NA CO/321/293 'St Lucia: Uncinariasis' (Disp. 57311, 18th September 1916).
[39] NA CO/323/653 'Grenada: International Health Commission (Ankylostomiasis Campaign): Report of the Medical Officer in Charge for the Quarter Ended 31st March 1915'.
[40] NA CO/321/294 'Grenada: Sanitary measures in connection with Ankylostomiasis Campaign' (Disp. 10263, 27th January 1917); CO/321/279 'St Vincent: Sanitary Inspector' (Disp. 9967, 19th February 1914); CO/321/307 'St Vincent: Hookworm Disease, Relief + Control' (Disp. 44065, 4th February 1919); see also R. Pemberton, 'A Different Intervention: The International Health Commission/Board, Health, Sanitation in the British Caribbean, 1914–1930', *Caribbean Quarterly* 49/4 (2003) pp.87-103.

maritime waste disposal (Figure 6.3).[41] Thus the colonial government, with Rockefeller assistance, was engaged in a project to literally sanitise and figuratively civilise the environment by removing the 'pollution' produced by the local populace. The colonial civilising mission operated on the environment as well as the individual. The environment was not always co-operative, however: many of Branch's beach latrines were destroyed by storms in September 1921.[42]

[41] RAC RF/RG5/FA115/3.457H/191/2346 S. Branch 'No. 7519, Report on Work for the Relief and Control of Hookworm Disease in St Lucia from January 1, 1915 to December 31, 1919'; RF/RG5/FA115/3.457H/190/2343 Branch to Administrator, 11th July 1916; RF/RG5/FA115/2.457H/190/2344 G. Walter to G.B. Haddon Smith, 24th July 1917.

[42] RAC RF/RG5/3.457H/191/2348 Acting Administrator, St Lucia, to W.S. Churchill, 6th February 1922.

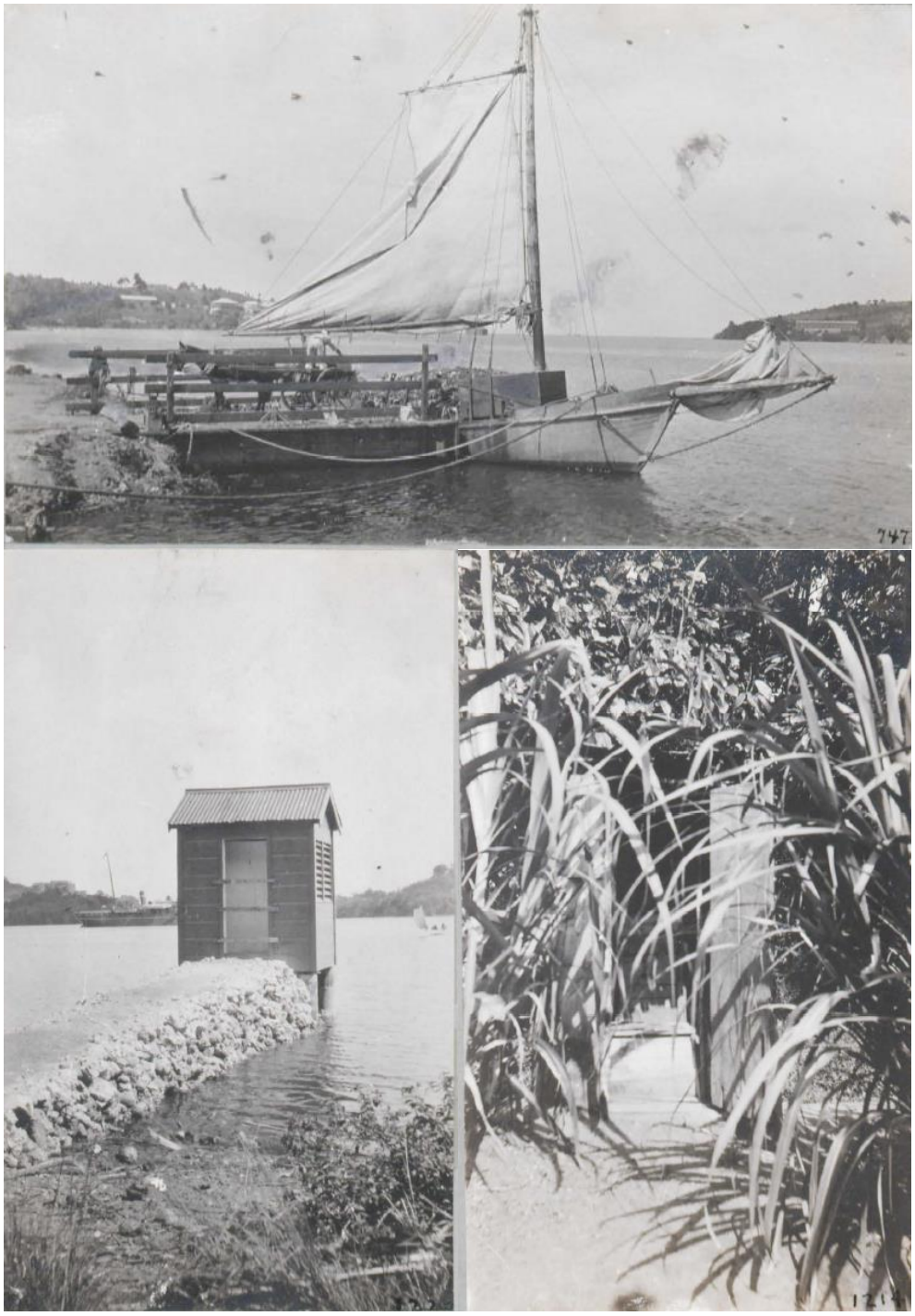

Figure 6.3: The sewage boat (above) and latrines erected by the St Lucia hookworm eradication campaign.
Photographed by Stanley Branch: RAC RF/RGP/457H/118/2309 St Lucia – Hookworm.

Once latrines had been constructed, and individuals tested and treated for hookworm, the responsibility for 'soil pollution' was felt to lie with the individual. It was thought necessary to 'educate' the colonised in proper, decent and moral behaviour. MacDonald was adamant that 'Discovery and Cure are to be effected free to everybody, but THE MEANS OF PREVENTION are a DOMESTIC and INDIVIDUAL MATTER' (emphasis

original).[43] He also asserted, in a 1914 public information leaflet blending scientific and providential language, that

> Health is Natural…Sickness is a Sin. SICKNESS is always due to a MISTAKE somewhere…in each case of bodily disease or sickness it is our first duty to ask ourselves "In what have I sinned against nature?" And if a true answer could be returned it would in most cases be found that I or my neighbour was the sinner, and a disregard of NATURE'S LAW OF CLEANLINESS the most frequent sin. CLEANLINESS underlies HEALTHY LIVING, and is the mainstay of every healthy life.[44] (Emphasis original)

He continued at some length about the importance of ventilation, hand-washing and latrine use. As well as victim-blaming on an island-wide scale, MacDonald provides an almost textbook example of Anderson's 'excremental colonialism', where hookworm and sanitary efforts focused on regulating the behaviour of colonised populations, and asserted that the reasons for their ill-health lay in their own lack of civilisation rather than the social, economic or environmental actions of the coloniser.[45]

Sanitation and sanitary behaviour thus became a site of colonial cultural contention, which like all colonial discourses fractured along race, class and gender lines. Gender was a regular battle-ground of colonial cultural conflict, with West Indian men and women routinely castigated for failing to adhere to idealised British roles of provider/patriarch and caregiver respectively.[46] Hookworm was no exception, with MacDonald attributing infection to failures of the colonised to act out appropriate gender roles. He harangued mothers who cooked without washing their hands (thus in his

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[43] NA CO 323/653 'Grenada: International Health Commission (Ankylostomiasis Campaign): Report of the Medical Officer in Charge for the Quarter Ended 31st March 1915'.
[44] NA CO/323/651 A.B.M[acDonald], '"Health Is Happiness"' public information leaflet, Grenada, 1914.
[45] Anderson, *Colonial Pathologies* pp.180-204.
[46] H. Altink, *Destined for a Life of Service: Defining African-Jamaican Womanhood, 1865-1938* (Manchester: Manchester University Press, 2011); J. de Barros, *Reproducing the British Caribbean: Sex, Gender, and Population Politics after Slavery* (Chapel Hill: University of North Carolina Press, 2014); R. Smith, *Jamaican Volunteers in the First World War: Race, masculinity and the development of national consciousness* (Manchester: Manchester University Press, 2004); L. Putnam, 'Global child-saving, transatlantic maternalism, and the pathologization of Caribbean childhood, 1930s–1940s', *Atlantic Studies* 11/4 (2014) pp.491-514.

view failing in their maternal duty to protect their children from disease), before turning to the men of the house:

> Equally great is the responsibility of the husband and father who FAILS TO PROVIDE a PROPER LATRINE FOR HIS FAMILY, and so encourages dirty conditions round his home. His children or his neighbours' children, or innocent strangers walk on the DANGEROUS FILTHY SOIL, and the YOUNG HOOKWORMS GET THE CHANCE of entering the skin of some unfortunate person, and of living in the body. Because of this common SIN AGAINST THE LAW OF CLEANLINESS many persons in this island suffer much sickness and misery.[47] (Emphasis original)

Hookworm was blamed on women failing to care and men failing to provide; in MacDonald's eyes it arose out of individuals failing to adhere to what British colonisers considered civilised gender roles.

Hookworm was also racialized. Both Branch and Colwell explained the low-intensity infections of many with recourse to a supposed (in Branch's phrase) 'racial immunity enjoyed by the black-skinned peoples from the extreme ravages of the disease'.[48] As Anderson and John Ettling have discussed in relation to the Philippines and the USA respectively, such stereotypes have a triple-layered meaning, at once claiming that Black people are more likely to be infected, that their infections are less serious and problematic because they are (claimed to be) more 'immune', and framing Black (or Filipino) people as vectors of infection endangering white society.[49]

However, race, particularly in the creole societies of the Caribbean, was not monolithic, and the hookworm doctors imposed gradations of civilisation (and therefore hookworm risk) which usually fell along class lines, but also reflected the willingness of the colonised to allow themselves to be

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[47] NA CO/323/651 MacDonald, '"Health is Happiness"'.
[48] NA CO/321/294 Grenada: Sanitary Measures in Connection with Ankylostomiasis Campaign (Disp. 10263; 27th January 1917); CO/321/294 Dr H.S. Colwell to Colonial Secretary, 22nd Jan 1917; CO/321/294 'Report by Dr. S. Branch on the Working of the Hookworm Eradication Campaign in St, Lucia During the Half-Year Ended 30th June, 1916'.
[49] Anderson, *Colonial Pathologies* pp.180-204; J. Ettling, *The Germ of Laziness* (London: Harvard University Press, 1981) pp.172-6; see also M. Wray, *Not Quite White* (Durham: Duke University Press, 1996) pp.96-133.

exploited by colonial employers.[50] Branch regularly gave his opinion not only on the status of sanitation in his areas of operation, but also on the character and willingness to work of the local populace, for example writing of Vieuxfort:

> The people are kindly but lazy and indolent. The quarter lies on the very outskirt of such civilisation as the colony boasts.[51]

The male inhabitants of the Soufriere valley and highlands, by contrast, he dubbed 'hard-working and industrious…the best class of labourers'.[52] Branch consistently described town-dwellers as more civilised and less prone to hookworm than the rural peasantry he described as 'rustics' and 'country folk'.[53] For instance, he disparaged Colobette and Coin de l'anse as:

> ...beyond the pale of cleanliness and sanitation, where the inhabitants, seeking to escape from the town and water rates, live a sort of parasite existence, and are always a source of danger to their more civilised neighbors.[54]

'Cleanliness and sanitation' were indelibly linked to 'civilisation' in Branch's mind, and to parasites and hookworm. He wrote of Choiseul: 'The peasant proprietors, many of them well to do, have not progressed to that stage of civilisation which requires toilet requisites.'[55] Civilisation, for Branch, had a class aspect, but also an individual one. As he wrote in 1915:

> The peasantry…fall into two groups, one occupying houses built of mud and wattle with thatched roofs, the other having more permanent habitations of wood work with a shingled or galvanised roof. The latter are naturally more well to do…The cleanliness or otherwise of these groups depends naturally on the individual

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[50] C.f. B. L. Moore and M. A. Johnson, *They do as They Please* (Kingston: University of the West Indies Press, 2011).
[51] RAC RF/RG5/3.457H/191/2348 Branch to W.B.-Davidson Houston, Administrator St. Lucia, 10th January 1923.
[52] RAC RF/RG5/3.457H/191/2346 Branch to W.B. Davidson Houston, 22nd January 1921.
[53] NA CO/321/294 'Report of the Half-year ended June 1916'; NA CO/321/293, S. Branch, 'Report on Work for the Relief and Control of Uncinariasis in St. Lucia From November 30, 1914, to December 31, 1915'.
[54] NA CO/321/213 'St. Lucia: Report on work in connection with Hookworm disease' (Disp. 2101, January 1920).
[55] RAC RF/RG5/3.457H/190/2348 Branch to E.D. Laborde 26th January 1922.

> idiosyncrasy resulting from their education and the degree of civilisation to which they may be said to have attained.[56]

Cleanliness, in Branch's view, was an index of civilisation, which depended on education (and therefore class), but could vary considerably even between individuals living in similar conditions. Either way, hookworm, cleanliness and sanitation were inextricably linked. He judged the residents of the Mabouya valley

> …the lowest type of native. Superstition, ignorance, dirt physical and moral are their outstanding qualities. Either as a cause or consequence it is not surprised [sic] to find a very heavy infection with malaria, intestinal parasites, spirachcetosis…[57]

Hookworm was seen by colonial doctors in the Windward Islands less as a cause of uncivilisedness and more as a product of it; they understood hookworm as a symptom of backwardness. But hookworm was not only a concept: it was also a physical animal. Thus, in the colonial imaginary it could become an embodiment of backwardness, to be physically expelled from the body and barred from re-entry by civilised sanitary behaviour.

John Ettling has drawn out the parallels in the RF imaginary between hookworm and the evangelical conception of sin.[58] He notes that hookworm, like sin, was an ever-present threat which could be purged from the body in a single dramatic moment (conversion/treatment), but which required constant vigilance and reformed living to guard against its re-entry. MacDonald is a rare case of this link being made explicitly, but like British colonial doctors more generally, he saw this 'sin' in civilisational terms, viewing hookworm as a product of uncivilised behaviour and thus social and colonial failure.

The reshaping of colonised lands to better approximate the socioecologies of the metropole had long been a feature of colonialism, with ongoing long-term consequences.[59] For instance, the establishment of many non-native

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[56] RAC RF/RG5/3.457H/190/2342 Branch to Administrator, St Lucia, 17th July, 1915.
[57] RAC RF/RG5/FA115/191/2348 Branch to W.B.-Davidson Houston, 10th January 1923.
[58] Ettling, *The Germ of Laziness* pp.205-8.
[59] A. W. Crosby, *Ecological Imperialism: the biological expansion of Europe, 900-1900* (Cambridge: Cambridge University Press, 1986).

birds in New Zealand can be attributed to releases of British fauna with this aim.[60] Likewise, colonisers attempted to justify the dispossession of indigenous peoples with reference to colonial cultivation and 'improvement' of the land.[61] But hookworm created an unusual attempt to shape and 'civilise' both the colonised environment and the colonised person at the same time. The worm, moving from outside the body to within it, bridged the environment and the person, and thus blame for hookworm as well as attempts to destroy it bridged the environmental and the personal.

Eradication and Extinction as Progress

Hookworm was, in the minds of both colonial administrators and doctors, a product of what the Acting Administrator of St Lucia in 1922 referred to as 'the primitive habits in sanitary matters of the native population'.[62] Its prevalence was an index of uncivilised behaviour, and thus its eradication was to be desired as an advance of 'progress' and a victory for the colonial civilising mission. As civilisation advanced and 'the natives' learned the habits of civilised defecation, it was thought, hookworm would disappear. The term 'eradication' (here referring to colonial or regional, rather than global, scales) was widely and frequently used, with the complete extinction of hookworm envisaged as a long-term aim. As Branch put it towards the end of the St Lucia campaign in 1924:

> That the dangerous effects of the disease can be controlled has been abundantly demonstrated; it may no longer be a menace to the labouring population. That the infection can be eradicated depends on the progress of the education in sanitation and hygiene. Great strides have been made and we hope there will be greater efforts to hold the ground gained as well as to maintain progress.[63]
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> Though infection with hookworm disease is still unfortunately very high, I have seen few cases of a severe nature. After 20 years [sic] experience I can confidently assert that there has been a steady

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[60] T. M. Blackburn et al., 'Propagule pressure as a driver of establishment success in deliberately introduced exotic species: fact or artefact?', *Biological Invasions* 15(2013) pp.1459-1469.
[61] E.g. B. Arneil, 'The wild Indian's venison: Locke's theory of property and English colonialism in America', *Political Studies* XLIV/1 (1996) pp.60-74.
[62] RAC RF/RG5/3.457H/191/2348 Acting Administrator, St Lucia, to W.S. Churchill, 6th February 1922.
[63] RAC RF/RG5/3.457H/191/2348 Branch to W.B. Davidson-Houston, Administrator, St Lucia, 29th December, 1924.

> improvement of the sanitary condition of these localities as well as a physical improvement of their population.[64]

As early as 1915 Governor George Basil Haddon-Smith, referring to Grenada, claimed that

> from my 28 years' experience in the tropics, a change for the better is perceptible; the progress may be slow, but, the advance in the civilized sanitary mode of living is taking place.[65]

Governors and doctors alike felt sanitary progress was taking place, something which Branch explicitly linked to the eradication and extinction of hookworm. However, this 'progress' depended on the co-operation of colonised populations with the coloniser's sanitary agenda.

Residents of the Windward Islands had differing reactions to the hookworm campaigns. Many used the campaigns and the treatments and improvements in sanitation they offered to improve their own health. Some resisted, by refusing to provide faecal samples for testing, refusing to take treatments, or – to Branch's particular frustration – taking treatments in their own time, rather than on the campaign's schedule.[66] Resistance could stem from a variety of causes, including suspicion of the colonial elite, adherence to non-biomedical epistemologies of disease (detectable through references to 'superstition'), and cultural stigma surrounding hookworm and defecation among the white population.[67] Class influenced willingness to co-operate with the colonial state; Branch notes that he found it easier to 'handle the suburban population medically', citing 'resistance and difficulty...among the labouring classes', and labelling 'country folk' 'quite another matter…you have to be at them unceasingly'.[68] He also notes, however, that relatively elite white St Lucians included 'the greatest objectors to examination' among their number.[69] Resistance to second and subsequent treatments

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[64] RAC RF/RG5/FA115/191/2348 Branch to C. Mackie, 21st January 1924.
[65] NA CO/323/351 G.B. Haddon-Smith to L. Harcourt (Secretary of State for the Colonies) 28th January 1915.
[66] E.g. NA CO/321/293 St Lucia: Uncinariasis (Disp. 57311, 1916).
[67] NA CO/321/294 S. Branch to G.B. Haddon-Smith, 8th August 1915; RAC RG5/FA115/190/2342 S. Branch 'No. 7100 Report on Work for the Relief and Control of Uncinariasis in St Lucia, November 20, 1914, to March 31, 1915'.
[68] NA CO/321/294 'Report by Dr. S. Branch on the Working of the Hookworm Eradication Campaign in St, Lucia During the Half-Year Ended 30th June, 1916'.
[69] Ibid.

could arise from the fact that a single treatment was usually sufficient to enable a heavily-infected patient to return to work. Feeling far healthier, patients were then 'less desirous of sacrificing a day's pay' by submitting to the seemingly unnecessary further treatments required to completely clear the infection.[70] Nevertheless, enough people did cooperate with the hookworm campaigns to allow the colonial elite to believe that 'progress' was occurring.

And 'progress' was defined almost teleologically as ending in the ultimate extinction of hookworm. Hookworm was very explicitly presented by MacDonald as unnatural:

> Health is Natural…in each case of bodily disease or sickness it is our first duty to ask ourselves "In what have I sinned against nature?" And if a true answer could be returned it would in most cases be found that I or my neighbour was the sinner, and a disregard of NATURE'S LAW OF CLEANLINESS the most frequent sin.[71]

The 'sin against nature', in his eyes, was not the extinction of hookworm, but its very existence. As in Ettling's US study, health was a lost state of grace which must be returned to through repentance and moral reformation; deworming was thus not removing humans from their natural state, but returning them to it.

The implication of this was that hookworm existed outside of nature and the natural world was not denuded by its loss but restored. Hookworm was an unnatural consequence of unnatural sanitary behaviour. Destroying and eradicating hookworm was upholding, not perturbing, the natural order of things; and the natural order was also the colonial social order. The contrast with non-medical understandings of extinction as an unnatural, human-induced disturbance of or offense against nature could hardly be starker. Extinction features here not as a failure of modernity but as its triumph, as the apogee of British imperial progress.[72] The natural state of humans, in the colonial imaginary, was not living in harmony with hookworms, but ridding the world of them via civilised sanitary behaviour.

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[70] Ibid.
[71] NA CO/323/651, MacDonald, '"Health Is Happiness"'
[72] For the failure of modernity, see L. Head, *Hope and Grief in the Anthropocene: Re-conceptualising human-nature relations* (Abingdon: Routledge, 2016).

Reinfection and the failure of Extinction

The eradication campaigns may have succeeded in gaining the cooperation of many of the human inhabitants of the Windward Islands, but the hookworms were another matter. Despite treatment and sanitation efforts, worms persisted in entering dewormed bodies, transforming a cured person into an infected one. As the presence of hookworm had been defined as a symptom of uncivilised behaviour and an uncivilised society, this was a problem for the colonial authorities. Hookworm reinfection indicated a failure of social, civilizational and sanitary 'progress'. The failure to induce extinction was therefore a failure of the civilising mission.

There has been some debate about whether the RF could have, and how far it ever aimed to, eradicate hookworm in the modern sense (i.e. to induce a complete or local extinction).[73] But, as has been discussed above, doctors in the Windward Islands very clearly identified eradication, and the extinction of hookworm in their islands, as their ultimate long-term aim. Hookworm campaigns were therefore expected to produce considerable progress in both promoting 'civilised' sanitary behaviour and reducing the prevalence of hookworm, since these two were closely connected, if not coterminous.

The benefits of treatment in turning dangerous high-burden infections into less dangerous, even asymptomatic, low-burden infections was recognised by Branch at least, who wrote at the closing of the St Lucia campaign:

> The chief feature of comparison between the original and the re-survey is to be found in the degree of infection, the absence of well marked clinical cases of the disease. It is not uncommon in the outlying districts where sanitary progress is still in abeyance to find victims formerly incapacitated from work in the active pursuit of their agricultural labour.
>
> Financial depression and tropical inertia do not make a happy combination but even amongst the more pessimistic there is a gleam of hope of true progress.[74]

Even as Branch acknowledged that his work had improved his patients' health, economic position and quality of life in the absence of 'sanitary

[73] Farley, *To Cast Out Disease* pp.59-87; S. P. Palmer, *Launching Global Health: The Caribbean Odyssey of the Rockefeller Foundation* (Ann Arbor: University of Michigan Press, 2010) pp.204-5.
[74] RF RAC/RG5/FA115/3.457H/191/2348 Branch to W.B. Davidson-Houston 29th December 1924.

progress', he refused to regard this as 'true progress'. Hookworm's continued presence – continued failure to induce its extinction – was all that was required to indicate a failure of progress.

In St Vincent, high levels of reinfection signalled a failure so complete as to prove fatal to the hookworm campaign. A 1918 resurvey of St Vincentians who had previously been 'cured' of hookworm (Figure 6.4) found that an average of 61% of these individuals had been reinfected in the two years since their cure.[75] This led doctor in charge Powell Gardener to conclude that

> The survey having shown that the high percentage of re-infection were due to inadequate provision for the disposal of excreta or to the failure on the part of the people to use latrines when provided, it was deemed inadvisable to continue work in St. Vincent until such time as the Government could organise a sanitary force to deal effectively with the problem of soil pollution.[76]

Hookworm infection was thus very explicitly a 'failure on the part of the people' and therefore a failure of the colonial state to indoctrinate the population in civilised defecation. One Colonial Office official further identified this as a failure of the colonial Administrator:

> I think we ought to stir the Administrator up or it seems clear that all the work done by the International Health Board in St. Vincent will be wasted.[77]

[75] NA CO/321/307 P.B. Gardener, 'Report on Work for Relief and Control of Hookworm Disease in St. Vincent from May 1, 1915 to August 26, 1918.'
[76] Ibid.
[77] NA CO/321/307 'St Vincent: Hookworm Disease Relief & Control' (Disp. 44065, 1st July 1919).

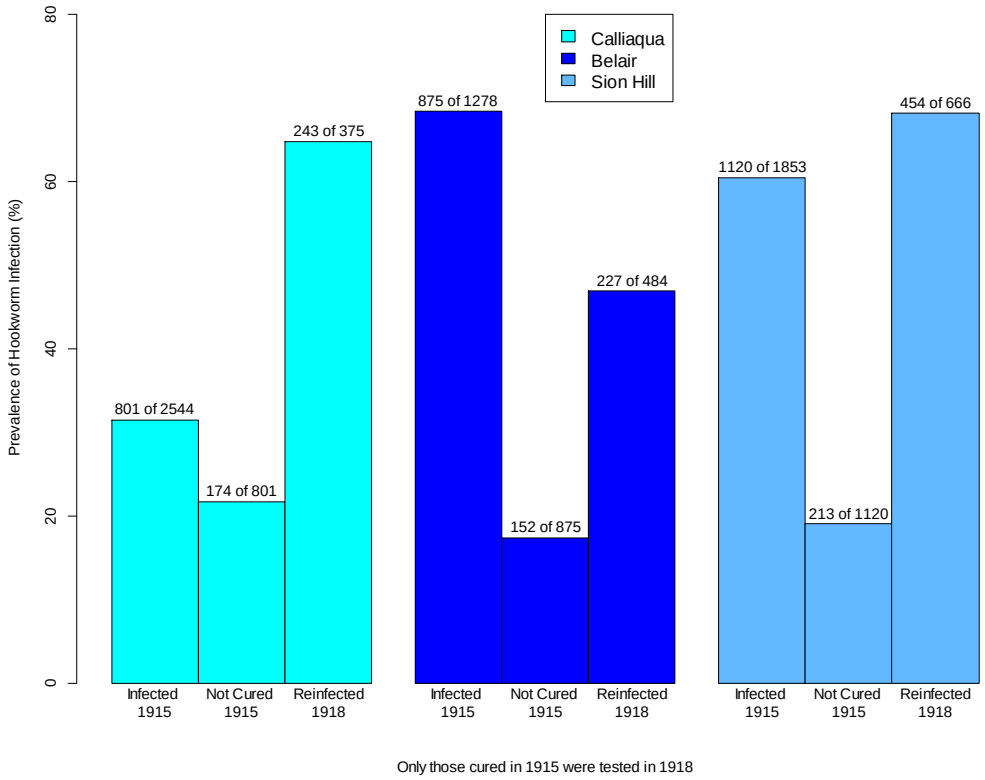

Figure 6.4: Prevalence of hookworm infection among the general population in 1915, individuals treated for hookworm in 1915, and individuals previously cured of hookworm in 1918 across three areas of St Vincent.
Original surveys took place 1915-6, with re-examinations in 1918. Only those cured in 1915 were re-examined in 1918; within areas, therefore, each bar represents a subgroup of the preceding bar.

Likewise, when areas of St Lucia surveyed and treated at the campaign's beginning were resurveyed in 1923, prevalence had only fallen modestly (Table 6.1) to around 6% lower than it had been in 1915. As Branch noted, these infections were likely of lower intensity than they had been before the treatment campaign, but the numbers of people infected with hookworm were roughly the same, which was taken to indicate a failure to civilise individuals, population and environment. It was not the extinction of hookworm which was seen as a failure of progress and modernity, but its very existence.

Table 6.1: Prevalence of hookworm infection in St Lucia compared in 1915 and 1923.
Surveys in 1915 and 1923 covered the same areas, but in different combinations, making direct comparisons difficult. Spelling of district names given as in original reports

1915		**1923**	
District	Prevalence	District	Prevalence
Ciceron, Anse Ferré, and Bellevue	71.2% (n=416)	Ciceron, Bellevue and Anse Ferré	74.6% (n=354)
L'Abbaye, Ravin, Poisson and Barré Chopin	89.8% (n=275)	L'Abbaye and Ravine-Poisson	78.6% (n=154)
Crown Lands	84.0% (n=269)	Crownlands, L'Abbaye, and Chopin	77.4% (n=248)
Bexton, Odsane and Ferrands	88.4% (n=157)	Bexon and Odsan	81.6% (n=354)
		Ferrands	90.9% (n=11)
Petite Rivere, Barré Denis, Barré Chaussé, La Croix Maingot and Petit Coulon	84.6% (n=486)	Soucis-Barré-Denis and Barré De-Chaussee	75.9% (n=399)
		La Croix-Maingot, Beausejour and Fromager	76.5% (n=429)
St Joseph and La Pointe	85.5% (n=393)	St Joseph	86.1% (n=353)
Soucis	87.8% (n=214)	Soucis	80.1% (n=191)
Prevalence (all districts)	84.4% (n=2,180)	**Prevalence (all districts)**	78.8% (n=2,493)

Likewise, St Lucian policemen were tested for hookworm on multiple occasions, and were also often reinfected. By 1920 (Table 6.2), 6 of the 13 who tested positive for hookworm in 1918 had been reinfected, whereas 6 of the 27 who tested negative in 1918 had been newly infected by 1920. Prevalence among officers remained relatively high between 1918 and 1922 despite treatment, though not as high among those treated as among new recruits (Table 6.3).

High levels of reinfection of the previously cured in both St Vincent (Figure 6.4) and St Lucia (Table 6.2) is consistent with particular individuals being more or less predisposed to hookworm infection. Indeed, in 1922, Gardener explained high levels of reinfection as being among individuals who 'because of environment or personal habits, or both, had all acquired the infection, and were more likely for the same reasons (environment and personal habits) to become re-infected.'[78] A century later, predisposition to hookworm is attributed to a mix of environmental, behavioural and genetic factors.[79] Predisposition is typically understood to arise from a combination of differing levels of exposure to infective larvae and differing levels of resistance provided by the host body against the invading parasite. But this host resistance could equally be described as hookworm larvae finding in some individuals less hazardous habitat; from the worm's point of view, some hosts were more congenial than others.

Table 6.2: Post-treatment reinfection with hookworm in 40 St Lucian police officers, 1918-1920.
Data from RAC RF/RG5/3.457H/191/2346 'Report on Examination of St. Lucia Constabulary' (1920).

<table>
<tr><td>Testing 1918</td><td colspan="3">13 infected</td><td colspan="2" rowspan="2">27 negative</td></tr>
<tr><td>Treatment 1918</td><td>2 not cured</td><td colspan="2">11 cured</td></tr>
<tr><td>Testing 1920</td><td>2 remained infected</td><td>6 reinfected</td><td>5 remained negative</td><td>6 newly infected</td><td>21 remained negative</td></tr>
</table>

[78] NA CO/321/307 P.B. Gardener, 'No. 7424 Report of the Work for the Relief and Control of Hookworm Disease in St. Vincent from May 1, 1915 to August 26, 1918' (1918).
[79] R. J. Quinnell et al., 'Genetic and household determinants of predisposition to human hookworm infection in a Brazilian community', *Journal of Infectious Diseases* 202/6 (2010) pp.954-961; Brooker et al., 'Human hookworm infection'; M. S. Wong et al., 'The rate of ingestion of Ascaris lumbricoides and Trichuris trichuira eggs in soil and its relationship to infection in two children's homes in Jamaica', *Transactions of the Royal Society of Tropical Medicine and Hygiene* 85(1991) pp.89-91.

Table 6.3: Prevalence of hookworm in the St Lucia Constabulary, 1918-1922. Data from CO/321/325 Branch to W.B.-Davidson Houston, 10th January 1923; CO/321/293 St Lucia: Uncinariasis (Disp. 57311, 1916) & RAC RF/RG5/3.457H/191/2346 'Report on Examination of St. Lucia Constabulary' (1920)

Group	Prevalence of hookworm infection			
	1915	**1918**	**1920**	**1922**
All officers	31.0% (n=74)	44.3% (n=79)	50.7% (n=75)	38.8% (n=67)
Newly-enlisted officers	-	-	71% (n=34)	83.3% (n=6)

For colonial officials, unconcerned with the worm's-eye view, the problem was that hookworm was simply too easy to come by. As Branch bemoaned in relation to the St Lucian police:

> I am driven to the conclusion that owing to the very general state of soil contamination throughout the island that the men become reinfected when they reside out of barracks. The habit of walking barefooted about the yards of their home or the places where they may sleep is all that is required to contract an infection.[80]

The extinction of hookworm would have been a sign of progress, but the worm's abundance was instead problematic. And as Eva Giraud *et al.* point out, abundance in the putative 'Anthropocene', particularly of problematic species, is the mirror of extinction, being likewise a product of human-mediated ecological disturbance.[81] Colonial doctors and officials who had hoped to make hookworm extinct were instead confronted with its disquieting abundance.

Colonial Extinctions

The hookworm campaigns in the Windward Islands Association were a very clear case of Anderson's 'excremental colonialism'. But their importance goes beyond that. They were attempts to begin the process of purging a parasite not only from the bodies of individuals, but also from the social body, to expel hookworm from the islands, and induce its local extinction. Extinction was not only an aim of colonial policy, but a signifier of its

[80] RAC RF/RG5/FA115/191/2348 Branch to W.B.-Davidson Houston, 10th January 1923.
[81] Giraud et al., 'Abundance in the Anthropocene' pp.357-373.

success, and of the advance of 'civilisation'. Civilisational progress was signified by the disappearance of hookworm; the failure to induce hookworm's extinction therefore signified a failure of the colonial civilising mission. As Mark Barrow has shown, a thoughtful minority among scientists had been mourning the loss of species with the advance of 'civilisation' since the previous century, but hookworm offers a rare case of the link between 'civilisation', modernity and extinction being elaborated and celebrated by colonial doctors.[82]

This aim of inducing extinction in the name of disease eradication is common to efforts against mosquitoes taking place in the same period, but these are usually understood as a triumph of technological interventions (i.e. insecticide) over social or hygiene-focused methods.[83] With hookworm, however, the aim was to reform the environment, minds and bodies of the colonised, and the methods focused on hygiene, treatment and education. Many extinctions have resulted from state persecution of species perceived as undesirable or economically threatening, such as the emblematic thylacine (*Thylacinus cynocephalus*).[84] In the case of hookworm, however, the extinction of undesirable species was explicitly part of an attempt to civilise the bodies, minds and lands of the colonised.

From a public health point of view, this conceptualisation undermined the effectiveness of the control programme. Had hookworm been understood as an economic problem of poor living conditions, treatment and sanitation efforts might have been sustained for long enough to make an impact. Had it been understood to be caused by a lack of knowledge, health education efforts might have adopted a more conciliatory and persuasive tone. But it was understood as a problem caused by a lack of civilisation, which meant that efforts to tackle it were cut short due to their failure to immediately transform the minds and bodies of the colonised. Branch's 'difficulties'

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[82] M. V. Barrow, *Nature's Ghosts: Confronting Extinction from the Age of Jefferson to the Age of Ecology* (Chicago: University of Chicago Press, 2009). pp.73, 113,161.
[83] See Stepan, *Eradication* pp.79-103.
[84] E. Fuller, *Lost Animals: Extinction and the Photographic Record* (London: Bloomsbury, 2013) pp.175-6.

'handling' his patients had much to do with to his conviction of his own civilisational and racial superiority.

The abundance of hookworm can, furthermore, likely be in part attributed to the socioecologies created by colonialism. MacDonald, for instance, noted that hookworm was particularly prevalent on 'an estate in St Andrew' (Grenada), with over 90% of labourers on the plantation infected.[85] This is consistent with plantations amplifying hookworm transmission, making hookworm more common.[86] Likewise, the limited budgets of colonial governments – set up to maximise economic extraction – hampered health efforts across the Caribbean.[87] Colonialism was attempting to solve problems of its own creation. Its solutions were to discipline and regulate the colonised, with the explicit aim of annihilating another species. Colonial socioecologies facilitated abundant hookworm infections, and the colonial state, despite its ambition to reform the sanitary environment of the Windward Islands through disciplining and moral transformation of the population, was ultimately unable to counteract the socioecological effects of its own system. However well-intentioned colonial doctors were, both the ideology and economic system they were enmeshed in hindered their efforts to induce the extinction of hookworm.

Their teleological vision of 'progress' ultimately resulting in the extinction of hookworm was not realised, and hookworm appears to have persisted (at much lower prevalence) even in the postcolonial Windward Islands – a survey found around one in ten children infected in St Lucia in 2010.[88] Likewise, hookworm infected around 5.8% of children in a 1982 survey of Grenada, and 0.9% of 5-9-year-olds in a 1992 survey of St Vincent.[89]

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[85] NA CO/323/653 'Grenada: International Health Commission (Ankylostomiasis Campaign): Report of the Medical Officer in Charge for the Quarter Ended 31st March, 1915'.
[86] Palmer, *Launching Global Health* pp.25-7; Lorimer, *The Probiotic Planet* pp.133-159, for further discussion see J.D Roberts et al., 'Parasites and Plantations: Disease, Environment and Society in efforts to induce Extinction of Hookworm in Jamaica, 1919-1936' *Cambridge PRISMS: Extinction* 3 (2025).
[87] See Farley, *To Cast Out Disease,* Heuring, *Health and the Politics of 'Improvement'* Ch.1.
[88] E. S. Tikasingh et al., 'The control of hookworm disease in Commonwealth Caribbean countries', *Acta Tropica* 120(2011) pp.24-30.
[89] Ibid.

The transformation of the ecologies of the Caribbean brought about by colonialism and plantation capitalism has resulted in many extinctions.[90] In Barbados, for instance, deforestation to provide space and fuel for sugar production drove the mastic tree *Mastichodendron sloaneanum* extinct, likely in addition to many undescribed species.[91] 18th-century extinctions include multiple macaws (*Ara goseeei, A. erythrocephala,* and *A. atwoodii*), amazons (*Amazona violacea* and *A. martinica*) and the Windward Islands hutias.[92] Species extinctions have also been produced by colonial-era introductions of invasive species such as the mongoose (*Urva auropunctata, Herpestes javanicus*), initially introduced to control its fellow colonial traveller the rat.[93] Losses following these introductions include the Jamaican petrel *Pterodroma caribbaea*.[94] The Jamaican sunset moth *Urania sloanus* and the St Lucia pilorie *Megalomys luciae* also disappeared in the 19th and 20th centuries.[95] Similarly, species extinction and human genocide have been inseparable across colonial contexts, including throughout the circum-Caribbean.[96] The Kalinago of the Lesser Antilles and the Taíno elsewhere in the Caribbean suffered European encroachment, exploitation and disease.[97]

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[90] For ecological transformations see further Watts, *The West Indies*; A. W. Crosby, *The Columbian Exchange: Biological and Cultural Consequences of 1492* (Connecticut: Praeger, 2003/1973); J. R. McNeill, *Mosquito Empires: ecology and war in the Greater Caribbean, 1620-1914* (Cambridge: Cambridge University Press, 2010).

[91] Watts, *The West Indies* pp.186,219-223.

[92] Ibid. pp.438-9.

[93] C.f. S. B. Cooke et al., 'Anthropogenic Extinction Dominates Holocene Declines of West Indian Mammals', *Annual Review of Ecology, Evolution and Systematics* 48/(2017) pp.301-327; for mongoose see V. Louppe et al., 'Dispersal history of a globally introduced carnivore, the small Indian mongoose Urva auropunctata, with an emphasis on the Caribbean region', *Biological Invasions* 23(2021) pp.2573-2590.

[94] B. Outram & F.H. Kennard, *A list of the birds of Jamaica* (Kingston: Government Printing Office, 1920) p.2, c.f. pp.10,11,17. A stuffed *P. caribbea* can be viewed alongside other extinct Jamaican species in the National Museum of Jamaica, Kingston.

[95] R. Borroto-Páez et al., 'Updated Checklist of Endemic Terrestrial Mammals of the West Indies' in (eds.) *Terrestrial Mammals of the West Indies* (Gainesville: Florida Museum of Natural History And Wacahoota Press, 2012); V. Nazari et al., 'Century-Old DNA Barcodes Reveal Phylogenetic Placement of the Extinct Jamaican Sunset Moth, Urania sloanus Cramer (Lepidoptera: Uraniidae)', *PLoS One* 11/10 (2016) pp.e0164405.

[96] As reviewed by, for instance, J. Schuster, *What is Extinction? A Natural and Cultural History* (New York: Fordham University Press, 2023) pp.5-7.

[97] H. M. Beckles, 'Kalinago (Carib) resistance to European Colonisation of the Caribbean', *Caribbean Quarterly* 38/2/3 (1992) pp.1-14; H. Freund, 'Who should

Hookworm, however, offers us the odd case of the colonial authorities actively attempting to drive an abundant animal towards extinction – and failing. Colonialism and the plantation economy are implicated in many extinctions in the Caribbean, but colonialism in the Windward Islands was unable to induce the extinction of a species it had inadvertently cultivated.

Colonialism, that is, has been a significant driver of extinctions, largely through its drive to create extractive landscapes. Here its drive to produce a 'civilised' landscape through environmental and personal reform attempted to induce an extinction, but ultimately failed to do so. The colonial conception of extinction as progress elucidates not only the close connection between colonialism and extinction but also challenges us to understand extinction in historical context, as a process which may not be seen as tragic by all, or indeed any, of the actors involved.

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be treated "with every degree of humanity"? Debating rights for planters, soldiers, and Caribs/Kalinago on St. Vincent, 1763–1773', *Atlantic Studies* 13/1 (2016) pp.125-143; P. P. Boucher, *Cannibal encounters: Europeans and Island Caribs, 1492-1763* (Baltimore: Johns Hopkins University Press, 1992).

Chapter 7 Dolcoath Anaemia: The Peculiarities of Cornish Hookworm from Arrival to Extinction, 1895-1920

Abstract

Parasites offer a useful lens with which to understand the interactions of societies and environments. Here an outbreak of hookworm disease in Cornish mines is used to explore the relationships between people, parasites and places. Hookworm, a usually tropical nematode worm, was brought to Cornwall within infected miners returning from abroad and was able to spread due to the unusually warm, wet and muddy environments produced by Cornish mining. Mining shaped the transmission dynamics and symptoms of the disease which became known as Dolcoath Anaemia. Dolcoath Anaemia therefore arose out of a particular socioecological configuration of mines, miners and hookworm. Defined by miners as a miners' disease, hookworm in turn defined Cornwall as a quasi-tropical destination within Britain to which scientists could travel to study an exotic tropical disease: a medical domestic exotic. Scientists used Dolcoath to create knew knowledge about hookworm which also circulated along Cornish, diasporic and mining networks, before hookworm disappeared with the closures of the mines.

Introduction

Some say of the Cornish miner
His home is the wide, wide world,
For his pick is always ringing
Where the Union Jack's unfurled

The Song of the Cornish Miners[1]

Parasitic organisms exist within complex networks of relationships between parasite, host(s) and environment. As such, human diseases arising from parasite infections are products of particular socioecological configurations and relations between people, parasites and environments. Mosquito-borne diseases such as yellow fever and dengue, for example, thrive or decline

[1] H. Thomas, *Cornish Mining Interviews* (Camborne: Camborne Printing and Stationery Co, 1896) p.350.

depending on what breeding environments the social and economic structures of humans create for mosquitoes.[2] Parasites can have complex and intimate relationships with particular places.

These socioecological relationships between people, parasites and places can be explored through unusual cases: highlighting where people, environment and parasites interact in atypical ways shows how socially- and environmentally-contingent their interactions are. This study takes the unusual example of hookworm in Cornish mines at the opening of the 20th century to demonstrate how environments created by humans shape not only the transmission dynamics of parasites, but also their cultural meanings and even clinical presentation.

Hookworm is a soil-transmitted nematode worm which feeds on blood in the small intestine. Infection with small numbers of hookworms is typically asymptomatic, but higher burdens can cause iron-deficiency anaemia.[3] In Cornwall, hookworm disease manifested as a set of symptoms known as Dolcoath Anaemia. This was not just a name, but reflects that hookworm, an environmentally-sensitive parasite, was entangled with Dolcoath Mine as a place. To establish in a new area, hookworm requires three conditions: a suitably wet and warm environment in the soil; the presence of people who had been previously infected elsewhere; and poor sanitation to facilitate transmission. Cornwall – and Dolcoath in particular – was one of the few places in Europe which provided all three of these conditions. Cornish mines, especially Dolcoath, were unusually deep, warm and wet. Cornish miners were legendarily mobile, working all over the world, and often returning to Cornwall from hookworm-endemic areas. And finally, the insanitary conditions of the mines allowed hookworm many opportunities to infect miners. Cornwall – its diasporic connections, deep lodes and mining culture – shaped hookworm and its symptoms, as well as medical responses to it, as hookworm became defined as a mining disease and Cornwall as a

[2] R. Gibb et al., 'Interactions between climate change, urban infrastructure and mobility are driving dengue emergence in Vietnam', *Nature Communications* 14/8179 (2023); J. R. McNeill, *Mosquito Empires: ecology and war in the Greater Caribbean, 1620-1914* (Cambridge: Cambridge University Press, 2010).
[3] A. Loukas et al., 'Hookworm infection', *Nat Rev Dis Primers* 2/16088 (2016) pp.16088.

place within Britain to which scientists could travel to study this tropical disease. Hookworm was shaped by Cornwall and its mines, in terms of both its meanings and its pathology, and shaped understandings of Cornwall and Dolcoath in turn.

Hookworm is mostly known to medical historians as the beginning of Rockefeller Foundation health philanthropy, and thus an origin point of international health.[4] In recent years this has been expanded by histories exploring the role of non-Rockefeller actors in developing hookworm science and anti-hookworm public health.[5] The arrival of hookworm in Cornish mines at the end of the 19th century has been noted by historians of mining and occasionally by historians of hookworm, but has not been explored in detail since the time of the outbreak.[6] This study examines the outbreak of hookworm infection (ankylostomiasis/ancylostomiasis) in Cornwall a decade before the disease came to the attention of John D. Rockefeller.

I draw from the scientific papers and government reports written by John Scott Haldane and Arthur Edwin Boycott, who investigated hookworm in Cornwall; the correspondence of Dolcoath's agent, Richard Arthur Thomas; the research of mining clinician Josiah Court; textbooks on mining from the Camborne School of Mines library; administrative documents from local

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[4] J. Ettling, *The Germ of Laziness: Rockefeller Philanthropy and Public Health in the New South* (London: Harvard University Press, 1981); J. Farley, *To Cast Out Disease: A History of the International Health Division of the Rockefeller Foundation (1913-1951)* (Oxford: Oxford University Press, 2004); S. P. Palmer, 'Migrant Clinics and Hookworm Science: Peripheral Origins of International Health, 1840–1920', *Bulletin of the History of Medicine* 83/4 (2009) pp.679-709; R. Hoefte, 'Cleansing the world of the germ of laziness: hygiene, sanitation, and the Javanese population in Suriname', *História, Ciências, Saúde–Manguinhos* 21/4 (2014) pp.1437-1455; S. N. Kavadi, "Parasites Lost and Parasites Regained': Rockefeller Foundation's Anti-Hookworm Campaign in Madras Presidency', *Economic and Political Weekly* 42/2 (2007) pp.130-137; M. Boccaccio, 'Ground Itch and Dew Poison: The Rockefeller Sanitary Commission 1909–14', *Journal of the History of Medicine and Allied Sciences* 27/1 (1972) pp.30-53.

[5] E.g. S. P. Palmer, *Launching Global Health: The Caribbean Odyssey of the Rockefeller Foundation* (Ann Arbor: University of Michigan Press, 2010); N. Bhattacharya, *Contagion and Enclaves: Tropical Medicine in Colonial India* (Liverpool: Liverpool University Press, 2017).

[6] Palmer, *Launching Global Health* pp.43-44; C. Mills, *Regulating Health and Safety in the British Mining Industries, 1800-1914* (Farnham: Ashgate, 2010) pp.90,172-3,178,180,198.

district councils; records of the Mining Association of Great Britain from the National Coal Mining Museum for England library; and the Colonial Office archives. Comparisons with hookworm in Caribbean contexts, particularly Jamaica, Grenada, St Lucia and St Vincent, are made throughout.

Hookworm and Cousin Jack

Hookworm was first reported in Cornwall in 1902 by John Scott Haldane (father of the geneticist J.B.S. Haldane), who had been dispatched by the national government to investigate ventilation in Cornish mines.[7] A longstanding expert in mine gases and credited with the introduction of the miners' canary, he was asked to investigate what was known locally as Dolcoath Anaemia by Joseph Martin, the Inspector of Mines for the south-western mining district.[8] Haldane appears to have initially suspected that dust from rock-drills contributed to Dolcoath Anaemia, but mine agent Richard Arthur Thomas pointed out that some cases, including one Jacob Smith, had 'never worked in places where there is likely to be much dust'.[9] Suspecting hookworm (which had caused anaemia epidemics in continental European mines several times over the previous 50 years), Haldane consulted Patrick Manson at the London School of Tropical Medicine, and brought Arthur Edwin Boycott into his investigations.[10] They found hookworm eggs in the faeces of miners suffering from Dolcoath Anaemia. Dolcoath Anaemia had by this point been known for 'about five or six' years, suggesting that hookworm had begun to circulate at Dolcoath prior to 1896.[11] In 1903, Haldane and Boycott suggested that the outbreak began 'about 8 years ago', in 1895.[12] They identified the parasite responsible as *Ancylostoma duodenale*, but it is impossible to be certain that the other

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[7] J.S. Haldane, *Report to the Secretary of State for the Home Department on an Outbreak of Ankylostomiasis in a Cornish Mine* (London: Home Office, 1902).
[8] Ibid.; for canaries see O. Sonne, 'Kanariefugle, mikrober og giftgas: Fysiologen J.S. Haldanes indsats inden for samfundsmedicin og hygiejne', *Dan Medicinhist Arbog* 43(2015) pp.71-100.
[9] Thomas Papers, Archives and Special Collections, Penryn Campus (Penryn) [henceforth PT] ECP1 Box 21 Thomas to Haldane, 29th October 1902.
[10] Ibid.
[11] Ibid. p.6.
[12] J.S. Haldane & A.E. Boycott, 'An Outbreak of Ankylostomiasis in England No.I', *Journal of Hygiene* [henceforth *J Hyg*] 3/1 (1903) pp.95-136.

major hookworm, only described in 1902 as *Necator americanus,* was not also present in Cornwall.[13]

Throughout the 19th century, Cornwall was a major emigration zone, and migration is consequently a major theme in Cornish Studies.[14] Many emigrants, as elsewhere, were small farmers and unskilled workers seeking a better life, but the 'Cousin Jack myth' of superior Cornish mining skill and the 'Cousin Jack network' of recommendations produced demand for Cornish hard-rock miners in mining frontiers across the globe.[15] 'Cousin Jacks' were at the forefront of frontier mining in the Americas and Australia at in the early 19th century, and migration intensified in the second half of the century, as Cornish mining declined while gold, copper and tin fields opened up in Australia, California, India and South Africa.[16] As mining in Cornwall declined, copper collapsed, and tin struggled to compete with imports from Bolivia, Australia and the Federated Malay Straits, migration became both a 'safety valve' allowing unemployed miners to seek work abroad and a source of remittances keeping their families at home fed.[17] Cousin Jacks and Jennies overseas could access higher wages, improved social status and retire to farming or shopkeeping.[18]

Even as emigration slowed towards the start of the 20th century, Cornwall retained a 'culture of mobility'.[19] Haldane's 1904 *Report…on the Health of Cornish Miners* contains the employment histories of 217 miners who died in Cornwall (Figure 7.1), compiled by the district registrar. These miners travelled all over the world, particularly to the British territories of South

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[13] Ibid. p.96.
[14] R. J. P. Harris, 'Building Regional Identity: Social and Cultural Significance of Railways for Cornwall in the Late Nineteenth and Early Twentieth Centuries', *Journal of Transport History* 41/2 (2020) pp.254-277; B. Deacon and S. Schwartz, 'Cornish Identities and Migration: A Multi-scalar Approach', *Global Networks* 7/3 (2007) pp.289-306; P. Payton, *The Cornish Overseas: the epic story of the 'Great Migration'* (Fowey: Cornwall Editions, 2005); B. Deacon, *Industrial Celts: Making the Modern Cornish Identity 1750-1870* (Redruth: Cornish Social and Economic Research Group 2018). Ch.7.
[15] Payton, *The Cornish Overseas*.
[16] Ibid.
[17] D. B. Barton, *A History of Tin Mining and Smelting in Cornwall* (Truro: D. Bradford Barton Ltd., 1967) pp.99-214; Payton, *The Cornish Overseas* pp.256-295.
[18] Payton, *The Cornish Overseas* pp.374-5.
[19] Ibid. Ch.1-2,12.

Africa, India and Australia, but also to Britain's informal trading empire in the Americas. It was possible to acquire hookworm in any of these places. Some learnt mining in Cornwall and then travelled abroad in their twenties (though these details are not consistently given, 10 miners are explicitly noted to have left Cornwall between the ages of 19 and 30) but it was also common to return and work in Cornwall for stints in between more lucrative overseas work. Sometimes miners returned to Cornwall to recover from ailments, particularly silicosis (miners' phthisis). Several of those recorded did not live long after their return to Cornwall.[20] Others returned and took up other professions – quarrymen, farmers, servants, publicans and grocers are all recorded in Haldane's cases – but many returned to mining in Redruth-Camborne and St Just. Before taking over Dolcoath from his father Josiah, for example, Arthur Thomas had been a mine captain in Witwatersrand, South Africa.[21]

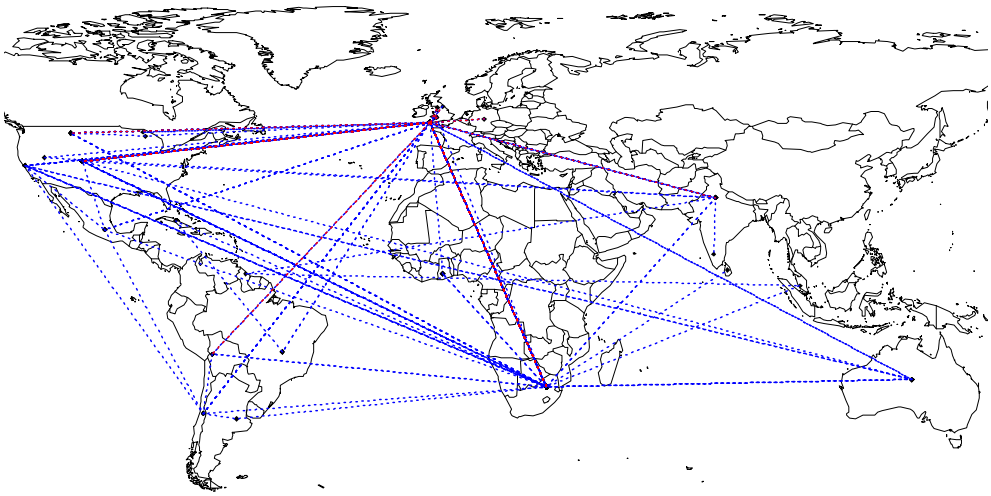


Figure 7.1: Employment histories of 217 Cornish miners.
Data from J.S. Haldane, J.S. Martin & R. Arthur Thomas, *Report to the Secretary of State for the Home Department on the Health of Cornish Miners* (1904). Lines are drawn between places of work listed sequentially in employment histories of individual miners. Heavier lines indicate more miners travelling between two places. Red lines indicate miners returning from elsewhere who then worked in Cornish mines. All died in Cornwall, but many did not return to mining after their return to Cornwall.

[20] See also G. Burke and P. Richardson, 'The Profits of Death: A Comparative Study of Miners' Phthisis in Cornwall and the Transvaal, 1876-1918', *Journal of Southern African Studies* 4/2 (1978) pp.147-171.
[21] Payton, *The Cornish Overseas* p.361.

The available evidence suggests that prior to 1895 one or more miners returning from abroad introduced hookworm to Dolcoath. Dolcoath had been steadily deepening since the opening of the century, and was by then among the deepest mines in the world.[22] Hookworm larvae cannot normally survive in northern Europe, but the wet, warm conditions of the mine allowed them to establish a cycle of infection. Arthur Thomas noticed Dolcoath Anaemia but did not understand its aetiology: in 1898, on the understanding that poor sanitation was the cause of many diseases, he installed privies at the surface, improved ventilation and provided disinfectant to be used underground.[23] Such sanitary measures may have reduced hookworm transmission, but failed to halt its spread. In 1900, suspecting (incorrectly) that the disease was due to poor ventilation, Thomas installed fans in the New Sump (the Engine Shaft).[24] These likely lowered temperatures in the shafts, making Dolcoath less hospitable to hookworm, but hookworm continued to thrive in Dolcoath.

By 1903, Hookworm infection was ubiquitous at Dolcoath, being found in 95% of Dolcoath miners, but was less prevalent in other mines (Table 7.1). At other mines hookworm was more prevalent among miners who had previously worked at Dolcoath (47% and 50% prevalence at Grenville and Tincroft respectively in 1908) than among those who had not (15% and 9.5%). This suggests secondary spread from Dolcoath to other mines; miners, Haldane's employment histories show, moved frequently between mines. However, independent introductions of hookworm to Cornwall may also have occurred, and indeed Boycott reports that the only man in West Kitty Mine testing positive for hookworm had previously worked in Mysore, India, where he presumably contracted the infection; Boycott considered West Kitty (probably correctly, see Figure 7.4 below) too cold and shallow for hookworm to establish.

[22] T. R. Harris, *Dolcoath: Queen of Cornish Mines* (Penzance: Trevithick Society, 1974).
[23] Ibid.
[24] Ibid. See also PT ECP Box 21 R. Arthur Thomas to J.S. Haldane 29th October 1902; Thomas to Secretary, Tregarthens Hotel Ltd., 16th September 1898.

Table 7.1: Prevalence of Hookworm infection in Cornish Miners.
Data from Boycott, *The Milroy Lectures* and Haldane & Boycott, 'The Progress of Ankylostomiasis in Cornwall' *J Hyg.* 9/3 (1909) pp.264-270.

Year	Mine	Prevalence of Hookworm Infection		
		All tested	Previously employed at Dolcoath	Not previously employed at Dolcoath
1903	Dolcoath	95%[a]	-	-
1903	East Pool	-	-	42%
1903	South Crofty	-	-	12%
1908	Grenville	24%	47%	15%
1908	Tincroft	25%	50%	9.5%
1908	Dolcoath	-	-	76%[b]

[a]of a random sample of 65 miners
[b]of 89 miners, mostly boys, who had arrived in Dolcoath since the introduction of pails and had only previously worked above ground or in mines known to be uninfected

The Peculiarities of Dolcoath Anaemia

Before examining how the social and environmental conditions of Dolcoath shaped the clinical presentation of the disease, it is necessary to outline the biology of its infection process. Humans, like other animals, typically avoid faeces; this disgust response has evolutionary utility as a parasite avoidance strategy.[25] However, this is of limited effectiveness against hookworm. Hookworm eggs passed in faeces hatch in the soil in 1-2 days into L1 larvae, which feed on the bacteria and debris, before moulting into L2, then L3 larvae in 5-10 days.[26] It thus takes 6-12 days for ground contaminated with faeces to pose a risk of hookworm infection (though fresh faeces provide an immediate risk of infection with many other pathogens). L3 can, furthermore, survive in the soil in a state of developmental arrest for around 3-4 weeks, though they may lose infectivity after around 2 weeks.[27] The

[25] J. C. Buck et al., 'Ecological and Evolutionary Consequences of Parasite Avoidance', *Trends in Ecology and Evolution* 33/8 (2018) pp.619-632; V. Curtis et al., 'Disgust as an adaptive system for disease avoidance behaviour', *Phil Trans R Soc B* 366(2011) pp.389-401.
[26] S. Brooker et al., 'Human hookworm infection in the 21st century', *Adv Parasitol* 58/(2004) pp.197-288; A. Loukas et al., 'Hookworm infection', *Nat Rev Dis Primers* 2/16088 (2016) pp.16088.
[27] A. O. Shalash et al., 'Hookworm infection: Toward development of safe and effective peptide vaccines', *J Allergy Clin Immunol* 148/6 (2021) pp.1394-1419

infective L3 infect hosts through the skin (percutaneously), traveling to the small intestine via the peripheral circulation, heart and lungs.[28] Contaminated soil therefore poses the greatest risk of hookworm infection 2-4 weeks after faecal deposition, by which time it may no longer induce a disgust response.

Cornish miners worked in bare arms and heavy boots (Figure 7.2). Hookworm typically infects humans through the feet, but the miners' boots rendered this impossible.[29] These same boots, however, provided efficient vectors for the movement of soil contaminated with hookworm larvae around the mine, particularly onto ladders, tools and rocks.[30]

Figure 7.2: Three Miners at work, East Pool.
Photograph by J. C. Burrow, 1890. From the Welcome Collection, 564740i (Public Domain).

Consequently, infection with hookworm in Cornish mines typically occurred through the arms. Infection through the buttocks or thighs after

e1396; Loukas et al., 'Hookworm infection'; N. B. Mudenda et al., 'Modelling the ecological niche of hookworm in Brazil based on climate', *Geospatial Health* 6/3 (2012) pp.S111-S123.

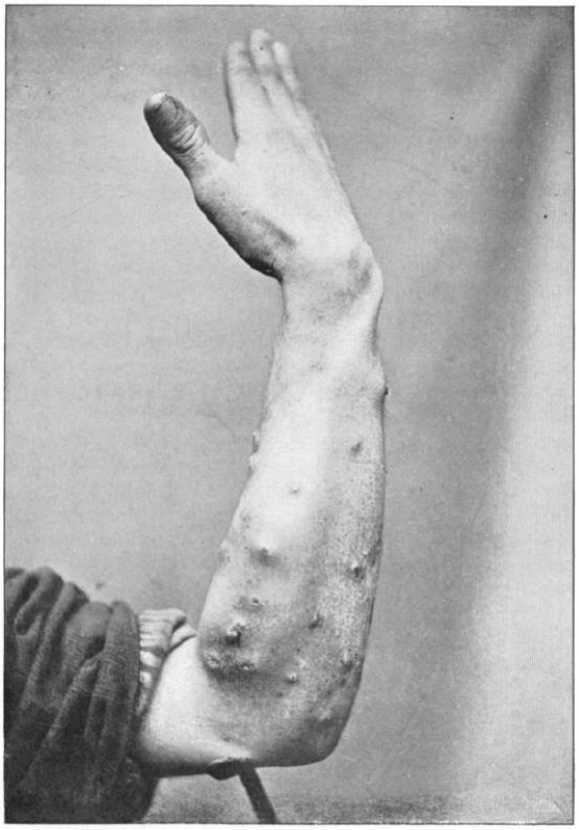
[28] Ibid.

[29] Loukas et al., 'Hookworm Infection'.

[30] Haldane & Boycott, 'Ankylostomiasis No. ii' *J Hyg* 4/1 (1904) pp.73-111, p.104; Haldane, *Report* p.6.

sitting or kneeling on muddy stones or wood was also common as larvae could penetrate thinner textile garments.[31] This produced a symptom peculiar to Cornwall: New Sump bunches (Figure 7.3). L3 entry through hair follicles typically causes an itchy skin rash known as 'ground-itch' on the feet and legs.[32] In Cornwall, however, infection through the arms created atypical itchy swellings (pruritic furuncles) in the arms which the Dolcoath miners dubbed 'New Sump bunches' after the New Sump where they were usually acquired.[33] These were so distinctive as to be considered diagnostic of Dolcoath Anaemia by the miners themselves, but have not been recorded elsewhere in the world.[34] One of the only known comparable cases of hookworm causing such symptoms dates from 1977, when a game of the contact sport kabbadi played on muddy and heavily contaminated ground in North India resulted in 27 men developing comparable itchy skin and pallor, with some also developing coughs and shortness of breath.[35] The distinctive irruptions of 'bunches' may have partly resulted from secondary bacterial infections, warm wet mud providing ideal conditions for hookworm and bacteria alike.

[31] Haldane & Boycott 'An outbreak of Ankylostomiasis in England' p.107-8.
[32] Loukas et al., 'Hookworm infection'; J. H. Cassedy, 'The "Germ of Laziness" in the South, 1900-1915: Charles Wardell Stiles and the Progressive Paradox'', *Bulletin of the History of Medicine* 45/2 (1971) pp.159-169; P. R. Chapman et al., 'Experimental human hookworm infection: a narrative historical review', *PLoS Negl Trop Dis* 15/12 (2021) pp.e0009908. S. Gaze et al., 'Immunology of experimental and natural human hookworm infection', *Parasite Immunology* 36(2014) pp.357-366.
[33] Haldane & Boycott 'An outbreak of Ankylostomiasis in England' p.107-9; Boycott, *Milroy Lectures* pp.7-11.
[34] Ibid.
[35] A. Koshy et al., 'An unusual outbreak of hookworm disease in North India', *Am J Trop Med Hyg* 27/1 (1978) pp.42-45.



A severe case of "bunches" on the arm of a Cornish miner. See pp. 88—89.

Figure 7.3: Bunches.
From Haldane & Boycott, 'Ankylostomiasis no. ii'.

Other symptoms of hookworm disease were interpreted in a mining context, and incorporated into the unique symptomatology of Dolcoath Anaemia. Haldane and Boycott recorded:

> Pallor, particularly of the lips and conjunctivae, together with palpitations and dyspnoea [shortness of breath] on exertion are the three chief signs which ankylostomiasis produces in common with any other anaemia. Underground work in Cornish mines always involves a good deal of climbing up almost vertical ladders. This is a form of exertion which soon brings to prominence any tendency to dyspnoea…[36]

Court likewise reported: 'one of the first signs noticed by a Dolcoath miner is that he cannot go up the ladders in the mine'.[37] Inability to climb ladders became a symptom in itself, and one necessarily peculiar to the mining

[36] Haldane & Boycott 'An outbreak of Ankylostomiasis in England' p.106.
[37] J. Court, w. Batley (ed.) *Miners' Diseases: Records of the Researches of Dr J. Court (of Staveley) into Miner's Nystagmus & Ankylostomiasis.* (No publication information given: University of Leeds Library) p.87; Haldane, *Report* p.5.

context. Pallor of the lips was also treated by both Haldane and Josiah Court as diagnostic: miners were generally pale, but a healthy miner would not have pallid lips.[38] Pallor and dyspnoea are common symptoms of iron-deficiency anaemia, but these were explained by Haldane and Court in terms of mining.[39] Haldane and Boycott also highlight that among other typical symptoms of hookworm disease, oedema was unknown in Cornwall, but gastrointestinal disturbances and heart palpitations were common.[40]

A number of miners became severely ill – Haldane and Boycott's figures record 18 miners who were, by 21st-century standards, severely anaemic, with a further 10 being moderately anaemic (Table 7.2). Many of these continued to work, but 'R.C.' was described as being 'in bed, very weak and intensely pale' prior to treatment, while 'B.R.' was 'too ill to work but can get about'.[41]

Table 7.2: Anaemia among 37 Dolcoath miners who had hookworm eggs present in their faeces.
Categories from World Health Organization, *Guideline on haemoglobin cutoffs to define anaemia in individuals and populations* (Geneva: WHO, 2024); g/L figure obtained by multiplying Haldane's % Haemoglobin figures by 1/100th of his arbitrary 100% mark of 1.3g/L (see E.J. King, M. Gilchrist & A. Matheson 'The Haemoglobin Equivalent of the B.S.I Haldane Standard' *BMJ* 1/4337 (1944) pp.250-252). Data from Haldane & Boycott, 'An outbreak of Ankylostomiasis in England' *J Hyg* 3/1 (1903) pp.128-134.

No Anaemia (>130g/L)	Mild Anaemia (110-129g/L)	Moderate Anaemia (80-109g/L)	Severe Anaemia (<80g/L)	Data Missing
10.8% (n=37)	10.8% (n=37)	27.0% (n=37)	48.6% (n=37)	2.70% (n=37)

[38] Court, *Miner's Diseases* pp.87,92-93; Haldane, *Report* p.5.
[39] A. Lopez et al., 'Iron deficiency anaemia', *The Lancet* 387/10021 (2016) pp.907-916.
[40] Haldane & Boycott 'An outbreak of Ankylostomiasis in England' p.107-9
[41] Ibid. p.129.

Table 7.3: Summary data of blood measurements of Dolcoath miners who had hookworm eggs present in their faeces.
Data from Haldane & Boycott, 'An outbreak of Ankylostomiasis in England' *J Hyg* 3/1 (1903) pp.128-134.

	Number of individuals data are available for	Range	Mean	Median	Standard deviation
Haemoglobin (g/L) Normal range for adult males 140-180	36	23.5-144	83.6	78.7	31.4
Million red blood cells per cubic mm	25	1.53-5.35	3.73	3.43	0.952
Eosinophils per cubic mm	37	3.6-66.2	17.5	16.0	11.0

Dolcoath as a Site of Knowledge Extraction: The Medical Domestic Exotic

As a result of Haldane's research, Dolcoath became a site of knowledge extraction, as physicians and scientists looked to it to learn about hookworm and miners' phthisis (silicosis). A variety of scientists, including not just Haldane (who used the laboratory at Dolcoath) and Boycott, but also Court, W.H. Drew, Norman Campbell and Frank Wethered (presumably a relation of mining magnate Oliver Wethered) enquired about and took samples from Dolcoath and its miners.[42] Drew and Court visited Dolcoath, as Haldane and Boycott also frequently did.[43] Court had been alerted to hookworm by Haldane, who wrote to him in November 1902 'asking me to call the attention of the medical men in my district to the importance of the discovery', and sending Court a faecal sample containing hookworm eggs and larvae.[44] Court also travelled to Belgium as part of his investigations,

[42] PT ECP1 Box 19 Thomas to W.H. Drew 25th November 1903; Thomas to J. Court 5th November 1903; Thomas to F. Wethered 3rd December 1903; Box 21 Thomas to Haldane 29th October 1902.
[43] PT ECP1 Box 19 Thomas to W.H. Drew 25th November 1903; ECP1 Box 19 R. Arthur Thomas to J. Court 5th November 1903.
[44] Court, *Miners' Diseases* p.86.

and illustrated his 1903 address to the Miner's Federation (the collier's trade union) with photographs taken at Dolcoath.[45]

Arthur Thomas was crucial in the extraction of knowledge from Dolcoath and its movement to Oxford and London, collecting and interpreting a considerable volume of samples which he forwarded on to scientists (Table 7.4).[46] These samples were a mixture of blood films and faecal samples containing eggs and larvae, and were used by Haldane and Boycott to generate a variety of hypotheses about hookworm (see below). Arthur Thomas became particularly skilled in searching faecal samples microscopically for hookworm eggs and larvae.[47] He wrote in 1903 that he had 'examined some half dozen cases all of which had an enormous number of ova…'[48] He became known as such an expert on hookworm that individuals who suspected themselves to be infected came to him for diagnosis. He did not find J. Ridley, recently returned from India, to be infected, but did despatch William Heather and James Lowdon to their doctor with a note explaining their condition and directing treatment.[49] Others he sent to his brother, J. Telfer Thomas, Medical Officer of Health for Camborne, and often re-examined after treatment.[50] Similarly, Arthur Thomas found Ed Peters still infected after one round of treatment, and wrote to Peters' doctor 'saying he had better be treated again'.[51]

Table 7.4: Miners infected with Hookworm from whom Thomas took samples of blood and faeces

Name (? Indicates name unclear in handwritten letter)	Source: PT ECP 1 Box 19 Thomas to…
Capt. Tom Uren	Boycott 6/6/1904
Ed Peters	Boycott 24/6/1904, 4/8/1904
Gailyon (?)	Boycott 3/10/1904
J. Tregona	Boycott 17/5/1904, 5/7/1905; Haldane 17/5/1904
Jacob Smith	Boycott 4/8/1904

[45]Court, *Miners' Diseases*; PT ECP1 Box 19 R. Arthur Thomas to J. Court 5th November 1903.
[46] PT ECP1 Box 19 Thomas to Haldane 10th July 1905; 23rd May 1905 Box 28 Thomas to Mrs Haldane 7th August 1912.
[47] PT ECP 1 Box 19 Thomas to Boycott 18th November 1903.
[48] PT ECP 1 Box 19 Thomas to Haldane 20th November 1903.
[49] PT ECP 1 Box 19 Thomas to J. Ridley 5th July 1905; to Boycott 5th July 1905; to Dr Gardiner, 10th December 1903.
[50] PT ECP1 Box 19 Thomas to Haldane 5th July 1903; Box 28 Thomas to Haldane 17th June 1910.
[51] PT ECP1 Box 19 Thomas to Boycott, 4th August 1904.

James Elliott	Haldane 15/5/1904; Boycott 17/05/1904
James Lowdon	Gardiner 10/12/1903
Joseph Rowe	Boycott 17/5/1904, 6/6/1904
Leavons (?)	Boycott 28/11/1903
Mayne	Boycott 28/11/1903
Pengilly	Boycott 5/7/1907; Haldane 5/7/1903
R.J. Curnow	Boycott 22/2/1904
William Heather	Gardiner 10/12/1903

At the end of the 19th and into the 20th century, Cornwall's emerging tourist industry began to depict Cornwall as an 'English Riviera', offering the sunshine and exoticness of foreign travel without any need to leave England.[52] Chris Thomas has termed this the 'domestic exotic', defining Cornwall as foreign but not distant, un-English but safely British.[53] In an odd parallel, Cornwall briefly became around the same time a place within England to which scientists could easily travel to learn about a tropical disease. Cornwall – and Dolcoath in particular – allowed Boycott to participate in the rapidly advancing field of hookworm research pioneered by scientists in Egypt, Costa Rico, Brazil, Italy and Puerto Rico without leaving Britain.[54] This applied not only to hookworm, but also to miners' phthisis.[55]

Arthur Thomas played a key role in facilitating research and knowledge circulation. For instance, he invited Court to his house and dine with himself and Haldane.[56] He made arrangements in advance of scientific visits, on one occasion asking Haldane 'Would you like to ask my brother to get some cases together for when you come down?'[57] When contacted by a Vaughan Bateson requesting samples for use in a lecture, Thomas replied that he could not provide any 'ankylostoma', as 'the ova do not keep on

[52] Harris, 'Building Regional Identity' pp.254-277.
[53] C. Thomas, 'See Your Own Country First: the geography of a railway landscape' in Westland (eds.) *Cornwall: The Cultural Construction of a Place* (Penzance: Patten Press, 1997) pp.107-129; c.f. Deacon, *Industrial Celts* p.232.
[54] For an overview of early research into hookworm see Palmer, *Launching Global Health* Ch.1.
[55] T. Oliver, *The Health of the Workers* (London: Faber and Guyer, 1925) pp.94-96; PT ECP 1 Box 19 Thomas to Haldane 26th May 1904.
[56] PT ECP 1 Box 19 Thomas to Court 5th November 1903.
[57] PT ECP 1 Box 21 Thomas to Haldane 18th February 1903 c.f. Box 28 Thomas to Haldane 7th April 1908.

microscopic slides', but that he would 'endeavor [sic] to get you some faeces…I may possibly be able to get a few of the worms', and offering to procure magic lantern slides.[58] He sent Frank Wethered 'some faeces of a man suffering from this disease, which…you will find fruitful in ova'.[59]

The samples which Arthur Thomas took from Dolcoath and the miners he employed allowed him, Haldane and Boycott to create new knowledge about hookworm. The physiologist Haldane principally focused on mine gases and ventilation, and collaborated closely with Arthur Thomas, a skilled engineer, in redesigning the rock drill to damp down the dust which killed so many miners.[60] Boycott searched for hookworm in various mines (see below) and used blood samples from hundreds of miners, some collected by Arthur Thomas, in an effort to create a blood test for hookworm infection.[61] He believed himself to have been successful in this, arguing that the pronounced eosinophilia (relative excess of white (immune) blood cells which bind to eosin dye) he observed was diagnostic of infection with hookworm.[62]

Boycott was further able to use Cornish hookworms provided by Arthur Thomas to demonstrate percutaneous infection. In April 1905, having previously failed to infect himself, he succeeded in infecting Dr J.B. Leathes using 'a small quantity of water containing encapsuled [L3] larvae of *A. duodenale,* hatched artificially from infected faeces from Cornwall, and 13 days old'.[63] Percutaneous infection had been reported by Arthur Looss in Egypt in 1898, and subsequently demonstrated by several scientists around the world, but Boycott's experiments contributed to a growing scientific

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[58] PT ECP1 Box 19 Thomas to V. Bateson, 9th November 1904.
[59] PT ECP 1 Box 19 Thomas to F. Wethered 3rd December 1903.
[60] PT ECP Box 21 Thomas to Haldane 18th February 1903; 15th June 1903; 19th June 1903; 26th June 1903; to Martin 12th June 1903; Box 19 Thomas to Haldane 6th June 1904.
[61] Haldane &. Boycott 'Ankylostomiasis No.II' pp.73-111, 'The Progress of Ankylostomiasis in Cornwall' *J Hyg* 9/3 (1909) pp.264-270;Boycott *The Milroy Lectures*; 'Further Observations on the Diagnosis of Ankylostoma Infection with Special Reference to the Examination of the Blood' *J Hyg* 4/4 (1904).
[62] Ibid.
[63] A.E. Boycott, 'A Case of Skin Infection with Ankylostoma' *J Hyg* 5/3 (1905) pp.280-284. Thomas had sent Boycott many faecal samples over the autumn of 1904, see Table 7.2.

consensus that both percutaneous and oral infection with hookworm were possible.[64]

Ironically, Boycott's scientific approach initially failed to locate relevant knowledge about percutaneous infection. He recalled:

> The Cornish miners knew long ago that the agent which lived in Dalcoath [sic] Mine, and ultimately led to anaemia, was also the cause of their skin troubles; they were perfectly clear that "bunches" preceded shortness of breath and that the two had some etiological connexion, and produced cogent topographical evidence that one did not occur without the other. I am free to confess that for my own part, having failed to infect myself through the skin, I neglected their epidemiological evidence…But evidently they knew more about it than I did…[65]

Arthur Thomas transmitted information about hookworm and miners' phthisis across Cornwall and the Cornish diaspora. In 1903 he discussed hookworm with Captain Richards of East Pool (who had himself contracted hookworm), and in 1905 advised E. Taylor on how to deal with 'cases of ankylostomiasis among your [Taylor's] employees'.[66] He also liaised with Haldane to equip possibly the same Captain Richards of Crofty, due to sail for Bolivia, with 'the necessary equipment' for haemoglobin measurements while he was abroad; and fielded 'enquiries from America and elsewhere' regarding hookworm and miner's phthisis.[67] The chairman of the Transvaal Phthisis Commission visited and discussed rock drilling with Thomas in 1906, leaving with a letter of introduction to Haldane and an intention to take 'apparatus' back to South Africa.[68] Thomas additionally forwarded on copies of Boycott's papers on hookworm to his contacts overseas.[69]

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[64] Ibid; P. R. Chapman et al., 'Experimental human hookworm infection: a narrative historical review', *PLoS Negl Trop Dis* 15/12 (2021) pp.e0009908.
[65] A.E. Boycott, *The Milroy Lectures: on ankylostoma infection delivered before the Royal College of Physicians of London on March 2, 7, and 9, 1911* (London: Lancet, 1911) via Wellcome Collection, https://wellcomecollection.org/works/h95zje3a [7th October 2024] p.8.
[66] PT ECP 1 Box 19 Thomas to E. Taylor 13th April 1904; Thomas to Haldane 5th July 1903.
[67] PT ECP 1 Box 19 Thomas to Haldane 20th October 1904; Thomas to Boycott 18th October 1904; Thomas to C. McDermaid 18th October 1904.
[68] PT ECP2 Box 19 Thomas to Haldane 5th December 1906.
[69] PT ECP 1 Box 19 Thomas to Boycott 18th October 1904.

Knowledge extracted at Dolcoath also informed hookworm campaigns and knowledge extraction in the colonial periphery. In 1914, Haldane, who knew little about hookworm prior to visiting Dolcoath, advised the Colonial Office on their 'Instructions to the Medical Officers in Charge' of hookworm campaigns, urging an addition stating that 'the Medical Officer will be expected to add if possible, to existing knowledge of Ankylostomiasis + the means by which it is spread'.[70] Patrick Manson, whom Haldane had consulted regarding hookworm in 1902, in 1905 received from the Colonial Office a report into hookworm in Grenada, which he described as 'careful work into a class of disease until recently completely ignored in the West Indies' and advising that the author, a Dr Leonard, expand his research to 'the helminthological problems that the West Indies present', including schistosomiasis and lymphatic filiariasis as well as the question of which species of hookworm were present in Grenada.[71]

In 1920 Robert Leiper of the London School of Tropical Medicine visited Cornwall.[72] He tested miners for hookworm, and 'showed a propaganda film on hookworm disease, prepared by the International Health Board of the Rockefeller Foundation'.[73] Leiper, Lise Wilkinson demonstrates, had met Rockefeller director Wickliffe Rose alongside hookworm expert Fleming Sandwith (who had previously worked with Looss in Egypt) during Rose's mission to London in 1913, forging an enduring 'hookworm connection' between the London School and the Rockefeller Foundation.[74] Leiper was later instrumental in securing Rockefeller funding for a new institute of hygiene which transformed Manson's London School of Tropical Medicine into today's London School of Hygiene and Tropical Medicine.[75]

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[70] UK National Archives (Kew) [henceforth NA] CO/323/648 Haldane to Colonial Office 29th May 1914.
[71] Ibid.
[72] Anon, 'Hookworm in Cornwall', *BMJ* 1/3193 (1922) p.406.
[73] Ibid.
[74] L. Wilkinson, 'Burgeoning Visions of Global Public Health: The Rockefeller Foundation, The London School of Hygiene and Tropical Medicine, and the 'Hookworm Connection'', *Stud Hist Phil Biol & Biomed Sci* 31/1 (2000) pp.397-407.
[75] Ibid., Farley, *To Cast Out Disease* pp.216-220.

Like the Caribbean, Cornwall became drawn into the world of tropical medical research as a research destination; a medical domestic exotic, where scientists could study a tropical disease without visiting the tropics.

A Miners' Disease

While hookworm was viewed by scientists as a tropical disease, it quickly became defined by those concerned with mines as a miners' disease. This drew from the precedents of similar outbreaks in the St Gotthard Tunnel (Switzerland) and elsewhere in Europe, but the Cornwall outbreak brought the British mining industries' attention to hookworm.[76] As early as 1903 Clement le Neve Foster claimed that

> it may fairly be called an occupational disease among miners in northern countries, because in our climate the conditions necessary for the hatching of the eggs, the development, and the spreading about of the larvae, would rarely exist above ground. As a matter of fact, the wives and children of miners in Europe are not attacked.[77]

Following the Dolcoath outbreak, hookworm disease appeared in mining textbooks as a miners' disease which mine managers ought to know how to mitigate (Table 7.5). T.H. Cockin, for instance, covered hookworm along with phthisis and nystagmus under the heading 'Diseases to which Miners are liable'.[78] Newspapers based in the mining districts of Cornwall were also quick to situate the new disease at Dolcoath, and define it as a miners' ailment.[79] Newspapers in mining areas of the Midlands also noted the 'New Mining Danger'.[80]

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[76] I. Löwy, "Intervenir et représenter': Campagnes sanitaires et élaboration des cartographies de l'ankylostomiase', *History and Philosophy of the Life Sciences* 25/3 (2003) pp.337-362; Ettling, *The Germ of Laziness* pp.25-27.
[77] C. le Neve Foster, *The Elements of Mining and Quarrying* (3rd edn) (London: Griffin, 1903) p.285.
[78] T.H. Cockin, *An Elementary Class-Book of Practical Coal Mining* (5th edn) (London: Crosby Lockwood & Sons, 1915).
[79] *Cornish Post and Mining News* 20th November 1902 p.4; *The Cornishman* 20th November 1902 p.5, 22nd January 1903 p.6; *Devon and Exeter Gazette* 16th January 1903 p.2, 3rd March 1903 p7; PT ECP1 Box 20 Newspaper Clippings.
[80] *Nottingham Evening Post* 15th January 1903 p.6; *Sheffield Daily Telegraph* 16th January 1903 p.6.

Table 7.5: Textbooks of Mining in the Camborne School of Mines library which discuss ankylostomiasis as a problem in mines

Year	Author	Title	Publication
1903	C. le Neve Foster	*The Elements of Mining and Quarrying*	London: Charles Griffin & Co. (3rd edn)
1909	Joseph Parker	*An Introductory Course in Mining Science*[a]	Edinburgh: Oliver and Boyd.
1910	C. le Neve Foster, revised by S. Herbert Cox	*A Treatise on Ore and Stone Mining*	London: Charles Griffin & Co. (7th edn)
1915	T.H. Cockin	*An Elementary Class-Book of Practical Coal Mining*	London: Crosby Lockwood & Sons (5th edn)
1916	George J. Young	*Elements of Mining*	New York: McGraw-Hill (1st edn)
1919	C. le Neve Foster	*The Elements of Mining and Quarrying*	London: Charles Griffin & Co. (4th edn)
1924	M.H. Haddock	*Mine Ventilation and Ventilators*	London: Charles Griffin & Co.
1927	Robert Peele (ed.)	*Mining Engineers' Handbook*	New York: John Wiley & Sons
1927	David Penman & J.S. Penman	*The Principles and Practice of Mine Ventilation*	London: Charles Griffin & Co.
1941	Robert Peele (ed.)	*Mining Engineers' Handbook* Vol. II[b]	New York: John Wiley & Sons (3rd edn)
1946	George J. Young	*Elements of Mining*	New York: McGraw-Hill (4th edn)
1950	Frederick Danvers Power	*Pocket-book for Miners and Metallurgists*	London: Isaac Pitman & Sons (5th edn)
[a]In the National Coal Mining Museum for England Library [b]The 1st edition is a single, massive volume. The 3rd edition was split into two volumes.			

In August 1903 Arthur Thomas was invited, based on his newfound expertise in hookworm and miner's phthisis, 'to write a paper on Diseases Incidental to Mining'.[81] Court addressed the annual meeting of the Miners' Federation on hookworm (which he called 'miner's worm disease') on the 8th October 1903.[82] A month later, the *Colliery Guardian* published *Ankylostomiasis: Its Cause, Treatment and Prevention,* which also outlined

[81] PT ECP 1 Box 21 Thomas to McDermid 13th August 1903.
[82] Court, *Miners' Diseases.*

the history of hookworm outbreaks in other European countries.[83] Those concerned with mines recognised hookworm as a mine-specific threat, and knowledge about it spread along mining networks.

The fact that hookworm was defined as a miners' disease is also attested to by the surface authorities' lack of interest. No mention of ankylostomiasis or hookworm can be found in the minutes of the Camborne or Redruth Local Boards of Health, the minutes of the Sanitary Committee of Redruth Urban District Council, nor the report books of the Sanitary Inspector of Camborne Urban District Council.[84] Mine safety, and consequently miners' diseases, were the province of the Mining Inspectorate. Hookworm served a political role in the Caribbean that it did not serve in Cornwall. In the Caribbean hookworm formed the justification for the development of public health infrastructure and the extension of state control into the sanitary arrangements of householders.[85] Sanitary Inspectors and 'Sanitary Forces' were appointed across the British Caribbean in response to hookworm.[86] St Vincent appears to have imported a Sanitary Inspector from Sedgefield in 1914 as part of its hookworm campaign.[87] In Jamaica, Rockefeller personnel lobbied for the hiring of additional health officers and the adoption of standardised sanitary regulations by the Parochial Boards.[88] In Cornwall, by contrast, the state in the form of the District Council and Sanitary Inspector

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[83] *Ankylostomiasis: Its Cause, Treatment and Prevention*, Supplement to the *Colliery Guardian* (London: 6th November 1903) via Wellcome Collection https://wellcomecollection.org/works/bq56paga [11th October 2024].
[84] Kresen Kernow [henceforth KK] DCCR/748-750 Report books, Sanitary Inspector, Camborne Urban District Council (1895-1908); DCCR/621 Minutes, Camborne Local Board of Health and Urban District Council (1893-1897); DCCR/92 Minutes, Redruth Local Board of Health; DCCR/623 Sanitary Committee draft minutes, Redruth Urban District Council (1901-1915).
[85] A.-E. Birn and A. Solórzano, 'Public health policy paradoxes: science and politics in the Rockefeller Foundation's hookworm campaign in Mexico in the 1920s', *Social Science and Medicine* 49(1999) pp.1197-1213; Palmer *Launching Global Health.*
[86] NA CO/321/307 'St Vincent: Hookworm Disease, Relief + Control' Disp.44065 (1919); R. Pemberton, 'A Different Intervention: The International Health Commission/Board, Health, Sanitation in the British Caribbean, 1914–1930', *Caribbean Quarterly* 49/4 (2003) pp.87-103.
[87] NA CO/321/279 'St Vincent: Sanitary Inspector' Disp.9967 (1914).
[88] NA CO/141/88 'Report of the Jamaica Hookworm Commission for 1924', Sup. *Jam. Gaz.* 48:7 (23rd Apr. 1925); NA CO/137/742 B.E. Washburn to Dr Hunt (Superintending Medical Officer) 6th Sept. 1920; CO/137/711 H.H. Howard to Colonial Secretary, Feb 8th 1915.

was already using their existing legal powers to compel householders and landlords to provide or improve privies.[89]

A Foreign Enemy: Concerns about Coal

There was considerable anxiety amongst those concerned with mining about hookworm spreading to the collieries. This often focused on the figure of the healthy 'carrier', whom Boycott claimed 'is in many ways a more important person than the sick man'.[90] Despite the fact that hookworm was introduced to Britain by Cornishmen, this carrier was typically identified as a foreign worker, drawing from existing xenophobia and hookworm's status as a tropical disease to make hookworm a foreign enemy of British industry. Court, for instance, (ironically drawing upon German precedents) insisted upon 'the importance of preventing any foreigner from going into an English colliery until he has been certified to be free from the ankylostoma parasite'.[91] Arthur Thomas similarly felt that mines would have to screen workers before sending them underground 'to protect themselves' from compensation claims if the disease spread.[92] As early as 1898 Foster had drawn the attention of the government to outbreaks in continental Europe, leading newspapers in mining areas to fear that 'it may be introduced here by foreign work-men'.[93] However, hookworm had already been introduced to Cornwall by British miners.

Catherine Mills suggests that this anxiety surrounding the coalfields was partly because coal, unlike tin, was considered an important strategic resource by the imperial government, powering as it did railways, shipping, industry, and the Royal Navy.[94] Coal was particularly important at a time when international tensions and imperial anxiety were rising as a naval arms race with Germany (another major coal producer) accelerated and Britain

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[89] KK DCCR/621 Minutes, Redruth Urban District Council Sanitary Commission (1906-1928); DCCR/6 Minutes, Camborne Local Board of Health and Urban District Council; DCCR/748-750 Report book, Sanitary Inspector, Camborne Urban District Council.
[90] Boycott, *Milroy Lectures* p.4.
[91] Court, *Miners' Diseases* p.74.
[92] PT ECP 1 Box 19 Thomas to Haldane 5th December 1906.
[93] *Sheffield and Rotherham Independent* 12th April 1900 p.6; *Glasgow Herald* 17th April 1900 p.7.
[94] Mills, *Regulating Health and Safety* p.178.

fought a bloody war in South Africa.[95] This may explain why Haldane reported on 'Ankylostomiasis in Westphalian Collieries' for the Home Office in 1903 and Cecil Hertslet reported for the Foreign Office on 'precautions taken to combat ankylostomiasis' in Belgium in 1907.[96]

Nor were concerns about hookworm spreading through Britain confined to the government: delegates at Court's address to the Miners' Federation in 1903 had asked several questions about the risks of hookworm spreading to other mining areas of Britain, such as South Wales, the Scottish Collieries and Derbyshire.[97] Cockin, in his 1915 *Class-book of Practical Coal-Mining*, referring to outbreaks in Westphalia, insisted that 'all collieries should be provided with portable sanitary appliances, placed in convenient places underground, and their use insisted upon'.[98] Joseph Parker likewise claimed in 1909 that hookworm presented a 'Danger to our Coal-fields'.[99] Upon learning about hookworm via Haldane in 1902, Court 'immediately wrote 250 letters to doctors residing amongst the coal miners of South Yorkshire, Derbyshire and Nottinghamshire' alerting them to the disease.[100]

Implementation of hookworm screening, alongside additional sanitation measures, was proposed by Benjamin Pickard MP of the Miners' Federation at a meeting organised by the Home Secretary in November 1903, but no new rules were agreed upon.[101] Before this meeting, representatives of the Mining Association (the employers' organisation) expressed concern about the cost of hookworm prevention, perhaps explaining the lack of action.[102]

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[95] See for instance M. MacMillan, *The War that Ended Peace: How Europe Abandonded Peace for the First World War* (Croydon: Profile, 2013). ch.5, pp.100-130; J. C. Mitcham, *Race and Imperial Defense in the British World, 1870-1914* (Cambridge: Cambridge University Press, 2016). ch.6, pp.129-156.
[96] C. Hertslet, *Belgium: Diplomatic and Consular Report: report on the precautions taken to combat ankylostomiasis (miners' worm disease) in Belgium* (London: Foreign Office, February 1907); J.S Haldane, *Report to the Secretary of State for the Home Department on Ankylostomiasis in Westphalian Collieries* (London: Home Office, 1903).
[97] Court, *Miners' Diseases* pp.91-4.
[98] Cockin, *Elementary Class-Book* p.407.
[99] Parker, *Introductory Course* p.156.
[100] Court, *Miners' Diseases* p.88.
[101] National Coal Mining Museum for England Library [henceforth NCM] Mining Association of Great Britain [henceforth MAGB] 'Ankylostomiasis: Minutes of Proceedings' (1903).
[102] NCM MAGB Minutes of Executive Council 21st October 1903.

The British Association for the Advancement of Science investigated the possibility of hookworm 'becoming a permanent inhabitant of our coalmines'; their interim report triggered the Mining Association to internally revive the prospect of screening in 1904, though their executive committee, loath to involve the government, deferred the matter once again.[103] The same year, sanitary improvements appear to have been carried out in South Yorkshire, and meetings between workers, owners and government inspectors held in Lancashire and Cheshire and elsewhere, but no national action against hookworm materialised.[104]

Hookworm never did establish in British collieries.[105] Mills suggests British collieries, unlike continental ones, were too cool and dry for hookworm, and that colliers generally defecated in areas which were soon to be collapsed, reducing the risk of hookworm infection further.[106] Watering coal mines to prevent coal-dust explosions had preceded epidemics of hookworm in Germany; the practice was not adopted in Britain.[107] Boycott similarly noted that metal mining was a slower process than coal mining, meaning that contaminated ground was occupied for a greater period of time, facilitating infection cycles.[108]

The mining industry feared introduction of hookworm to mines from the outside. They saw hookworm as a foreign invader threatening British mines and British industry. Newspapers dubbed it 'A Foreign Enemy' and 'A Tropical Parasite'.[109] The tropical nature of hookworm was frequently invoked, alongside its presence in Egypt and Brazil.[110] Court similarly reassured 'A Scotch Delegate' that

> The disease could not be developed in a British mine unless the germs were brought there by somebody infected. The worms

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[103] NCM MAGB Minutes of Executive Council 13th December 1904.
[104] NCM MAGB Minutes of Executive Council 23rd March 1904; ditto 9th February 1904; 24th March 1904.
[105] Oliver, *Health of the Workers* p.96.
[106] Mills, *Regulating Health and Safety* p.178.
[107] E.g. Colliery Guardian, *Ankylostomiasis* p.12.
[108] Boycott, *Milroy Lectures* p.43.
[109] PT ECP1 Box 20, Newspaper Clippings.
[110] E.g. *The Cornishman* 22nd January 1903 p.6 & 20th November 1902; *Cornish Post and Mining News* 20th November 1902 p.4; *Devon and Exeter Gazette* 16th January 1903 p.2 & 3rd March 1903 p7.

> themselves were natives of the tropics, and did not exist in Great Britain.[111]

The Tropicality of Dolcoath Anaemia

Hookworm was a tropical disease which was also a miners' disease. This had the odd effect of defining mines as tropical zones within Europe. Boycott, for instance, explained the prevalence of intestinal worms in general, including hookworm but also *Ascaris, Trichuris* and *Strongyloides,* with reference to 'the tropical temperatures which obtain underground' as well as 'the filthy conditions which prevailed underground'.[112] As Warwick Anderson has demonstrated, colonised populations in the tropics were defined by colonisers in terms of their (perceived lack of) sanitary habits.[113] The discovery of this tropical disease in mines therefore defined miners as tropical both in the temperatures they lived in, and in their perceived filthiness. The improvement of conditions in the mines therefore absorbed the rhetoric of a civilising mission. Boycott reported:

> …the whole of the mines were more or less offensive…the hands and arms become covered with mud and filth which has been carried on to the ladders on the men's boots…In 1904 sanitary appliances were introduced into Dolcoath mine in the form of loose pails…After some turbulence on the part of the less responsible workmen their use became habitual….[114]

This language would not look out of place in a colonial medical officer's report. Camborne's Medical Officer of Health and brother of Arthur Thomas, Telfer Thomas, in 1904 complained that

> if the miners will only loyally conform to the rule, there is no reason why the cause of the disease should not be quite successfully dealt with and the disease itself ultimately stamped out.[115]

His brother took a similar view:

> Anyone now contracting this disease does so as a result of the men not using provisions made for them, and although the Mines urge the

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[111] Court, *Miners' Diseases* p.94.
[112] Boycott, *Milroy Lectures* p.41.
[113] W. Anderson, *Colonial Pathologies: American Tropical Medicine, Race, and Hygiene in the Philippines* (London: Duke University Press, 2006).
[114] Boycott, *Milroy Lectures* p.42.
[115] KK DCCR/756 Telfer Thomas, 'Annual Report of the Medical Officer of Health for the Urban Sanitary District of Camborne for the Year 1904'.

> men to carry out the law relating thereto, occasional laxity is met with.[116]

Resistance of miners to 'the rule' enforcing the use of 'sanitary conveniences' was assumed to be reckless, lazy and irrational – a similar situation to that in the tropics. Mills has discussed the resistance of Cornish miners to safety regulations, and argues that the miners' status as independent contractors and their consequently individualist culture, lack of supervision and workplace freedom created a relaxed approach to risk.[117] She argues that 'acts of bravado and daring demonstrated mining prowess and maintained notions of self-image', making the miners resistant to imposed change from the outside as well as to taking safety precautions.[118] Bernard Deacon has similarly noted in 19th-century industrial Cornish identity an emphasis on self-identified 'independence'.[119] Roger Burt and Sandra Kippen have argued in the context of mid-19th century Cornish miners that good pay compensated adequately for a dangerous profession; perhaps anaemia was considered to be merely a risk of the job.[120] 'Tributing' miners, paid by the amount of ore they raised, or else the length of shaft they drove ('tutwork') may also have preferred to take the risk of spreading hookworm rather than lose working time travelling to pails. However, in sharp contrast to workers in the Caribbean, the state did not feel obliged to coerce miners into improving their sanitary behaviour.

Both Cornwall and the Caribbean were extraction zones from which resources were taken to feed manufacturing elsewhere. Cornwall had one industry: mining, an extractive industry. Like the plantation agriculture of the Caribbean, this provided ideal conditions for hookworm. Steven Palmer has described hookworm disease as a disease of 'liminal zones of capitalist

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[116] PT ECP 1 Box 19 Thomas to Haldane 5th December 1906.
[117] C. Mills, 'A Hazardous Bargain: Occupational Risk in Cornish Mining 1875-1914', *Labour History Review* 70/1 (2005).
[118] Ibid.
[119] Deacon, *Industrial Celts* pp.52ff.
[120] R. Burt and S. Kippen, 'Rational Choice and a Lifetime in Metal Mining: Employment Decisions by Nineteenth-Century Cornish Miners', *International Review of Social History* 46(2001) pp.45-75.

expansion'.[121] However, both the West Indies and Cornwall by this stage were declining extraction landscapes neglected by the imperial government.[122] Anna Tsing defines ruins as the spaces left behind after asset production has abandoned them.[123] Here hookworm appears during the transition to ruin status, as the mines and plantations were outcompeted by cheaper methods of production: Malay and Australian tin in the case of Cornwall, and beet sugar in the Caribbean.[124] Hookworm did not only thrive in Palmer's 'liminal zones of capitalist expansion'. The desperate insistence of Arthur Thomas that tin could be made profitable echoes the contemporaneous insistence of planters such as George Muirhead in Jamaica that sugar could be made profitable.[125]

It was the fact that hookworm could only survive in warm, wet conditions which led to it becoming a tropical disease; and it was the fact that it could only survive in a handful of deep, warm wet mines in Europe which led to it being defined as a miners' disease, as will be explored in the following section.

Place and the Agency of Hookworm and Miners

Dolcoath's position at the epicentre of the hookworm outbreak was shaped by a variety of social and environmental factors and by the agency of miners, mine-agents and hookworm itself. The introduction of hookworm to Cornwall was possible because of the migration and actions of miners, which were themselves limited by the failure of mine agents and captains to offer sanitation. The agency of the worm, furthermore, can be seen in its dependence on environmental conditions. In northern Europe the parasite

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[121] Palmer, *Launching Global Health* pp.22-54; J. Lorimer, *The Probiotic Planet: Using Life to Manage Life* (London: University of Minnesota Press, 2020) pp.133-159.
[122] For imperial neglect, see M. Jones, *Public Health in Jamaica, 1850-1940: Neglect, Philanthropy and Development* (Kingston: University of the West Indies, 2013).
[123] A. L. Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015).
[124] P. Bryan, *The Jamaican People 1880-1902: Race, Class and Social Control* (Kingston: University of the West Indies Press, 2000) Ch.1; Barton, *A History of Tin Mining* pp.154-214.
[125] Penrhyn Archives, University of Bangor (Bangor), PFA/5/234 George Muirhead to George McGrath 24th June 1901.

could only establish in deep mines, and in Britain only a handful of Cornish mines seems to have been suitable.

Temperatures of 20-30°C are optimal for hookworm.[126] Even within Cornwall, Dolcoath was unusually deep and therefore unusually hot – Haldane and Boycott give a temperature range of 24-29°C for the bottom of the Engine Shaft – and while several deep mines reached similar temperatures, shallower mines such as West Kitty (as mentioned above) did not (Figure 7.4).[127]

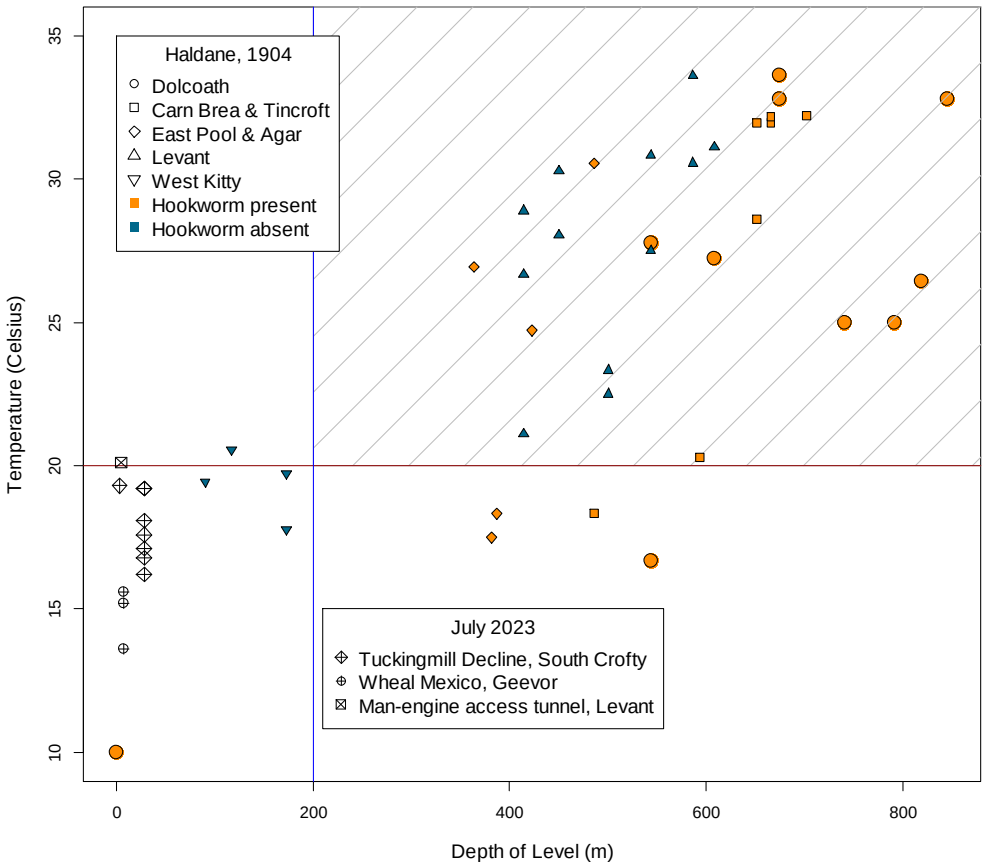

Figure 7.4: Temperatures at depth in Cornish mines, which conditions suitable for hookworm shaded.
Vertical line indicates approximate pre-pumping depth of water in South Crofty, below which mines in Redruth-Camborne were extremely wet. Horizontal line indicates temperature range suitable for hookworm. Points scaled to prevalence of hookworm 1900-1904. Historical data from Haldane, *Report…On the Health of Cornish Miners* (1904), Appendix III.

[126] Mudenda et al., 'Modelling the ecological niche of hookworm in Brazil based on climate'; Brooker et al. 'Human Hookworm Infection'.
[127] A.E. Boycott & J.S Haldane, 'An Outbreak of Ankylostomiasis in England No. 1', pp.95-136.

Cornwall, and Dolcoath specifically, also provided hookworm with unusual levels of moisture. 'In Cornwall', claims Boycott, 'all the mines are more or less wet, but those which have a considerable proportion of dry roads and galleries are among the less heavily infected'.[128] Dolcoath was 'almost everywhere damp'.[129] Court similarly insisted:

> It was due to the heat, and dampness, and insanitary conditions, and bad practices of the men that the Worm Disease was started and developed.
>
> The Dolcoath Tin Mine was 3,000 feet deep, and the temperature always high. It contained a lot of water, and the miners were always exposed to wet and damp…[130]

Deep mines such as Dolcoath and East Pool would have been submerged without the use of steam pumps removing groundwater; these were often a mine's most expensive investment and running cost, and their engine-houses remain a distinctive feature of the Cornish landscape (Figure 7.5).[131] Deacon has even noted the 'iconic status' of these steam engines as symbols of Cornwall.[132]

Hookworm infection has been found in field studies to be associated with more acidic soils, while an experimental study has reported that hookworm eggs survive poorly in alkaline soils and better in acidic soils, with an optimum pH of around 6.[133] Soil samples taken at 50m depth from the Tuckingmill Decline at South Crofty, Camborne in July 2023 were acidic (mean pH=4.5, Standard Deviation ±0.5), demonstrating another way in which the mud of the Redruth-Camborne district was suitable for hookworm.

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[128] Boycott, *Milroy Lectures* p.30.
[129] Haldane & Boycott, 'An Outbreak of Ankylostomiasis' p.102.
[130] Court *Miners' Diseases* pp.87-88.
[131] Barton, *A History of Tin Mining* pp.249-263.
[132] Deacon, *Industrial Celts* pp.124-7&145.
[133] J. K. Udonsi and G. Atata, 'Necator americanus: temperature, pH, light, and larval development, longevity, and desiccation tolerance', *Experimental Parasitology* 62/2 (1987) pp.136-142; M. Anegagrie et al., 'Environmental characteristics around the household and their association with hookworm infection in rural communities from Bahir Dar, Amhara Region, Ethiopia', *PLoS Neglected Tropical Diseases* 15/6 (2021) pp.e0009466.

Figure 7.5: Cornish engine houses
Clockwise from top left: West Basset, Wheal Uny, South Tincroft, Carn Brea, East Pool, Levant and Botallack, 2023. Photographs by the author.

Environmental conditions could also prevent hookworm establishing in a mine. Boycott reports that hookworm never spread to Levant mine, despite poor sanitation and the presence of infected miners who had previously worked at Dolcoath.[134] Levant mine extended beneath the sea (Figure 7.6), which he argued made its soil too saline for hookworm, and reported experiments where hookworm eggs and larvae failed to survive in saltwater,

[134] Boycott, *Milroy Lectures* pp.87-9.

including water from Levant.[135] The soil pH at nearby Wheal Mexico, Geevor, in July 2023 was tolerable for hookworm eggs (mean=6.02, SD±1.15).[136] This supports Boycott's emphasis on the salinity of Levant; he reports water salinities ranging from 0.94% on the landward side to 3.01% in a pump at adit level (mean=2.23, median=2.42, n=7; the adit opened into the sea).[137]

Figure 7.6: Dolcoath (above) and Levant (below) mines, January 2023. Photographs by the author.

Each mine was environmentally and ecologically distinct. Varying depths and geography led to varying temperatures, moisture levels, and soil conditions. As the cases of Dolcoath and Levant show, these differing

[135] Ibid.
[136] Udonsi & Atata '*Necator americanus*' p.139.
[137] Boycott, 'Further Observations' p.450.

conditions (Figure 7.6) influenced the parasites which could survive there. Even nearby mines could host divergent parasite assemblages, as a comparison of Dolcoath and East Pool show (Figure 7.7). In 1902 Dolcoath was dominated by hookworm (which infected over 90% of miners), with *Trichuris* and *Strongyloides* less prevalent. Hookworm was less prevalent at nearby East Pool, perhaps due to slightly colder temperatures (Figure 7.4, Table 7.1), occurring in 17% of Boycott's 1904 samples, 61% of which contained *Trichuris* and 39% *Ascaris* (however, hookworm infected captains Richards and William Trelear at East Pool).[138] Similarly, hookworm was absent from Levant, where *Trichuris* was found in 96% of samples and *Ascaris* 12%. Cornish mines seem to have been particularly suited to parasites: Boycott's 22 samples from Snailbeach (Shropshire) and 28 from 'various' Staffordshire collieries contained no parasites. These are small samples, and Boycott's *ad hoc* method of sampling faeces from the environment leaves much to be desired, but they indicate that different mines could have varying parasite faunas.

[138] PT ECP1 Box 19 Thomas to Haldane 5th July 1903.

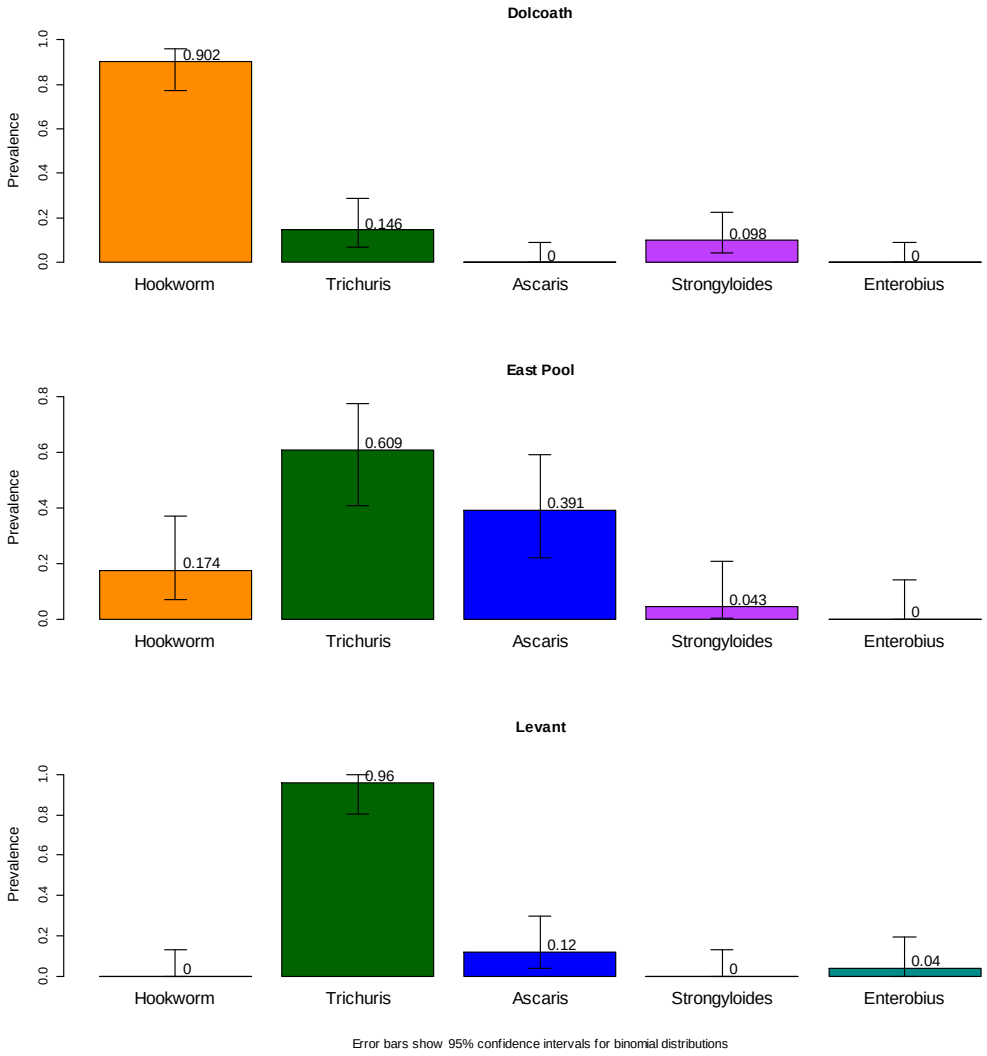

Figure 7.7: Prevalences of intestinal helminths in 41 individuals at Dolcoath and 23 and 25 faecal samples gathered at Levant and East Pool respectively.
Data from Haldane & Boycott, 'An Outbreak of Ankylostomiasis in England No.1' *J Hyg* 3/1 (1903) and Boycott, 'Further Observations on the Diagnosis of Ankylostoma Infection with Special Reference to the Examination of the Blood', *J Hyg* 4/4 (1904).

There is no evidence that hookworm spread to metalliferous mines of other regions; indeed, Boycott's parasite-free samples from Snailbeach suggest the converse. This may be due to the mobility of Cornish miners: it seems to have been unusual for miners from other regions to travel overseas, giving them fewer opportunities to acquire hookworm.

An Unnoticed Extinction: the Extinction of a Disease, and the Extinction of an Industry

The measures taken to eradicate hookworm from Cornwall were somewhat half-hearted. Dolcoath improved ventilation and provided pails for miners to defecate in. In 1905 the Home Office mandated pail provision across Devon

and Cornwall.[139] Dolcoath's pails pale in comparison to efforts in Germany and Belgium: in Westphalia a fifth of the workforce, and all workers at pits known to be infected, were tested for hookworm three times.[140] Privies were improved and showers and portable hospitals installed, and infected workers were quarantined above ground on full sick pay until they tested negative.[141] In Belgium, regular examinations and above-ground quarantine were instituted, alongside government-mandated privies and mandatory notification of cases.[142]

Miners continued to host hookworm for many years after its discovery (see Table 7.1). Infections amongst miners who had not worked at Dolcoath during the original outbreak show continued spread after Haldane's initial intervention. But hookworm is now extinct in Cornwall. It is impossible to be sure what drove this extinction, but it is likely a combination of improvements in sanitation and the closures of the remaining mines: the extinction of Corish mining. The disease and the parasite became extinct at different paces: Dolcoath Anaemia gradually disappeared between 1902 and 1911, while hookworm persisted for several years longer, becoming extinct in Cornwall after 1920.

In 1904, Telfer Thomas reported

> The number of cases of this disease have certainly decreased during the past twelve months, and in those who are affected the disease is being recognised in its early stages and successfully treated, and the very bad cases of extreme Anaemia of a year or two ago are now rarely seen.[143]

The next year he again remarked that 'The number of cases of this disease have certainly markedly decreased'.[144] However, his brother told Haldane the same year that

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[139] Boycott, *Milroy* p.59.
[140] Boycott, *Milroy* pp.50-56.
[141] Ibid.; *Ankylostomiasis: Its Cause, Treatment and Prevention*, Löwy, 'Intervenir et représenter'*;* G. A. Boyd, "Shining temples of health': pithead bath architecture in Britain 1921-1939', *Journal of Architecture* 27/2-3 (2022) pp.176-203.;
[142] *Ankylostomiasis: Its Cause, Treatment and Prevention.*
[143] KK DCCR/756 Telfer Thomas, 'Annual Report of the Medical Officer of Health for the Urban Sanitary District of Camborne for the Year 1904'.
[144] KK DCCR/757 Telfer Thomas, 'Annual Report of the Medical Officer of Health for the Urban Sanitary District of Camborne for the Year 1905'.

> I have had some bad cases in Dolcoath lately but they are all recovering…The men are using the buckets on the whole very well but there are still some isolated cases using any stope convenient to themselves.[145]

In 1906 Telfer had 'little to add to my former report…it has certainly markedly decreased'.[146] Meanwhile Arthur Thomas noted that ankylostomiasis 'is considerably on the decrease, and I rarely find men suffering from it'.[147] By 1907, Telfer reported that

> This disease occasionally makes its appearance but the cases are comparatively few, and are successfully treated in the early stages.[148]

In 1908 his brother told Haldane that 'the infection has diminished in Cornwall, but I still get a few cases cropping up from time to time'.[149] Telfer Thomas further testified to the 1911 Royal Commission on mines that though

> there was still a great deal of lurking infection throughout a great many mines in Cornwall…I rarely now see any pronounced cases.[150]

While hookworm infection persisted, hookworm disease and anaemia were rare. Resistance to sanitary measures had also subsided: Telfer opined that the miners 'are getting more cleanly in their habits, and I think they appreciate the danger of reverting to their old habits'.[151]

Dolcoath Anaemia was disappearing from Cornwall, but hookworm infection was still relatively widespread. As late as 1908, a quarter of miners in Tincroft and Grenville were infected with the parasite (Table 7.1). The new sanitary rules may have reduced transmission, but infection was still widespread.[152] This was partly because parasites persisted for years after the original infection: in 1910 Arthur Thomas encountered a severely ill William Hill, who had not worked underground since 1906, but nevertheless

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[145] PT ECP1 Box 19 Thomas to Haldane 5th July 1905.
[146] KK DCCR/758 Telfer Thomas, 'Annual Report of the Medical Officer of Health for the Urban Sanitary District of Camborne for the Year 1906'.
[147] PT ECP1 Box 19 Thomas to Haldane 5th December 1906.
[148] KK DCCR/759 Telfer Thomas, 'Annual Report of the Medical Officer of Health for the Urban Sanitary District of Camborne for the Year 1907'.
[149] PT ECP 3 Box 28 Thomas to Haldane 7th April 1908.
[150] UK Parliament, *Minutes of Evidence taken before the Royal Commission on Metalliferous Mines and Quarries* vol.II p.659/71.
[151] Ibid.
[152] Haldane & Boycott, 'Progress' p.265.

hosted hookworm, *Ascaris* and *Trichuris* in addition to a parasite whose eggs Arthur Thomas did not recognise but probably correctly suggested was tapeworm (*Taenia*).[153] By 1912 around 10% of miners at South Crofty and Botallack were infected, closer to half at East Pool and 69% at Dolcoath.[154] Hookworm was slowly becoming less common, but was still prevalent.

Hookworm was still present, if less common still, when Robert Leiper tested miners for hookworm disease in 1920 (Table 7.6). Despite finding other parasitic worms 'with considerable frequency', he found only 8 miners (6.1%, n=130) infected with hookworm.[155] By this point, symptomatic cases were rarely reported. How was a situation created where the disease was sliding towards extinction far more rapidly than the parasite itself? Haldane and Boycott are candid:

> Once the nature of the disease was recognised it was, in the great majority of cases, very easy to cure those actually sick by the repeated administration of appropriate anthelmintics: in the case of Dolcoath thymol has been exclusively used. The effects of this treatment have been almost entirely gauged by the clinical results: no serious attempt has been made to ascertain whether all the worms had been killed in any particular case if the man's general condition improved so far that he was able to return to work. Having been restored to a condition of efficiency, therefore, the men returned to work in a place which was still infected. They were of course reinfected again and again; any return of symptoms was noted at once and corrected by a dose of thymol. In this was actual sickness from ankylostomiasis has been practically abolished.[156]

Miners were continuously reinfected, but their burden of worms regulated with thymol (or occasionally male fern) to keep infections subclinical. Asked in 1911 whether he had seen any cases in the last year, Telfer Thomas described treating 'a Dolcoath man who had been previously treated no less than two or three times' who had been reinfected following treatment, only to be treated again, just as Haldane and Boycott describe.[157]

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[153] PT ECPT 1 Box 28 Thomas to Haldane 17th June 1910.
[154] Barton, *A History of Tin Mining* p.244.
[155] *BMJ*, 'Hookworm in Cornwall' p.406.
[156] Haldane & Boycott, 'Progress' p.265.
[157] UK Parliament, *Minutes of Evidence taken before the Royal Commission on Metalliferous Mines and Quarries* vol.II p.659/71.

Table 7.6: Prevalence of hookworm infection in 120 miners, 1920. Data from Leiper, 'Hookworm in Cornwall', *BMJ* 1/3193 (1922) p.406. 95% Confidence Intervals calculated assuming a binomial distribution.

Mine	Prevalence of Hookworm infection
All	6.1% (n=130; 95%CI 3.15-11.7%)
Dolcoath	5.9% (n=34; 95%CI 1.63-19.1%)
'Neighbouring mines'	0% ('not a single case was discovered'; 95%CI 0-2.9%)
East Pool*	27.3% (n=22; 95%CI 13.2-48.2%)
*'a newly worked mine at East Pool, where there had been a breakdown of pumping machinery, so that the sanitary precautions at the time of the investigation were not fully effective'	

A decade later the Rockefeller Foundation discovered that while 'complete eradication' was near-impossible to achieve, 'intensive' control methods could produce an 'approximate eradication', and 'the restoration of health to…severe cases'.[158] The Foundation felt that it had eradicated hookworm disease from the US without eradicating hookworm infection.[159] Similarly, present-day public health workers have come to realise that 'elimination as a public health problem' is an easier-to-reach goal than elimination of a disease or parasite.[160] The method adopted in Cornwall of treating only symptomatic cases offers an intriguing precedent for targeting modern-day anthelmintic treatment to those who show severe symptoms of disease, as has frequently been suggested but rarely implemented.[161]

Dolcoath Anaemia's slow slide towards extinction recalls Thom van Dooren's 'dull edge of extinction', a slow process of unknotting of tangled webs.[162] As Cornish hookworm slid off this dull edge, so too did Cornish mining and the culture which had grown up around it.[163] The second half of the 19th century witnessed the beginning of Cornwall's gradual

[158] H. H. Howard, *The Control of Hookworm Disease by the Intensive Method* (New York: Rockefeller Foundation, 1919) pp.21-25; NA CO/137/742 B.E. Washburn to Dr. Hunt, 6th September 1920.
[159] Ettling, *Germ of Laziness* p.210.
[160] E.g. Farley, *To Cast Out Disease* pp.83-4; R.E. Wiegand et al., 'Defining elimination as a public health problem for schistosomiasis control programmes', *Lancet Global Health* 10/9(2022) pp.e1355-e1359.
[161] Brooker et al., 'Human Hookworm Infection', Loukas et al., 'Hookworm Infection'.
[162] T. van Dooren, *Flight Ways: Life and Loss at the Edge of Extinction* (New York: Columbia University Press, 2014).
[163] See Deacon, *Industrial Celts* Ch.6 for the importance of mining to Cornish identity.

deindustrialisation, which accelerated after the First World War. Dolcoath and Grenville-Tincroft did not survive the 1920s; East Pool closed after the Second World War. Philip Payton also portrays the period as the melancholy end of the 'great migration' and the wandering Cousin Jack's way of life.[164] Payton elsewhere argues that this deindustrialisation drove the emergence of a Celtic Cornish identity in response to the decline of Cornwall's industrial identity.[165]

Dolcoath, already partially flooded, closed in 1920; hookworm can survive in the soil for 5-6 weeks.[166] By the time Dolcoath was purchased by neighbouring South Crofty in 1936 any hookworm in its soils would have been long dead. There is no hookworm in Cornwall today, but it is not possible to trace the last individual hookworm, the last person infected, or when transmission ceased. The extinction of the Cornish hookworm went so unnoticed as to leave no 'endling'.[167] The extinction of the disease predated and prefigured the extinction of the parasite. Dolcoath Anaemia, was nearly extinct by 1907. Cornish hookworm went extinct at some point in the following decades. I do not suggest that Cornish hookworm was some kind of unique subspecies which merited preservation, but an organism does not have to be biologically distinctive to be of a place. The lifeway of Cornish hookworm was uniquely situated within Cornwall.

Dolcoath Anaemia was a disease situated in Dolcoath. It had its own aetiological peculiarities (infection through the hands and arms) and a distinct symptomatology (bunches; difficulty climbing ladders). This configuration of hookworm disease no longer exists; it has become extinct. And with it, a small part the distinct experience peculiar to working at Dolcoath at the end of the 19th century became extinct. The extinction of Cornish hookworm paralleled that of Cornish mining. The endling mines,

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[164] Payton, *Cornish Overseas* Ch.12.
[165] P. Payton, 'Paralysis and Revival: the reconstruction of a Celtic-Catholic Cornwall 1890-1945' in Westland (eds.) *Cornwall: The Cultural Construction of Place* (Penzance: Patten Press, 1997).
[166] Brooker et al., 'Human Hookworm Infection'; Loukas et al., 'Hookworm Infection'; A. O. Shalash et al., 'Hookworm infection: Toward development of safe and effective peptide vaccines', *J Allergy Clin Immunol* 148/6 (2021) pp.1394-1419 e1396.
[167] D. Jørgensen, 'Endling: The Power of the Last in an Extinction-Prone World', *Environmental Philosophy* 14/1 (2017) pp.119-138.

South Crofty and Geevor – one remnant each of the Redruth-Camborne and St Just mining districts – survived until the 1990s, but in the end Cornish mining and Cornish hookworm shared parallel fates.

Chapter 8 Comparisons and General Discussion

This final chapter draws together the findings of the previous chapters, and makes comparisons between the different case studies to explore how hookworm has been shaped by the differing socioecological contexts produced within the uneven capitalist modernity I referred to in Chapter 1. Each chapter has examined different questions within a particular case study – here I integrate my findings, showing how hookworm and attempts to induce its extinction were shaped by social, environmental and political context. Comparing the eradication programmes and the ways hookworm was understood by the people involved in them shows how these were shaped by social and political context, while comparing the epidemiology of hookworm between the case studies demonstrates the ways this was shaped by socioecological context. For instance, the differences in the ways hookworm was conceptualised between Jamaica and the Windward Islands were influenced by the individuals and political coalitions involved in attempts to induce its extinction. Similarly, the unusual epidemiology and ecology of hookworm in Cornwall compared to the Caribbean was created by the particular socioecology of deep tin mining – and also highlights the role of modernity in shaping hookworm's epidemiology across both contexts. Hookworm had a complex and ambivalent relationship with modernity, and this chapter also explains why I have avoided framing this in terms of an 'Anthropocene'. I discuss the differing ways different historical actors have encountered hookworm, and explore the implications of my findings for health, and for understandings of extinction. Before this, however, I briefly summarise my findings.

In Chapter 2, it was discussed how the Jamaica Hookworm Commission (JHC) tried to induce the extinction of hookworm because of its perceived threat to work. Spatial epidemiological analysis, meanwhile, revealed that hookworm was significantly more prevalent in districts with a namesake plantation, districts which were wetter, and districts which were more heavily vegetated, and that hookworm prevalence had a curvilinear relationship with temperature. Despite these associations, however, the burden of hookworms carried varied considerably even between individuals

living together, complicating the suggestion that plantations or socioecological conditions produced hookworm disease, even though plantations do seem to have made hookworm infection more prevalent.

Chapter 3 examined the ways hookworm was experienced and understood in Jamaica. While the colonial elite emphasised profit and productivity, framing hookworm as a threat to work, ordinary Jamaicans were more likely to see hookworm as an obstacle to subsistence. Similarly, while some people were made very ill by hookworm, often describing weariness and drowsiness, others did not notice their infections. Hookworm infected adults more often than children and men more often than women, effects which seem to have been mediated by differential exposure to the parasite's infective stage.

In Chapter 4, the ecological and epistemic relationships between hookworm and *Ascaris lumbricoides* (roundworm) were discussed. Individuals infected with hookworm were at increased risk of infection with *Ascaris* and *Trichuris trichiuria* (whipworm). Unlike hookworm, *Ascaris* was widely known to Jamaicans as the greedy or stomach worm, and *Chenopodium ambrisoides* was used to treat it in folk medicine. This leant credibility to the JHC as they claimed knowledge of a different intestinal worm, credibility which was further enhanced by their use of chenopodium oil as a treatment. Not only did biomedical use of a time-honoured folk remedy encourage trust in the JHC, but expulsions of *Ascaris* following treatment also provided dramatic visual proof of the treatment's effectiveness.

Chapter 5 developed this by discussing hookworm's role as a tool of health education. JHC head Benjamin Washburn envisaged the extinction of hookworm as both a consequence of an advancing hygienic modernity and a means to bring this about, and was adept at recruiting allies across Jamaican society, particularly among its increasingly influential middle classes, who shared his vision of educating and 'improving' Jamaican society. At the same time, Washburn also anticipated that folk medicine would disappear as Jamaica became hygienically modern.

Chapter 6 turned to the Windward Islands Association, discussing the slightly earlier attempts to induce the extinction of hookworm in St Vincent,

Grenada and St Lucia. It was found that in this context hookworm was seen by colonial doctors as a signifier of an uncivilised and backwards environment and people, and hookworm eradication therefore became folded into what Warwick Anderson describes as 'excremental colonialism'. The extinction of hookworm was therefore desired as a signifier of civilisational progress. However, hookworm, by reinfecting previously cured individuals, became instead a symbol of colonial failure, as the colonial state failed to induce its extinction.

Chapter 7 discussed Cornwall, examining an unusual example of hookworm infection in the deep tin mines of the region. It was found that Cornwall as a place shaped the transmission dynamics, ecology, symptoms and clinical presentation of hookworm. The worm arrived via travelling 'Cousin Jacks' returning from the Cornish diaspora, but was only able to spread deep underground in a handful of warm, wet and non-saline mines. First noticed at Dolcoath Mine, hookworm presented as a unique mining-specific set of symptoms known as Dolcoath Anaemia. Once Dolcoath Anaemia was identified as hookworm, Cornwall became a research destination, to which scientists could travel to study a tropical disease without leaving Britain – a medical domestic exotic. Hookworm was also identified by the mining industry as a miners' disease, and it was feared that it might spread to the collieries, though this never occurred. While hookworm infection continued to spread, treatment of symptomatic individuals meant the disease had mostly disappeared by the 1910s. The parasite itself subsequently disappeared at some point after 1920, as the remaining deep mines began to shut down (or improve sanitation), leaving it no suitable conditions for it to spread.

Across all these chapters, I have emphasised the complex interactions between parasites, environments and societies shaping hookworm. The following section will make comparisons between my case studies to discuss these interactions further.

Modernity's Parasite?

In epidemiological terms, hookworm presented a mixture of consistencies and differences between case studies. Chapter 3 demonstrated that in

Jamaica hookworm was more prevalent in adults than children, and Chapter 6 that hookworm in St Lucia followed this same pattern. This age-prevalence profile is typical of hookworm, and arises out of the dynamics of exposure to infective (L3) larvae.[1] In areas where hookworm was endemic, people faced a more-or-less constant risk of exposure to L3. This resulted in rising prevalence through childhood, as children were exposed to more L3 in the environment as they aged. Prevalence then plateaued in adulthood, as people tended to acquire new hookworms at a similar rate as the worms they already had died or were cleared from the body. However, in Cornwall, this effect was exaggerated as children were never infected, as L3 could only survive deep underground in the warm, wet mud of the mines. Only adult miners could enter this industrial environment and become infected. While hookworm shared particular epidemiological traits across contexts, the role of host exposure in producing these characteristics meant that these were noticeably modulated by socioecological context.

Exposure to L3 mediated by working patterns and socioecological context likewise influenced variations in the ways hookworm infection was shaped by gender. As I showed in Chapter 3, in Jamaica, the prevalence of hookworm infection was influenced by interactions of location and gender. Men were more likely than women to be infected, but this risk was modulated by where they lived. This makes perfect sense in light of Chapter 2, where I showed that the prevalence of hookworm infection was influenced by both environment (principally rainfall) and the presence of plantations. While both men and women worked on plantations and in agriculture, which increased their exposure to L3, women were more likely to seek domestic and indoor forms of labour where this was available to them. As Henrice Altink has shown, however, middle-class and light-skinned women had a better chance of securing indoor jobs such as shopkeeping or nursing.[2] In the one district of St Lucia for which data were

[1] See S. Brooker et al., 'Human hookworm infection in the 21st century', *Adv Parasitol* 58(2004) pp.197-288.
[2] H. Altink, *Destined for a Life of Service: Defining African-Jamaican Womanhood, 1865-1938* (Manchester: Manchester University Press, 2011) pp.107-150. Altink demonstrates that nursing and teaching were considered middle-class and required financial support from parents, while open colour discrimination was widespread in shop and domestic service advertisements.

available, however, hookworm was only marginally more prevalent in men (88.4%, n=744) than women (87.6%, n=781).[3] Hookworm was also sometimes discussed in gendered ways – colonial doctors in the Windward Islands, as shown in Chapter 6, attributed infections to the colonised failing to act out what the colonisers considered civilised gender roles.

In Cornwall, the socioecology of mining exaggerated this gendered epidemiology. Hookworm in Cornwall only infected men, as these were the only people legally permitted to work underground (the Mines and Collieries Act 1842 had prohibited women and girls from working underground, and subsequent legislation had banned the employment of boys).[4] Women still worked above ground at mines – in Cornwall they were known as Bal Maidens, and chiefly worked in 'dressing' the ores – but they were not permitted to enter areas where they could be exposed to L3.[5] In this period, furthermore, Bal Maidens were in the process of being replaced by machines overseen by men.[6] The epidemiology of hookworm was shaped by a complex interaction of environment, society, economics and politics.

Across all three contexts, however, experiences of hookworm varied considerably between individuals. Where data are available, as shown in Chapter 2, worm burdens varied widely, and so too therefore did the pathogenicity of hookworm infections. As Chapters 2 and 3 also discussed, some Jamaicans did not seem to particularly notice their infections, while others were severely debilitated through a variety of symptoms. Cornish miners, spending much of their lives in spaces where they were at risk from infection, appear to have suffered particularly severe anaemia. This is suggestive of how Cornish mines and Jamaican plantations, while both spreading hookworm, were different: in Jamaica in this period (in contrast to other times and places), labour was often casual, perhaps limiting the amount of time workers spent in proximity to L3.

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[3] Data contained within NA CO/231/294 'Ankylostomiasis Campaign' (Disp. 10266, 1917).
[4] See C. Mills, *Regulating Health and Safety in the British Mining Industries, 1800-1914* (Farnham: Ashgate, 2010).
[5] L. Mayers, *Bal Maidens: Women and Girls of the Cornwall and Devon Mines* (Cinderford: Blaize Bailey, 2008).
[6] Ibid. pp.10-15,112-4. Mayers notes that the last spalling maidens were dismissed from Dolcoath in 1921.

As Chapter 7 showed, even the symptoms of hookworm were shaped by the environments humans created. In Cornwall, 'Dolcoath Anaemia' was not just a name given to hookworm disease, but denoted a particular set of symptoms arising out of a particular socioecological configuration of hookworm, mines and miners. This was clinically distinctive, characterised by bunches, pale eyes and shortness of breath on climbing ladders. The symptom of bunches seems peculiar to Cornwall, arising from L3 penetrating the muddy arms of the miners rather than their booted feet. Miners were generally pale from lack of sunlight, meaning that Dolcoath Anaemia was recognised – and thereby constituted as a disease-category – by pallor of the eyes rather than the general pallor of anaemia. Likewise, shortness of breath upon exertion is a common symptom of anaemia, but shortness of breath upon climbing ladders specifically became a symptom of Dolcoath Anaemia. Mining delineated a miners' disease. Dolcoath Anaemia is in some ways reminiscent of 'Burdwan Fever' and other epidemics which were defined as of particular places, but is noteworthy in its biological distinctiveness.[7] While colonial doctors, particularly in the British-Indian medical tradition, often created disease-categories which were tied to particular places well after bacteriology had established diseases as unitary entities in Europe, hookworm offers an interesting example of a disease manifesting in clinically different ways in different places.[8] Dolcoath Anaemia was medically and discursively constituted as a miners' disease, while simultaneously being shaped biologically and epidemiologically by the mines.

Hookworm was shaped by context, but shared similarities across contexts and differences within contexts. The ways hookworm was viewed had some commonalities across case studies – in part because of the circulation of knowledge between them – but were also shaped by their particular social and political situation. Across all three case studies hookworm was understood as a threat to work, but this was particularly pronounced in

[7] R. D. Roy, *Malarial Subjects: Empire, Medicine and Nonhumans in British India, 1820-1909* (Cambridge: Cambridge University Press, 2017) pp.120-155.
[8] M. Harrison, 'A Question of Locality': The Identity of Cholera in British India, 1860-1890' in Arnold (eds.) *Warm Climates and Western Medicine* (Leiden: Brill, 1996).

Jamaica, where more elite Jamaicans were anxious to maintain a capitalist plantation production model while elements of the labouring classes – principally the small settlers – sought economic independence and freedom through peasant smallholdings. This focus on work was intensified by an ideological belief on the part of elites (and middle classes) that waged labour was itself good and necessary to civilise Jamaicans. Even *Jamaica Public Health* defined good citizenship in part as the ability to work (Chapter 5). In Cornwall, by contrast, though mine-owners fretted about hookworm and the potential for it to spread to the collieries, and medical scientists gauged the success of treatment by the patient's ability to work, there was notably less anxiety about hookworm diminishing the productivity or availability of labour. This may be connected to the fact that Cornwall in this period contained a surplus of skilled labour.

Likewise, hookworm was considered to arise from backwardness and dirtiness in all contexts, but this was particularly emphasised in the Windward Islands, where the local medical service already viewed the population as dirty and backward, and sought to use hookworm eradication to civilise them. This view of hookworm had echoes in Cornwall, but there hookworm did not serve the same political function as it did in the Caribbean and miners – while still viewed as dirty – did not face such intense pressure to conform. I have, furthermore, explored in Chapter 5 how the particular political circumstances of Jamaica, and the political coalition assembled by the JHC contributed towards hookworm eradication becoming part of a project to modernise the island. In the Windward Islands, there was no such coalition, and the racist contempt of the colonial elites for the 'natives' consequently dominated the way hookworm was discussed. In Cornwall, doctors and mine-agents were certainly paternalistic, even patronising, towards miners, but they did not view them as a racial other, and consequently did not view hookworm as a sign of the need to civilise them.

In many cases, my findings have aligned with that of 20th and 21st-century scientific studies. In certain of its epidemiological characteristics – its overdispersion, age-prevalence profile and relationship with rainfall and temperature – hookworm displays similar traits in 1924 as 2024, even

though it now seems less prevalent (as I will discuss further below). However, by making comparisons across these three different contexts, I have also shown that hookworm's ecology, its transmission dynamics, its meanings and its clinical presentation were contextual, the products of human-shaped environments and societies. Hookworm was even shaped by other animals, as the role of *Ascaris lumbricoides* (discussed in Chapter 4) in influencing transmission dynamics, clinical presentation (multiple infections tending to be more severe) and knowledge of hookworm, shows.

Moreover, the shaping of hookworm has been mediated by colonial and industrial capitalism. In Jamaica, hookworm infection was more prevalent in the proximity of plantations, whether these were the remnants of the sugar industry or the banana farms of the new American conglomerates. As I argued in Chapter 2, plantations played a major role in problematizing hookworm while also facilitating its transmission. In Cornwall, only the deep mines produced by industrial excavation, pneumatic rock drills and coal-fired steam engines produced the environmental conditions which allowed hookworm to thrive while also shaping its bodily and discursive being in distinctive ways.

We might then view hookworm as modernity's parasite. Hookworm became known, as Steven Palmer has demonstrated, in the 'liminal zones of capitalist expansion' towards the end of the 19th century; knowledge of hookworm, that is, only emerged in the modern period, within loci of capitalist modernity.[9] Palmer and Jamie Lorimer have argued that hookworm disease reached epidemic proportions in these liminal zones.[10] Though my research has supported their contention that socio-spatial context is crucial in shaping human-microbial relations, I have complicated this in three particular ways.

Firstly, my case studies show hookworm thriving not just in the places where capitalism is expanding, but in declining extraction zones. Though the plantation economy was starting to revive in early 20th-century Jamaica,

[9] S. P. Palmer, *Launching Global Health: The Caribbean Odyssey of the Rockefeller Foundation* (Ann Arbor: University of Michigan Press, 2010) Ch. 1.
[10] Ibid.; J. Lorimer, *The Probiotic Planet: Using Life to Manage Life* (London: University of Minnesota Press, 2020).

the sugar industry no longer dominated the economy, society and environments of the Caribbean (or indeed the British Empire). Nevertheless, hookworm was widespread, particularly around plantations, which may be due to their reliance on casual labourers who worked in multiple locations. Likewise, the Cornwall of 1900 was beginning to deindustrialise as the mining industry struggled to survive. This enabled the arrival of hookworm by promoting the emergence of a mobile diasporic workforce who moved fluidly across the globe in part because work in Cornwall was comparatively poorly-paid and hard to come by; and also because the mines became deeper – and therefore hotter – as shallower deposits were exhausted. In both cases, hookworm thrived amid the decline of extraction economies. Secondly, I have shown that even people living in the same socio-spatial context could experience hookworm very differently. Whether people experienced hookworm as harmless or as a deadly parasite could be shaped by socioecological context, but there was much individual variation within contexts. As shown in Chapter 2, hookworm was unevenly distributed and people living even in the same building could experience it as either harmless or debilitating. Thirdly, hookworm was widespread across Jamaica and the Windward Islands: plantations were not the only source of hookworm infection, but instead amplified transmission of a parasite which was present even in the most isolated districts.

Moreover, while hookworm thrived in the spaces capitalism created, the same economic and political forces drove efforts to induce its extinction. Its perceived threat to productivity, for instance, helped inspire attempts to eradicate it. Furthermore, though hookworm's abundance was in part attributable to modernity, attempts to induce its extinction were self-consciously modernising. In the Windward Islands, hookworm was seen by the colonial medical service as an embodiment of backwardness, and its extinction was desired as a signifier of colonial and civilisational progress. In Jamaica, Washburn and the JHC saw the extinction of hookworm as both arising from and producing a hygienic modernity; eradicating hookworm was a way of advancing healthy modern ways of living, and modern ways of living would also destroy hookworm.

This ambivalent relationship between hookworm and capitalist modernity has surfaced several times through this thesis, most explicitly in Chapter 2, where I framed it in terms of the relationship between hookworm and plantations. Hookworm thrived in the conditions produced by colonial capitalism but that same economic system and the ideological emphasis on work and productivity it fostered drove attempts to destroy and eradicate it. For me, this relationship symbolises the precariousness of life in the 'Anthropocene'. Hookworm was able to survive and thrive within the environments created by capitalism, but once it was identified as a threat to the system, a range of actors mobilised to kill it.

This ain't an Anthropocene, it's an arms race[11]

Following the popularisation of the term Anthropocene, competing terms aiming to better describe the current moment of human-shaped global environmental change have proliferated, including most notably Capitalocene and Plantationocene.[12] Given my emphasis on the role of humans, capitalism and plantations in shaping hookworm, it might seem odd that I have avoided these terms. However, though my conclusions broadly align with their premises, none of these terms aim to be useful as historical eras; all are attempts to characterise and respond to human-other-than-human relations in the present.

One of the claims of the term Plantationocene, however, is historical: it decentres the industrial Global North in the story of capitalist modernity and environmental change, and emphasises that this was produced by the plantation as well as the factory. Historians have long recognised – at least since Eric Williams' 1944 *Capitalism and Slavery* – that the mill, the mine and the plantation were co-dependent fulcrums of a single economic system.[13] Hookworm thrived in two of these, at least, and its movement

[11] If you don't understand this joke, I firstly congratulate you on missing the mid-2000s and secondly refer you to Fall Out Boy's 2006 hit 'This Ain't a Scene, It's an Arms Race'.
[12] D. Haraway, 'Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin', *Environmental Humanities* 6/159-165 (2015); S. Chao et al., 'The Plantationocene as analytical concept: a forum for dialogue and reflection', *The Journal of Peasant Studies* (2023).
[13] E. Williams, *Capitalism and Slavery* (Chapel Hill: The University of North Carolina Press, 1944).

along commercial and imperial networks – particularly those of the Cornish diaspora – demonstrates the interconnectedness and interdependence of these loci. But while hookworm may seem a perfect emblem of the Plantationocene, I have also shown that even though it was more common in proximity to plantations, it was ubiquitous throughout Jamaica and the Windward Islands. Hookworm was far too cosmopolitan and mobile to be confined to the emblematic loci of capitalist modernity. Dubbing hookworm an animal of the Plantationocene therefore conceals more than it reveals.

Despite my reluctance to deploy either Plantationocene or Anthropocene, my study covers times and geographies where human agency has played a crucial role in shaping the lives of nonhumans, in this case hookworms. This is not particularly surprising – the fact that other species have their own histories which interact and intersect with human histories is the core insight and premise of environmental history. Hookworms, however, do not interact with a singular totalising 'humanity', as the term Anthropocene would imply, but with individual people in whose guts they dwell, and with the societies made up of those individuals. As I have shown, their opportunities to enter said guts are shaped by environmental and social conditions, and particularly those produced by capitalism. Poor working conditions, whether for Cornish miners or Jamaican day-labourers, were good living conditions for hookworm. This likewise disrupts the totalising 'humanity' implied by the term Anthropocene by highlighting that humanity is made up of a huge variety of people with differing and sometimes conflicting interests.

Hookworms require humans to live; they are obligate parasites and cannot grow beyond their third larval stage outside of the human body. This makes them particularly useful in disassembling the human/nature divide. This project of intellectually reconnecting humans and nature is a quintessential Anthropocene project, and one which requires the kind of interdisciplinarity this thesis has attempted. One key insight of this thesis has been that science and history do not work on separate problems or separate kinds of problems; their methods can be used in concert, and doing so produces a more holistic understanding than any discipline would in isolation.

Many people, many hookworms

Interactions between humans and hookworm were not merely a two-way process between only two kinds of beings. In Jamaica, hookworm had both ecological and epistemic relationships with other worms, as well as with the plant *Chenopodium ambrisoides*, as discussed in Chapter 4. Hookworm, being more prevalent in more vegetated districts, was also shaped by the presence of plants surrounding it, as shown in Chapter 2. Similarly, human societies are far from monolithic, and hookworm meant something different to ordinary Jamaican labourers than it meant to the colonial elite, as discussed in Chapter 3. Likewise, the extent to which the Jamaican middle classes allied with the JHC, discussed in Chapter 5, shows that the complex social structures of late-colonial societies could lead to the formation of alliances across the colonised/coloniser divide.

Hookworm was many things to many people. To some ordinary Jamaicans, it was an obstacle to subsistence. To plantation managers, it was an obstacle to productivity. To Washburn it was an 'advance agent of health' and a tool of health education, while in the Windward Islands Stanley Branch and Angus MacDonald saw it as an embodiment of backwardness. In Cornwall, Arthur Boycott and John Scott Haldane saw in it an opportunity to learn more about exotic diseases, while the British mining industry viewed it as a 'foreign enemy' and a 'danger to our coal-fields'.

This multiplicity of meanings and understandings of hookworm is also reflected in the many ways knowledge of hookworm was produced and circulated, which has been another theme running through this thesis. In Cornwall, knowledge about hookworm was produced by both visiting scientists and Richard Arthur Thomas, who mined his employees for blood and faecal samples even as they mined Dolcoath for tin. This knowledge was circulated along a variety of networks: scientific networks, colonial networks, mining networks and Cornish diasporic networks. The knowledge unearthed (pun intended) at Dolcoath also, via Patrick Manson, the Colonial Office, and Robert Leiper, informed hookworm eradication efforts in the Caribbean.

In Jamaica, I demonstrated in Chapter 4 that existing folk knowledge of *Ascaris* made biomedical assertions about hookworm plausible, and likewise that existing use of *C. ambrisoides* to treat *Ascaris* helped make biomedical usage of chenopodium oil acceptable. Simultaneously, Washburn and the JHC embarked on a large-scale project of health education, aiming to spread their knowledge of hygiene. As discussed in Chapter 5, this was embraced by the Jamaican middle classes, in part as an element of a wider project of national modernisation and improvement, while Washburn continued to aim for the elimination of not just hookworm, but also Jamaican folk medicine. The darker side of such health education efforts was more obvious in the Windward Islands, where colonial doctors attempted to browbeat and coerce colonised St Lucians, Grenadians and St Vincentians into what they saw as proper civilised behaviour. The health leaflets authored by MacDonald, and Branch's reports both, as I discussed in Chapter 6, display the way colonial power structures and agendas were reproduced within health efforts.

Another theme which has surfaced at several points within this thesis has been the complexity and multi-layered nature of colonial society in the Caribbean, and the ways this shaped views of hookworm and eradication campaigns in sometimes unexpected ways. This will not be surprising to historians of the region, but it is worth drawing the attention of a scientific or non-specialist reader to the complex role of social structures in influencing health programmes. As discussed in Chapter 6, in the Windward Islands the eradication programmes replicated and reinforced the power dynamics of colonialism, with white doctors attempting to civilise the 'native' population (whose ancestors, in many cases, arrived at much the same time as theirs). However, a closer look at the archives reveals that the colonial bureaucracy and medical service encompassed several individuals who were, to use the Colonial Office's phrase, 'not of European parentage'.[14] Moreover, as I have discussed, even the words of an open racist like Branch illustrate a complex layering of colonial society along

[14] NA CO/321/279 St Vincent: Medical Officer (Disp. 1133, 1915); CO/232/623/70 Grenada: Ankylostomiasis Investigation (Disp. 24659, 1914); CO/321/315 Grenada: Officials Not of European Parentage (Disp. 6230, 1921); CO/321/294 Grenada: Colonial Surgeon (Disp. 18843, 1917).

class, racial and gendered lines, with colonial doctors applying gradations of 'civilisation' to individuals and communities. The identification of hookworm as a product of backwardness brought these complexities to the fore, as Branch and MacDonald in particular sought to explain their encounters with hookworm by way of their perceptions and prejudices regarding the 'degree of civilisation' attained by their patients.

In Jamaica, meanwhile, as I discussed in Chapter 5, the colonial government, an American philanthropy and the colonised middle classes formed a temporary alliance to 'improve' the colony and its people. This was not without tensions, particularly in a period where the middle classes came into conflict with the colonial government over several other health issues, resulting in their increasing dissatisfaction with Crown Colony government, as Darcy Heuring has shown.[15] One particularly interesting tension, as discussed, was the way Washburn sought to supplant Jamaica's own tradition of folk medicine with his own form of biomedical hygiene while also acknowledging the effectiveness of folk medicine. In Chapter 4, I also discussed the role folk medical knowledge played in assisting Washburn's biomedical health intervention and making his treatments credible. Many of those who participated in Washburn's project not only used folk medicine (as most Jamaicans seem to have done), but were persuaded of biomedicine's value through its congruence with folk medical knowledge. Moreover, Washburn had clearly realised this by the 1930s, and sought to exploit it. This assisted him in assembling a slightly amorphous cross-class coalition, incorporating both coloniser and colonised, with very different aims, but a shared interest in improving the health (and more dubiously, the morals) of Jamaicans.

In the next section I will explore what present-day health science can learn from these complex situations about improving health.

Lessons of History

Despite my reservations about the term 'lessons of history', I do think that health workers in the present have much to learn from engaging with

[15] D.H. Heuring, *Health and the Politics of 'Improvement' in British Colonial Jamaica, 1914-1945* (DPhil Thesis: Northwestern University, Illinois, 2011).

historical health and disease control efforts.[16] Within this thesis it has been apparent that Washburn's engagement with Jamaican culture and efforts to recruit allies among influential elements of Jamaican society were far more successful in building up health institutions (e.g. the Bureau of Health Education) and improving health than the ephemeral hookworm campaigns in the Windward Islands. Though it is difficult to say whether the drop in hookworm prevalence in Jamaica shown in Chapter 2 was sustained in the longer term, improvements in medical provision and in life expectancy are, as Margaret Jones and James Riley have shown, observable in this period.[17] As Riley has argued, such improvements in life expectancy in a relatively poor country lacking a socialist or social democratic health system are unusual, and would seem indicate positive impacts arising out of a long-term, multipronged health and health education programme which focused on measures individuals and households could easily and cheaply implement in their own homes.[18] I have additionally shown (in Chapter 5) that the JHC left a number of trained and enthused Jamaican healthworkers behind it, which may have helped remedy the chronic understaffing of the Jamaican medical service discussed by Heuring.[19] The JHC had also produced jobs for these healthworkers to move into, particularly by promoting the appointment of local government sanitary inspectors. By contrast, the short campaigns in the Windward Islands, though they did improve the health of a number of individuals, as discussed in Chapter 6, do not seem to have particularly depressed the prevalence of hookworm, and for this reason were considered a failure at the time. Nor do they seem to have left a legacy of infrastructure or personnel. As I argued in the chapter, the goal of eradication overshadowed the positive impacts the campaign did have, and the view that hookworm was a signifier of backwardness

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[16] J. Roberts, 'Questioning the Lessons of History: In Defence of the Usefulness of Medical History', *Northern Environmental History Network Blog*, https://nehnetwork.wordpress.com/2023/06/16/jon-roberts-questioning-the-lessons-of-history-in-defence-of-the-usefulness-of-medical-history/ [12th August 2024].
[17] J. C. Riley, *Poverty and Life Expectancy: The Jamaica Paradox* (Cambridge: Cambridge University Press, 2005); M. Jones, *Public Health in Jamaica, 1850-1940: Neglect, Philanthropy and Development* (Kingston: University of the West Indies, 2013).
[18] Riley, *Poverty and Life Expectancy* pp.73-113.
[19] Heuring, '*Health and the Politics of 'Improvement'*' Ch.1.

prevented the programme from being sustained long enough to have a more significant impact.

Furthermore, Washburn's alliance- and institution-building, alongside his stories, events and educational articles (Chapter 5), unsurprisingly seem to have been far more successful in persuading people to engage with hookworm than MacDonald's hectoring or Branch's dismissiveness. While Washburn's regular celebrations of the interest and cooperativeness of Jamaicans cannot be taken entirely at face value (he was, after all, reporting his own success), a significant section of Jamaican society, encompassing many individuals who were influential locally or nationally, does seem to have mobilised against hookworm. It is worth recalling that around 99.2% of Jamaicans (where data is available, Chapter 2) chose to cooperate with JHC testing. This contrasts sharply with Branch's complaints about resistance and lack of cooperation from St Lucians and his difficulties in persuading those furthest outside his own social class to cooperate with testing and treatment.

Similarly, the epistemic relationships of *Ascaris, C. ambrisoides* and hookworm in Jamaica discussed in Chapter 4 offer a useful example of how both engaging with non-biomedical knowledge systems can aid biomedical health programmes. The positive responses to *Ascaris* expulsion, like the letters sent to the JHC from patients, also shows how health programmes can gain from providing interventions which benefit their beneficiaries in immediate, tangible and apparent ways.

I have been critical of scientific knowledge extraction and have emphasised the importance and usefulness of non-scientific knowledge systems. Scientific modes of knowledge creation in Cornwall and the Caribbean were, like the industries and economies in which hookworm thrived, extractive, focused on removing samples, data and information to the centres of calculation in London and Oxford where they were fashioned into knowledge.[20] This knowledge, through control programmes and particularly through biomedical health education, often reproduced and reinforced the

[20] The term 'centres of calculation' is of course Bruno Latour's; B. Latour, *Science in action: how to follow scientists and engineers through society* (Cambridge: Harvard University Press, 1987).

power dynamics of colonialism. But this was not always the case, and a variety of peripheral actors became involved in hookworm eradication efforts for their own reasons, and used them to achieve their own ends. As I discussed in Chapter 5, not only did middle-class Jamaicans use the JHC to advance their own project of modernising and improving the island and its people, but less well-to-do Jamaicans, by becoming microscopists, nurses and sanitary inspectors, used it to improve their own social position. And of course, it must be emphasised that co-operating with testing and taking treatments was a conscious choice people made, and a means by which they used government and RF programmes to improve their own health. Likewise, adoption of the healthy ways of living promoted by Washburn was also a strategy individuals consciously chose to follow in order to gain and retain health. And as discussed in Chapter 3, different individuals and sections of society valued health for different reasons.

Despite my criticisms, I remain convinced of the value of science as a mode of knowledge production and of biomedicine as a means of improving health. Indeed, throughout this thesis I have applied scientific approaches with significant success. Nevertheless, from Boycott ignoring the knowledge of miners about the relationship of bunches to anaemia to ordinary Jamaicans teaching Washburn the value of bush teas, it has been apparent that science can learn much from engaging with other knowledge systems. We have much to learn from each other, and scientists should engage with an open mind and in good faith with other knowledge systems.

The experiment of Haldane, Boycott and the Thomases in Cornwall offers an intriguing precedent for how maintaining hookworm burdens at a subclinical level in concert with reducing but not eliminating transmission. This does seem to have significantly improved the health of hookworm-infected miners, though admittedly from a very low base. However, this is an intervention which would perhaps apply poorly to other contexts – it worked because miners possessed a high level of knowledge and awareness of the symptoms of Dolcoath Anaemia in concert with ready access to treatment. This requires an accessible, well-supplied and responsive primary healthcare system which may not exist in areas where hookworm is endemic. Even in 21st-century Britain it is hard to imagine a situation in

which someone could receive a diagnosis from their employer, and then receive treatment either from their general practitioner or a medical officer employed by the local government more or less immediately. The fact that Arthur Thomas was not only well-known locally, but also the brother of the district Medical Officer of Health was significant.

I am sometimes asked whether the eradication of hookworm is a desirable goal of public health policy. It has been suggested that the rise of autoimmune and allergic diseases in many parts of the world is connected to the absence of infections with certain parasites – these 'old friends', the theory goes, help keep human microbiomes and immune systems balanced and regulated.[21] *Necator americanus*, being the smaller and less dangerous hookworm as well as a potent immunomodulator, has been suggested as one such 'old friend'.[22] Hookworms have been trialled with mixed but somewhat promising results as therapeutics for a range of autoimmune and allergic disorders.[23] Consequently, Jamie Lorimer argues that hookworm has become seen in certain circles as a 'keystone species' through which disrupted ('dysbiotic') human microbiomes can be restored.[24] Lorimer develops a relational geography of hookworm as a 'pathobiont', which depending on socioecological and political ecological context, can appear as a parasite, a mutualist or as a ghost.[25] He notes that certain individuals and groups do seem to, by self-infecting with hookworms, have had some success in using them to govern their own bodies and improve their health.[26] However, it is not yet clear whether these benefits can be derived by all or

[21] See Lorimer, *Probiotic Planet* pp.37-47.
[22] Ibid.
[23] A. Loukas et al., 'The yin and yang of human soil-transmitted helminth infections', *Int J Parasitol* 51/13-14 (2021) pp.1243-1253; S. M. Ryan et al., 'Harnessing helminth-driven immunoregulation in the search for novel therapeutic modalities ', *PLoS Pathology* 16/5 (2020) pp.e1008508; J. Croese et al., 'Randomized, Placebo Controlled Trial of Experimental Hookworm Infection for Improving Gluten Tolerance in Celiac Disease ', *Clinical and Translational Gastroenterology* 11/12 (2020) pp.e00274; A. M. Croft et al., 'Helminth therapy (worms) for allergic rhinitis.', *Cochrane Database of Systematic Reviews* 2012/4 (2012); J. R. Feary et al., 'Experimental hookworm infection: a randomized placebo-controlled trial in asthma', *Clinical and Experimental Allergy* 40/(2010) pp.299-306, Loukas et al, 'Hookworm infection'.
[24] Lorimer, *Probiotic Planet* pp.37-47,133-159.
[25] Ibid. pp.133-159.
[26] Ibid. pp.37-47,118-130,187-207.

even most humans; it may be that those who live mutualistically with hookworms are unusual in ways we do not yet understand. Nevertheless, it seems clear (particularly from experimental infections) that a small burden of hookworms is mostly harmless to most people.[27] In that sense, the eradication of hookworm, even if it were feasible, is not necessary to avert human suffering: unlike smallpox or guinea worm, hookworm does not require human pain to reproduce.

In practise, living in harmony with hookworm presents some difficulties: as discussed, hookworms infect unevenly, and even where the average burden is low some individuals will still have dangerously high burdens. Any society with a healthcare system capable of maintaining burdens at asymptomatic levels through treatment, furthermore, will also require in order to prevent more dangerous diseases a sanitation system which is sufficiently developed to preclude the transmission of hookworm entirely. In such a scenario it would be possible for 'domestic' hookworm populations to be maintained as an instrument of bodily governance (Lorimer's 'symbiopolitics'), but how medically useful that would be remains to be seen.

I have shown that the ways parasites live and affect humans is deeply contextual: hookworm disease is not the same in different times and places. Nevertheless, it would be a mistake to assume that parasitism arises solely from particular socioecological configurations and that parasites are otherwise mutualistic or harmless.[28] Socioecological conditions shape parasitism, often promote or reduce transmission and can consequently alleviate or worsen infections. Furthermore, dietary iron deficiency exacerbates hookworm disease, and is a greater contributor to anaemia

[27] P. R. Chapman et al., 'Experimental human hookworm infection: a narrative historical review', *PLoS Negl Trop Dis* 15/12 (2021) pp.e0009908; D. Diemert et al., 'Controlled Human Hookworm Infection: Accelerating Human Hookworm Vaccine Development', *Open Forum Infect Dis* 5/5 (2018) pp.ofy083.; Loukas et al., 'Hookworm infection'; Brooker et al, 'Human Hookworm Infection', Loukas et al. 'The yin and yang'.

[28] Lorimer, *The Probiotic Planet* p.133*;* S. Chao, 'The Beetle or the Bug? Multispecies Politics in a West Papuan Oil Palm Plantation', *American Anthropologist* 123/3 (2021) pp.476-489.

globally.[29] However, even people living side-by-side experienced hookworm very differently; infections have very different consequences for different people. As Sophie Chao has argued, we should not react against anthropocentrism by uncritically assuming all other-than-human organisms to be always good.[30]

One notable difference between my case studies and the present is that hookworm is now far less common. The prevalence of hookworm infection across the Windward Islands and Jamaica in the period I cover, just as the first mass drug administration (MDA) programmes in the areas surveyed were about to commence, was around 60%, even above 90% in some areas. Tikasingh *et al.* have charted the drastic decreases in prevalence of hookworm across the Commonwealth Caribbean over the past century.[31] The most recent studies they review reported prevalences of 5.8% in Grenada, 0% in Jamaica (a slightly earlier study finding 2.2% of Jamaican children infected), 12% in St Lucia and 0.9% in St Vincent.[32] Though the figures for St Lucia are still concerningly high, hookworm has become far less common in the Caribbean over the past century. Though, as discussed in Chapter 2, it was only possible to assess hookworm burdens in three samples in early 20th century Jamaica, it is worth recalling that some of the burdens recorded were also remarkably high, compared to more recent studies.

It seems safe to say that hookworm, while still widespread, is less ubiquitous than it was a century ago. Present-day studies of endemic areas usually find prevalences between 0% and 20%: far lower than the average 60% prevalences I have encountered in the archives.[33] In 1947 Norman Stoll

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[29]Loukas et al., 'Hookworm Infection'; Lancet Global Burden of Disease Anaemia Collaborators, 'Prevalence, years lived with disability, and trends in anaemia burden by severity and cause, 1990–2021: findings from the Global Burden of Disease Study 2021', *Lancet Haematology* 10/9 (2023) pp.E713-E734.
[30] S. Chao, *In the Shadow of the Palms: More-Than-Human Becomings in West Papua* (Durham: Duke University Press, 2022) pp.203-217.
[31] E. S. Tikasingh et al., 'The control of hookworm disease in Commonwealth Caribbean countries', *Acta Tropica* 120 (2011) pp.24-30.
[32] Ibid.
[33] G. T. Leta et al., 'National mapping of soil-transmitted helminth and schistosome infections in Ethiopia', *Parasit Vectors* 13/437 (2020); B. Mengistu et al., 'Soil-transmitted helminth (STH) infections in the Wolaita zone in Southern Ethiopia: mid-stage evaluation of the Geshiyaro project and progress towards the interruption

estimated that 457 million people (then 21% of the world's population) were infected with hookworm.[34] By 2013, this was estimated to be 472 million people (95%CL 437-511 million): now only around 6.5% of humans.[35] As discussed, there has also been a dramatic drop in prevalence over the past century within the areas I have studied. Whether this should be attributed to MDA, improvements in sanitation, or more general economic development remains, however, an open question. The declines in Caribbean contexts such as Grenada where hookworm programmes were short-lived suggests a primary role for economic development rather than treatment campaigns. However, the example of Jamaica, as Riley has argued, suggests that treatment campaigns carried out in concert with effective health education efforts can significantly improve health and life expectancy. The fact that hookworm is now notably less prevalent across different contexts also hints that some of the measures taken over the last century across the globe – which have principally consisted of MDA – have had some impact in reducing transmission.

Historian James Webb in 2017 criticised global health policy for 'ignoring the lessons of history' in pursuing preventative chemotherapy over sanitation efforts to tackle soil-transmitted helminthiases.[36] Comparing the most recent WHO Neglected Tropical Disease (NTD) roadmap with the efforts of the JHC, however, suggests that while the lessons of history may

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of transmission ', *Parasit Vectors* 17/1 (2024) pp.355; B. Tinkitina et al., 'Prevalence and intensity of soil-transmitted helminth infections among school-aged children in five districts in Uganda', *PLoS Negl Trop Dis* 18/8 (2024) pp.e0012324; M. Calvopina et al., 'Anthroponotic and Zoonotic Hookworm DNA in an Indigenous Community in Coastal Ecuador: Potential Cross-Transmission between Dogs and Humans', *Pathogens* 13/8 (2024) pp.609; E. Nieves et al., 'Comparison of parasitological methods for the identification of soil-transmitted helminths, including Strongyloides stercoralis, in a regional reference laboratory in northwestern Argentina: An observational study', *Parasite Epidemiology and Control* 20/26 (2024) pp.e00370; V. Thitapakorn et al., 'Unveiling the Transmission Potential of Opisthorchis viverrini and Intestinal Helminths Along the Thailand-Laos Border in Thailand', *Zoonoses Public Health* (2024).

[34] N. R. Stoll, 'This wormy world', *Journal of Parasitology* 33/1 (1947) pp.1-18.

[35] Global Burden of Disease 2013 Collaborators, 'Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013', *The Lancet* 386/9995 (2015) pp.743-800.

[36] J. L. A. Webb, 'Battling Soil-Transmitted Intestinal Worm Disease: From the Hookworm Campaigns of the Rockefeller Foundation to Contemporary Mass Drug Administration', *Gesnerus* 74/2 (2017) pp.229-239.

have been forgotten, some of them have been independently re-learned. Whereas the RF attempted to secure the support of elites by emphasising the economic losses caused by hookworm, the WHO's current message for funders is that 'NTD treatments are considered one of the "best buys" in development, as they are donated, provide a high social return and are cost–effective.'[37] It is now no longer explicitly stated that disease is a threat to work, but the same focus on cost-effectiveness and returns on investment which drew John Rockefeller to hookworm remains present.[38] However, the roadmap also emphasises 'country ownership', which can be read as a belated correction against the kind of metropolitan priority-setting embodied by the RF and Colonial Office programmes.[39] The WHO further aims to 'move away from siloed, disease-specific programmes by mainstreaming programmes into national health systems and intensifying cross-cutting approaches centred on the needs of people and communities', which stands in contrast to the RF focus on single-disease programmes, and offers a welcome shift away from paternalism and towards prioritising the needs of those at risk of NTD infection.[40] At the same time, it is also reminiscent of the JHC's expansion beyond hookworm into a wide range of different health areas. The roadmap also refers to social mobilisation, self-care, capacity building and health care worker training – all of which have echoes of Washburn's broad coalition-building in order to spread health education and develop health systems. The notion of self-care in particular echoes Washburn's emphasis on simple interventions which people could carry out in their own homes.

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[37] World Health Organization, *Ending the neglect to attain the Sustainable Development Goals: A road map for neglected tropical diseases 2021-2030* (Geneva: World Health Organization, 2020) p.36.
[38] J. Ettling, *The Germ of Laziness: Rockefeller Philanthropy and Public Health in the New South* (London: Harvard University Press, 1981) pp.49-72,202-208, J. Farley, *To Cast Out Disease: A History of the International Health Division of the Rockefeller Foundation (1913-1951)* (Oxford: Oxford University Press, 2004) pp.4-6; E. R. Brown, *Rockefeller Medicine Men: Medicine and Capitalism in America* (Berkley: 1979).
[39] WHO, *Ending the neglect* p.xi.
[40] Ibid. p.9.

In December 1928 *Jamaica Public Health* argued that 'rural schools should be health centres'.[41] Nearly a century later, anthelmintic drugs are commonly distributed through schools and deworming is integrated into school health programmes.[42] Indeed, the WHO rates collaborations between STH control programmes and ministries of education 'highly productive'.[43] However, this is driven by the greater risk of high-burden helminth (principally *Ascaris*) infections among children rather than Washburn's belief in impressing the 'Rules of Health' upon children at an early age.

Rather than control or eradication, the WHO is currently pursuing 'elimination as a public health problem' of soil-transmitted helminthiases including hookworm.[44] While still emphasising preventative chemotherapy, the roadmap also lists 'provision of adequate sanitation' as a core strategic intervention, indicating a move away from an exclusively treatment-based approach.[45] Likewise, the roadmap also frames treatment as a means to 'increase universal health coverage' rather than existing purely for its own sake.[46] This echoes RF use of hookworm as wedge to build up health systems, though what it means beyond increasing access to treatment is not altogether clear. Though the roadmap does not address the social determinants of health beyond sanitation, it does show more awareness of the systemic problems facing global health than a chemotherapy-only approach would imply.

By integrating epidemiological with historical modes of analysis to explore how hookworm has varied across contexts, and how it has been shaped by mining and plantation agriculture, this thesis has added to a significant body of research from historians and scientists alike demonstrating that diseases are shaped by social, political and economic context.[47] It is therefore

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[41] 'Rural Schools should be Health Centres', *Jamaica Public Health* 3:12 (1928) p.3.
[42] WHO, *Ending the Neglect* p.161.
[43] Ibid.
[44] Ibid. p.158.
[45] Ibid.
[46] Ibid.
[47] E.g. J. R. McNeill, *Mosquito Empires: ecology and war in the Greater Caribbean, 1620-1914* (Cambridge: Cambridge University Press, 2010); R. Gibb et al., 'Interactions between climate change, urban infrastructure and mobility are driving dengue emergence in Vietnam', *Nature Communications* 14/8179 (2023) ;

apparent that to tackle disease and improve health, attention must be paid to society, economics, work and housing: the social determinants of health. Hookworm, like most diseases, is now a disease of poverty, and eradicating poverty remains the surest way to eradicate disease and improve health. As I and other scholars have shown, colonialism and capitalism breed ill-health and disease.[48] Dismantling systems of impoverishment seems an impossible task – it is far easier to secure funding from their beneficiaries to develop and implement technological fixes, drugs and vaccines. Indeed, the RF programmes, in which parasitologists with an agenda secured the support of a strikebreaking oil billionaire, are among the earliest examples of this approach! Nevertheless, a powerful argument in favour of system change is that the systems driving impoverishment are in large part the same as those producing climate and ecological breakdown. As WHO director general Tedros Adhanom Ghebreyesus and economist Mariana Mazzucato put it in a recent *Lancet* article: 'the interlinked crises of health, climate change, and inequality are the direct result of economic policy choices'.[49] The conditions of an unequal capitalist modernity which had such a complex relationship with hookworm are the same conditions which drive climate change and species extinction.

What does eradication tell us about extinction?

Extinction has been an important theme of thesis. I have discussed the heady, optimistic anticipation of hookworm's extinction in Jamaica; the role

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R. M. Packard, 'Maize, Cattle and Mosquitoes: the Political Economy of Malaria Epidemics in Colonial Swaziland', *The Journal of African History* 25/2 (1984) pp.189-212; E. Whitcombe, 'Indo-Gangetic river systems, monsoon and malaria', *Phil Trans R Soc A* 370(2012) pp.2216-2239.

[48] E.g. Packard, 'Maize, Cattle and Mosquitoes', E. T. Richardson, *Epidemic Illusions: On the Coloniality of Global Public Health* (Cambridge: MIT Press, 2020); D. Arnold, 'Cholera and Colonialism in British India', *Past & Present* 11/113 (1986) pp.118-151; T. S. Athni et al., 'The influence of vector-borne disease on human history: socio-ecological mechanisms', *Ecology Letters* 24/4 (2021) pp.829-846; S. Watts, 'British Development Policies and Malaria in India 1897-c.1929', *Past & Present* 165 (1999) pp.141-181; I. Klein, 'Development and death: Reinterpreting malaria, economics and ecology in British India', *The Indian Economic and Social History Review* 38/2 (2001) pp.145-178; I. Klein, 'Imperialism, ecology and disease: Cholera in India, 1850-1950', *The Indian Economic and Social History Review* 31/4 (1994) pp.491-518.

[49] M. Mazzucato and T. A. Ghebreyesus, 'Advancing the economics of health for all', *The Lancet* (2024).

of extinction as an aim of state policy in the Windward Islands, and the slow, unnoticed extinction of hookworm in Cornwall. Throughout, I have noted that hookworm's extinction was not considered a loss to be mourned, but was instead anticipated as a positive outcome of social progress and the advent of modernity. As Mark Barrow has noted, as early as the 19th century scientists such as Alfred Russell Wallace were mournfully observing and anticipating extinctions which they blamed on 'civilised man'.[50] However, while in the minds of zoologists and the environmental movement which began to coalesce through the early decades of the 20th century, extinction was entirely melancholy or negative, medical thinking continued to view extinction and its relationship to civilisation in a positive light. As historians of global health, most notably Nancy Stepan, have chronicled, healthworkers debated not whether complete eradication (i.e. the inducing of extinction) of parasites and diseases was desirable, but whether it was possible.[51] The destruction of game animals in a bid to control Human African Trypanosomiasis would bring these conflicting views of extinction and scientific and civilisational progress into conflict around the same time as Washburn was imagining a world without hookworm in Jamaica.[52] But unlike wildebeest and gazelles, no-one felt positively enough about hookworm to decry its destruction.

Indeed, public health scientists and parasitologists today would still view the extinction of hookworm as a positive outcome, even though this extinction seems far less likely in 2024 than it did in 1924 (we are today better informed about how huge a challenge global disease eradication is). The lifeway of hookworm – its parasitic drinking of its host's blood – and the

[50] M. V. Barrow, *Nature's Ghosts: Confronting Extinction from the Age of Jefferson to the Age of Ecology* (Chicago: University of Chicago Press, 2009). pp.73, 113,161.
[51] N. L. Stepan, *Eradication: Ridding the World of Diseases Forever?* (London: Reaktion, 2011); J. Farley, *To Cast Out Disease: A History of the International Health Division of the Rockefeller Foundation (1913-1951)* (Oxford: Oxford University Press, 2004); R. M. Packard, *A History of Global Health: Interventions into the Lives of Other Peoples* (Baltimore: Johns Hopkins University Press, 2016); M. Cueto et al., *The World Health Organization: A History* (Cambridge: Cambridge University Press, 2019).
[52] Barrow, *Nature's Ghosts*. pp.149-150

undoubted harm it causes to many of its hosts is seen to justify its destruction in the present as well as in the past.

As Dolly Jørgensen has pointed out, extinction is frequently anticipatory.[53] Conservation exists in the anticipation of extinctions which must be forestalled, and extinction studies concerns itself mostly with species 'on the edge'.[54] Furthermore, Thom van Dooren's formulation of the 'dull edge of extinction' (which I have made use of), in defining extinction as a slow process in which entanglements are slowly severed, sees extinction as a movement towards an anticipated endpoint.[55] This has interesting parallels with the early 20th-century drive to slowly induce hookworm's extinction through health education and civilisational progress. In the short term, colonial doctors aimed to control hookworm, and in the long term to eradicate it. The advance of civilisation was expected to drive hookworm to an anticipated end in a striking parallel of the conservation narrative where endangered species are slowly driven to extinction by human action. Disease eradication then inverts conservation-focused views of extinction by proclaiming extinction to be a good thing! What is particularly interesting from the point of view of extinction is the way the anticipated extinction of hookworm was discursively tied to civilisation, progress and modernity. As Barrow has shown, this was not the first linking of these concepts, but it was one of the most sustained.

To conclude: this thesis has shown, through holistic and comparative interdisciplinary study, that hookworm is shaped, discursively, ecologically, epidemiologically and clinically, by socioecological context in complex ways. That is not to say parasitism arises solely out of particular socioecological configurations, but that these configurations shape the way parasitism manifests. These same socioecological configurations shaped medical efforts to control and induce the extinction of hookworm in different ways in different contexts.

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[53] D. Jørgensen, 'Extinction and the End of Futures', *History and Theory* 61/2 (2022) pp.181-368.
[54] Ibid.
[55] T. van Dooren, *Flight Ways: Life and Loss at the Edge of Extinction* (New York: Columbia University Press, 2014).

The extinction of hookworm was frequently anticipated as positive outcome of civilisational progress and modernity. In Jamaica, hookworm's extinction was imagined as a way to produce a hygienic modernity. This hygienic modernity was utopian in imagining a healthy Jamaica without diseases such as hookworm and tuberculosis, but it anticipated this would be produced by individuals following 'the rules of health' according to their 'sanitary consciences' rather than changes to socioeconomic structures which produced disease. In the Windward Islands too, hookworm was imagined to arise from individual backwardness above social, ecological or economic conditions. The extinction of hookworm was thus defined as 'progress' in a way which excused the colonial state from making any substantial efforts to enact this progress, or to improve the lot of the colonised. In Jamaica, hygienic modernity had the explicit aim of fashioning hygienic citizens who knew how to stay healthy, in order that they could work hard on plantations and improve themselves and the island. Neither Washburn nor his Jamaican allies made much distinction between 'improvements' in health, morals and economics; despite its nationalist elements, his hygienic modernity retained features of the excremental colonialism it emerged from.

These multi-layered and tangled interactions between worm, ecology, society, economics and politics show the value of holistic interdisciplinary study in understanding health and disease. Using different disciplines to examine both the social and biological natures of hookworms in tandem shows how closely these were entwined; integrating biology and history has shown that hookworm and attempts to induce its extinction were shaped by and created through complex interactions of people, parasites and places.

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