Introduction

As the barque *Sophie Goerlitz* approached New Orleans on June 13, 1885, its captain first had to steer the vessel to the inspection station at Port Eads, an isolated area close to the Mississippi Delta, 110 miles from New Orleans. It was the first of three stations through which vessels had to pass before they were deemed safe to disembark in the harbor of the city. At the inspection station, the *Sophie Goerlitz*, like all inbound vessels, was swiftly boarded by a medical officer whose job was to inspect the ship and check its sanitary record. The *Sophie Goerlitz* had left Rio de Janeiro with a load of coffee approximately six weeks earlier. Upon disembarkation, it bore all the signs of excellent health. However, Rio was considered an infected port in 1885, as yellow fever was rampant in the Brazilian city. What was worse, during the six-week journey of the German barque, a seaman had fallen ill with unspecified fever and died en route to New Orleans.

Thus the *Sophie Goerlitz* came under the rules governing maritime sanitation at the great Louisiana harbor: If a ship was known to have departed from an infected port, where an epidemic disease was present and had developed further cases en route, it was subjected to the full extent of sanitary measures to protect the American South. If a vessel, such as in the case of *Sophie Goerlitz*, was known to be "foul"—bearing a case of fever on board—it was directed to the lower quarantine station, located on the Pass A L'Outre. Here, on an unused outlet on the Birdfoot Delta, 103 miles away from the city, the station doctor carried out a thorough inspection of all crewmembers. The sick, if any survived, where removed immediately to appropriate hospitals. The barque was then requested to dock onto the impressive wharf of the second, Upper Mississippi Quarantine Station, seventy miles below New Orleans. The station boasted hospitals dedicated to

yellow fever and smallpox, housing for crewmen and the quarantine officers, and a graveyard, as well as the barracks for comprehensive disinfection operations. The vessel was brought alongside the wharf and everyone on board was sent to shore and accommodated in appropriate shelters. Three procedures were then undertaken to guarantee the sanitary state of the vessel.

First, all surfaces—with the exception of cargo—were sprinkled with a solution of bichloride of mercury. Understood to be a universal germicide, the solution was applied to the bilge, the ballast, the hold, the saloons, the forecastle, and the decks of the ship. Applied with a simple, heavy, black-tin rose (similar to an ordinary watering-pot spray), about 2,000 gallons of the solution were used on the *Sophie Goerlitz*. The second—and most important—step was the complete fumigation of the prepared vessel. A tugboat was brought alongside the vessel, its pipes extended into the hatch and, once the fan of the power blower on the tugboat was started, the *Sophie Goerlitz* was subjected to three hours of sulphuric acid gas exposure. To this end, the tugboat came equipped with a battery of eighteen furnaces, in which roll sulphur was burned on pans. The furnaces opened to a common reservoir, in which the power blower pushed the sulphuric acid gas with huge pressure down the hatchway of the vessel into the bottom of the hold. Within an hour, the brand-new fumigation device on the tugboat could surcharge the atmosphere of ships with about 180,000 cubic feet of gas. The third and final step was carried out in parallel to the washing and fumigation of the vessel. All beddings, linen, mattresses, curtains, fabrics, and personal baggage were brought to a commodious building on the wharf and treated with moist heat at a temperature of not less than 230 degrees Fahrenheit (110 degrees Celsius). A large chamber had been constructed for this purpose, equipped with racks to loosely hang the fabrics so as to maximise exposure to moist heat. After completion of the procedures, the *Sophie Goerlitz* was allowed upstream to unload its coffee cargo onto the wharf in the city of New Orleans.

The *Sophie Goerlitz* had been one of 210 vessels to approach New Orleans in 1885 from a port known to be affected by smallpox, cholera, or yellow fever. All vessels underwent the same treatment, and only after the completion of the three procedures detailed above, and providing that no further case of fever had developed among the crew and passengers, was a ship considered as safe to enter the harbor. To the inventor of this new system of

maritime sanitation, Joseph Holt, the process was now in a "nearly perfect state." It was the product of long and tedious "experimental effort" and resulted in the long-aspired and needed modernizing of quarantine, bringing an outdated and questionable practice "into line with other branches of science and art in general progress."[1]

The system of maritime sanitation that Holt envisioned and built in New Orleans marked the beginning of a global drive for the technoscientific modernization of quarantine. Holt's experimental efforts introduced science and engineering to a dated procedure that had relied almost exclusively on detention and observation. Now, enabled through new chemical compounds and uniquely engineered furnaces and power blowers, quarantine was reinvented as a concerted form of intervention that mobilized scientifically grounded fumigation as a comprehensive method of disinfection. At the core of Holt's new system rested a simple gas made from burning sulphur: SO_2. Remarkably, the compound came to be trusted with the total destruction of bacteria, insects, and rodents. In the years following Holt's demonstration of its application, its toxic capacity would foster renewed enthusiasm and harbor the hope for the replacement of the unreliable and costly obstacle to global trade and traffic that was quarantine—a sulphuric utopia.

Histories of Maritime Sanitation

This book tells the history of a sulphur-based fumigation apparatus that was motivated and catalyzed by Holt's system of maritime sanitation. Shortly after its invention in the late 1880s, and its patenting at the end of the nineteenth century, the Clayton machine encapsulated and integrated the complex system set up in Louisiana and saw the widest distribution and application in harbors around the world. Posited against traditional methods, superstition, quackery, and a concerning lack of scientific validity, this new machine mobilized cutting-edge chemistry to reconcile the age-old opposition between commerce and quarantine, and the inseparable linkage of the flow of goods to the rift of epidemics. In this way, its inventors claimed, if adopted globally, the Clayton machine would allow for the first time for a hygienic and secure conduct of international trade and travel.

The machine carried the name of its inventor, Thomas Adam Clayton, a Scottish immigrant born in Banff, Aberdeenshire, in 1852, who settled

in the small town of Opelousas, in the Louisiana Parish of St. Landry, in the early 1880s as a cotton farmer. Like many farmers in the American South after the Civil War, Clayton joined the Farmers' Alliance to improve the economic hardship of rural agriculture.[2] He developed a modest political career, becoming Secretary for the Alliance in New Orleans, before Governor Nicholls appointed him in 1891 to the State Board of Health to represent farmers' interests. From there, he ventured into garbage processing and chemical processing endeavors before he joined forces with the Board's president from 1894, Samuel Olliphant, in the development of an effective, industrial apparatus for maritime sanitation.

Their collaboration led to two registered patents, expanding on the system that the previous president of the Board of Health, Joseph Holt, had set out in earlier years. Olliphant and Clayton identified the fumigation apparatus as the most significant contraption within the system of maritime sanitation and focused on the efficiency and reliability of the machine. Their product was a mechanical device, attached to a furnace, which could pressurize and deliver the sulphuric acid gas at constant pressure. The machine could then maintain a continuous circulation between the furnace and an enclosed compartment, to evenly fill the fumigated space with gas. As the chemical compound was also shown to have excellent capacities to extinguish fires, Clayton filed his patent on June 7, 1899, as "Method of and Apparatus for Fumigating and Extinguishing Fires in closed Compartments." In the same year, Clayton moved to New York to set up a company whose sole aim was to build and export the very successful and much-requested machine around the world. Yet the development of new procedures, practices, and technologies invented to relieve epidemic pressure on global trade would exceed the Clayton as a singular apparatus. Already by the late 1890s, rival technologies, employing different chemicals and methods, competed for the position of the most efficient technology of maritime fumigation. To compete, the Clayton would be improved and adapted in response, while also giving rise to new sulphur-based apparatuses such as the Aparato Marot. Eventually, following World War I, new fumigation processes based on cyanide came to dominate the field. These, however, continued to carry with them the technical and epistemological legacy of the Clayton machine, whose global dissemination over the preceding decades rendered it the paradigm of maritime sanitation.

The Clayton machine inhabits a position in which an astounding variety of historical narratives intersect and intertwine. This is a history of global scientific consolidation in the fight against infectious diseases before the emergence of "global health" as an epistemological and biopolitical framework. The development and distribution of the machine populates a timeframe in between the sanitary conferences of the nineteenth century and the foundation of the Pan-American Health Office in 1902, the Rockefeller's International Health Board in 1916, and later the League of Nations Health Office in 1924.[3] The history of the Clayton machine, its commercial distribution, and its experimental validation presents a world history of science and technology. Its application in quarantine islands and isolation stations across the world places this fumigation technology within a geopolitical context whose reference was not simply the nations and cities that these stations were built to protect, but a global archipelago of trade interests and capitalist as well as imperial competition.[4] Built to advance and support the unhindered flow of goods across the oceans, this apparatus was not only an integral element of a maritime world history. More importantly, it was a technology that enabled a global political economy and drove the success of global trade, thus constituting a forgotten pillar of globalization.

With respect to the inner workings of the apparatus itself, its chemical and mechanical technology was built on the hopes and dreams of laboratory science and sought its validation in the very experimental systems that were being devised at the time to frame bacteria as causes of disease and as agents of epidemics.[5] This then is also a history of the systematic and coordinated utilization of chemical gases as a means of interrupting the natural pathways of diseases, their vectors, and their microbial agents.[6] In this book we move beyond the traditional historiographical focus on DDT and antimosquito campaigns, and examine the Clayton machine and its global republic of epidemiological, medical, and mechanical experts to redraw the timeline of the systematic application of gases and chemical solutions as germicides, insecticides, and pesticides. We ask how the Clayton machine and its technological variants worked to stabilize budding bacteriological science and how its utility in harbors around the world accelerated epidemiological concepts. Finally, we ask how this technology shaped the perception of infectious disease against the backdrop of economic globalization.[7]

The Clayton machine's invention and development crosses in complex ways with the discovery of the causative agents of several diseases and their vectors. First, as we will see in chapter 2, the Clayton's invention and application in yellow fever–ridden New Orleans predated the identification of the mosquito, *Aedes aegypti*, as the pivotal vector of the yellow jack.[8] And yet the overwhelming success of the apparatus in both the American North and South fostered the research of James Carroll and Walter Reed on the etiology of yellow fever in Cuba in 1900, favoring the insect vector over "poisonous effluvia in the air."[9] Second, the Clayton became a significant pillar in global containment efforts toward the third plague pandemic. Erupting in Hong Kong in 1894 and quickly spreading across the globe, plague had been attributed to a pathogen (later known as *Yersinia pestis*) in 1894, but the disease's transmission pathway, maintenance mechanism, and vectors raised many questions. Once again, the machine was tested and entrusted with protection against plague before its paradigmatic target, the rat, had been accepted as a principal vector of the plague.[10]

As much as the Clayton machine connected and associated these two global disease biographies, it occupied a peculiar position within the unresolved etiology of each of these diseases. The apparatus could present its efficiency and capacities against bacteria, insects, and rats, forming the holy trinity of disinfection, insecticide, and deratization (better known as the three Ds: *désinfection, désinsectisation, dératisation*), while each of them were subject to heated controversy about their role in the transmission of yellow fever and plague. So, rather than giving the machine an auxiliary role in the history of the containment of infectious diseases, we need to recognize its substantial position within the larger experimental system that gave these epidemics their modern configuration. Outside of the conventional bacteriological laboratory and beyond the trodden pathways of pioneering doctors, maritime fumigation contributed to the epistemic and biopolitical shaping of these diseases in ways overlooked by current understandings of the history of medicine.[11]

From Infection to Infestation

The examination of fumigation and its apparatuses comes to unsettle prevailing notions in medical and public health historiography in two ways. First, it challenges the notion that by the end of the nineteenth century

the bacteriological revolution led to a shift of attention away from objects and toward human bodies. *Sulphuric Utopias* demonstrates this to be a fallacy. For, when bacteriology is considered in tandem with developments in chemical engineering, it becomes evident that while, on the one hand, human bodies enter the scene of public health with unprecedented force at the end of the nineteenth century, on the other hand, object-oriented techniques and technologies of epidemic control also intensify and proliferate. Second, drawing a history of maritime fumigation reveals another misconception: that the advance of bacteriology also led to a gradual shift of attention away from the environment and toward microbes as the true objects of medical intervention. Historians of disease ecology have already shown this to be a perspective that neglects developments of vast importance in the history of epidemiology and public health, including disease ecology.[12] *Sulphuric Utopias* enriches the challenge to this germ-centric approach, showing that fumigation was foremost a practice of both public health and free trade. Within maritime sanitation, it was vital to configure microorganisms beyond a microscopic perspective, and in relation to "macro" spatial and material conditions that could not be more removed from the aseptic environment of the lab: the built environment of cargo ships.

The history told in this book follows the practical consideration that went into the development and distribution of the Clayton machine. However, the practical problems that emerged around the machine's design and application were not simply solutions and fixes, but have themselves also contributed to the conceptual and theoretical development of hygiene, bacteriology, and ecology. This is then a history that begins with the consideration of pathogenic bacteria hiding in the surfaces of walls, ceilings, and floors. Throughout the second half of the nineteenth century, practices of whitewashing had proliferated and—as in the example above—were used to return infected surfaces to a clean state. However, quickly moving beyond the capacities of washing and scrubbing, the Clayton machine fostered an imagination of bacteria hiding in cracks and porous surfaces, as well as in the intermittent gaps and spaces in goods such as tobacco, coffee beans, or fabrics. Its gas was first imagined and then experimentally shown to halt bacterial growth in a great variety of structures, fabrics, foods, and goods. With the consolidation of mosquitoes, fleas, and other insects as vectors of microbial pathogens, this became a history of attributing infection to residues of moisture or bilge water in the holds of vessels, as well

as to organisms and insects found in foul air in confined spaces. The Clayton rendered habitats inhospitable to insects, as well as to bacteria. *Sulphuric Utopias* is finally a history of "dead" spaces: the Clayton machine's gas could act in those out-of-reach gaps and structural spaces that enable rats to build borrows or seek refuge and harborage. This is then the paradoxical image derived from the examination of maritime fumigation: while it was initially catalyzed by the bacteriological revolution in the 1870s, it ended up, by the 1920s, being practically indifferent to microbes and concerned solely with their hosts. This is perhaps the most unexpected outcome of this study: that bacteriologically informed maritime sanitation was, historically speaking, a process that gradually shifted its focus from infection to infestation.

Persistent Utopias

Like many technological inventions in history, the success of the Clayton machine is not one of rapid or sudden revolution, but a technoscientific history that is grounded in longstanding traditions, practices, and myths. Traces of the medicinal uses of sulphuric gases go back to Hippocrates and have a vibrant history throughout medieval and early modern periods.[13] Engineering sulphur's germicidal capacities in the late nineteenth century changed the epistemological position of the substance and its use. It did not, however, invent *ex nihilo* its use in the prevention against diseases and epidemics. On the contrary, the Clayton machine claims an almost paradigmatic position in the adaption of an age-old tradition, which was reinvented as a normalized and universally applicable scientific practice.

This is then a history of technological and scientific modernization and globalization. But it would be wrong to address the Clayton machine simply as a technological fix for a series of practical problems made available to sanitary officers at the turn of the century. Beyond its promises of delivering a sound and safe resolution of the enduring quarantine crisis of the nineteenth century, the invention of the apparatus was also driven by a range of imaginaries, desires, visions, and utopias—most pertinently ones related to what in this book we call a "sulphuric utopia."

The notion of "hygienic utopia" has been frequently used by medical historians to describe not just futuristic visions of a disease-free humanity,

as described, for example, in Jules Verne's *Begum's Fortune*, but more pertinently the medical and public health aspirations or programs, ranging from eugenics to turn-of-the-century mining industry hospitals in the Ruhr.[14] In relation to the history of epidemics, more specifically, Peter Baldwin has emphasized the importance of hygienic-utopian visions of modern European states in the development of quarantine as a technology of epidemic prevention. "Ultimately," he writes, "the goal of prophylactic endeavour was to sanitise each nation, whether west or east, thus preventing the spread of disease. But before the happy day of this hygienic utopia had dawned, much could, in European eyes, be accomplished through the judicious application of quarantinist and, later, neoquarantinist techniques to the connections between Orient and Occident."[15] In this book we argue that if indeed this may have been the case in the mid-nineteenth-century Europe, already by the 1870s the link between hygienic utopia and quarantine was becoming radically unsettled. By the start of the new century their relation was in fact reversed: hygienic utopia was a state of affairs envisioned as one liberated from quarantine, where the latter's parochial and time-wasting rules were replaced by the scientific expediency and accuracy of chemical engineering.

Yet, in promoting this historical revision, we should be wary of an analytical peril: that of inadvertently carrying with us a largely fossilized understanding and employment of the notion of "utopia." Medical histories that casually employ the term hygienic or, more broadly, technoscientific utopia often lack a consistent theory of utopia. Or rather, inherent in their use of the term are contained two evaluations, which, however, remain nonanalytical. First, in a manner following critiques of utopianism ranging from Jeremy Bentham to Friedrich Engels, the evaluation that utopias are symptomatic of approaches to social change that are divorced from the material (or economic) realities on the ground.[16] This is what we may call the "utopia as magic bullet" approach.[17] Second, in a manner that follows the "antitotalitarian" doctrine of Karl Popper, the New Philosophers, and their epigones, the assumption that all utopias inevitably lead to, and thereby contain within them the seeds of, authoritarian dystopias.[18] This is what we may call the "utopia as the anteroom to the gulag" approach. Reliance on these approaches, and frequently on their combination, has led to dismissive and at the same time cautionary historical narratives that depict utopias as both foolish and dangerous. In this way, a range of less

reductionist and more analytical approaches of utopias and utopianism, which form an important part of twentieth-century social theoretical thinking, are ignored. Most pertinently, this includes the notion of the "utopian imagination" as developed by the philosopher Ernst Bloch.[19]

This book is not a work of political philosophy, but as the result of the collaboration between a historian and an anthropologist it aspires to social theoretical coherence. Hence, while not aimed at reviewing or revising historical or anthropological approaches of utopia per se, we are interested in providing a more clear—and we hope more coherent—use of the term as this relates to hygienic technology. This will in turn help us underline key aspects of the hygienic, technoscientific utopianism shimmering under the surface of the historical fumigation practices examined in this book. And perhaps, this approach of historical utopian visions can also allow a critical interrogation and reflection of contemporary hygienic utopian projects, which, as in the case of the recent Zika crisis in South America, often return to and redeploy spectacles of fumigation.[20]

Hygienic utopias, at least as imagined and performed in the context of maritime fumigation, should be understood within the broader field of what Ernst Bloch's analysis of utopianism has identified as a "concrete utopia"; in other words, a "transformed future" which, however illusive, is practically and materially sought after.[21] Following Ruth Levitas's analysis of Bloch's work, this is a type of utopia that is based on reaching "forward to a real possible future, and involves not merely wishful but will-full thinking."[22] This is, in other words, a vision where "the future is 'not yet' and is a realm of possibility. Utopia reaches toward that future and anticipates it. And in so doing, it helps to affect the future. Human activity plays a central role here in choosing which possible future may become actual: 'the hinge in human history is its producer.'"[23]

The hygienic and technoscientific utopia examined in this book may pale in poetic insignificance by comparison to visions like William Morris's self-proclaimed Scientific Utopia.[24] And yet it shares with them a common principle of "educated hope": the ability to envision an "emergent future" on the basis of a belief that, "the material world is essentially unfinished and in a state of process."[25] In other words, a future that is both radically other to the present and within reach through the exercise of scientifically led human activity. Far from being merely part of technoscientific "dreamscapes of modernity," the fumigation machines and methods examined in

this book formed the material, and indeed mechanical, bases of a knowable and realizable future.[26]

Crucially, at least since Plato's account of Atlantis, and in spite of terminologically referring to the imagination or quest for a non-place (*ou topos*), whether abstract or concrete, utopianism has primarily been a spatial fantasy. This is not only in terms of imagining the perfect society as something that exists elsewhere, but also as something that is fundamentally imagined in spatial terms: through its urban planning, architecture, and geomorphic arrangement and transformation.[27] Even after Louis-Sebastian Mercier's *L'An 2440*, when utopia was "temporalized" by being transferred from across the ocean to across time, the spatial aspect of utopianism remained dominant.[28]

In the case of what we call sulphuric utopias, the end of quarantine and the technologies designed to achieve it have entailed a spatial mentality that was entangled with a dreamscape of capitalist hegemony that was particularly triumphant after the defeat of the Paris Commune in 1871 and the inaugural act in the colonization of the global south (Berlin Conference, 1884–1885). Sulphuric utopias undergird the late nineteenth century's economic globalization, envisioning seamless global trade networks built on the imperial maps of Western expansion. The global expansion of capitalist methods of production, the extension of labor markets beyond national boundaries, the rapid growth of global plantation agriculture, and the increasing linkage of markets relied, as Sebastian Conrad has argued, on revolutionary changes in transport.[29] The "amazing decline in international transport costs" was, according to the economic historians O'Rourke and Williamson, the true driver of nineteenth-century globalization. Among other factors, such as the opening of the Suez Canal in 1869, it was in particular the innovations in steamship transport that, a year later, led steam tonnage to exceed sail tonnage in British shipyards. The fall in transport costs ignited a race in the liberalization of trade policy. But, perhaps more importantly, low costs allowed for a transoceanic exchange of "basic" goods, such as wheat, rice, tobacco, and wool. Replacing the previous dominance of special and high-value goods, global trade became structured by the shipment of ever-increasing quantities of food and raw materials from "recent settlements" to the capital-abundant West.[30]

This hegemonic project relied on technoscientific visions of progress and fostered a spatial fantasy that lay at the heart of end-of-the-century

Empire building: the creation of a new spatial order that would guarantee the smooth production and circulation of commodities. This is the political and economic context of the spatial fantasy that, following Douglas Burgess, lay at the heart of maritime capitalism in the age of Empire: the annihilation of distance.[31]

If this is an image often used today, in the age of "jet travel," so as to weave cautionary tales about the spread of emerging pathogens, the trope in itself is in fact the product of the turn of the nineteenth century. The fact is best illustrated by the identical nature of maps used to warn about pandemic danger, where the globe appears to be spanned by a thick web of lines; now airplane flights, then shipping routes.[32] Set at the center of this fantasy was the steamship, which, as Burgess reminds us, Michel Foucault aptly described as a "heterotopia . . . a floating piece of space, a place without a place, that exists by itself, that is closed in on itself and at the same time is given over to the sea and that, from port to port . . . [is] the greatest reserve of the imagination."[33] Seen as a space outside space, but moreover as an indispensible mediator between spaces that mattered (commercial, military, and political hubs) the ship had for centuries been the object of rich symbolic and governmental renderings across the globe. Since at least the Delian League in classical Greece, it had been not simply a carrier of goods and soldiers but also an institutional catalyst of wealth and power. But there was a flip side to this story: for the ship was also the site of mutiny, rebellion, vice, and pestilence. There is no space here to draw the complex genealogy of the ways in which, in Europe at least, ships were constituted into such ambivalent sites. It is, however, important to note that if already in Late Antiquity and then again in the Middle Ages plague was believed to have "arrived" in the supposed seats of civilization (be these Constantinople or Venice) onboard ships, it was only with the rise of concerns about naval hygiene in the British Royal Navy during the eighteenth century that the boat started to be problematized as itself being what today we would call a pathogenic environment.[34] Following Burgess, we can maintain that, by the mid-1800s, "ships were not merely agents of their respective nations, but floating embodiments of empire."[35]

Accordingly, *Sulphuric Utopias* assumes steamships to have materially embodied the space of Empire, insofar as, at least since Pierre Bouguer's 1746 *Traité du navire*, naval architecture reflected not only the practical needs of imperial power (cargo displacement, crew capacity, etc.) but also

a set of imperial hierarchies, temporalities, and ideologies.[36] And yet, what Tamson Pietsch has called "the moving space of the steamship" was not always or only that: a moving space.[37] It was also a moored space—a space temporarily attached to the space of quays, docks, and wharfs, or connected to them via smaller vessels while anchored in port. It was moreover oftentimes a space sidelined and contained in another space, that of the quarantine station, which in turn embodied the transforming and transformative qualities of imperial space in its own way.

Although architectural and, more broadly, spatial histories of quarantine are still disproportional in number to political or social ones, following Alison Bashford, maritime quarantine stations may be said to be spaces of suspension: "quarantine was at once part of the world forged through connections of capital, trade, and empire, and one of the responses perceived to hinder those connections."[38] Krista Maglen has accordingly stressed that, as loci where quarantine was principally applied, ports were "more than just localities for arrival and commerce, they represented sites of tension between notions and constructions of 'exterior' and 'interior' or 'foreign' and 'domestic,' where the dangerous and diseased 'them' encountered the protected sphere of 'we.'"[39] Such sites of tension are notorious for their scattered, incomplete, and often fragmented archives and they present a number of challenges to the historian. Echoing Trouillot, our history of fumigation remains a historical account of scattered actors, and a network of accounts of historical events in which what has happened and is said to have happened remains ambiguous and sometimes inconclusive.[40] Finally, some of the Mississippi quarantine stations, where the Clayton apparatus was devised, have long dissipated with Louisiana's "disappearing coast." Parts of our history of maritime sanitation have thus been lost with that other utopia of controlling the forces of nature that continue to threaten—in the shape of the mighty Mississippi—the very existence of Louisiana.[41]

By the dawn of the bacteriological age, in the second half of the nineteenth century, quarantine had long been employed with the purpose of suspending the circulation of humans and goods. Detention was seen as key in hindering the spread of diseases. According to Erwin Ackerknecht's influential thesis, quarantine merged together commercial and medical debates along the lines of the principal transmissibility of diseases. Contagionists, who held that disease could be transmitted from human to

human, argued for strict quarantine throughout the nineteenth century, while anticontagionists opposed the costly restrictions to maritime trade, as they believed disease to emerge *de novo* in the places of its appearance.[42] According to this reading, anticontagionists were hailed as liberal reformers, defending freedom of individual movement as well as the freedom of trade against the shackles of contagionist "despotism." And they were thus often accused as being mere "mouthpieces of a ruthless and economy-minded bourgeoisie."[43] Yet recent scholarship has shown that mid-nineteenth-century quarantine was far more concerned with the question of infection than with that of contagion. Rather than human bodies, the principal source of concern for port authorities was the goods and their capacity of infecting populations at their point of destination. With the concept of an invisible human carrier (such as popularly established later by the figure of "Typhoid Mary") absent until the turn of the century, it was the seemingly inconspicuous state of the goods in the holds of the vessels, as well as the material structure of the vessels themselves, that generated suspicion and necessitated practices and regimes of quarantine, disinfection, and fumigation.[44]

In this sense, quarantine formed a sort of imperial counter-space, where besides suspicious objects that occasionally needed to be destroyed, what was sacrificed was a key component of capitalist production: quantifiable time. Quarantines delayed trade and the movement of both capital and labor power. Although in actual terms, on a local level, such delays may have formed part of complex political and economic circles of profit and power, in terms of both imperial policy and the imaginary goal of the capitalist economy, they were construed as an obstacle. In these terms, the fumigation technologies examined in this book contained a utopian potential that promised to abolish the *stasis* embodied by quarantine as a political, economic, and medical chronotope that, to return to Maglen, "extended both outward into maritime space and inward into port towns and cities."[45] Maritime fumigation was a technology imagined to free up the floating space of steamships from the stone-and-mortar space of quarantine stations and lazarettos. It was, in other words, a technology imagined, engineered, and practiced in and for its ability to halt the circulation of germs without suspending the circulation of capital.

The fact that sulphuric utopias were concrete, and that this concreteness was embodied in an apparatus employed to achieve them, does not mean

that these were in some way *limited* visions of a hygienic future. On the contrary, we could say that sulphuric utopias were able to persist across several decades and germinate hopes and aspirations across different nations and empires *because* of the limitations of the material practices employed to achieve them. In other words, and with apologies to Miguel Abensour, if sulphuric utopias were "persistent" this was not because they were imbued with some "stubborn impulse toward freedom and justice."[46] Rather it was because the technologies designed to achieve this state of quarantine-free trade continued to fail, *but not fail too much*.

As we will see in the course of the book, competing maritime fumigation technologies always promised to do what rival or previous models had failed to achieve. At the same time, its proponents always maintained their conviction in the fundamental achievability of the task. Particular goals were renegotiated and displaced, etiological theories were discredited or enriched, all under the confessed-as-realistic goal of complete disinfection. Yet where methods were successful, they were never successful enough; always something came up to disturb technoscientific closure. And in turn, where such methods were unsuccessful, they were never unsuccessful enough; always new scientific or technological breakthroughs came up to reignite technoscientific hope. This combination of *limited success* and *limited failure* created the concrete conditions for furthering the innovation, experimentation, and implementation of technoscientific methods aimed at the utopian *telos* of fumigation.

A Technoscientific Vision

Our history of the Clayton machine is a history of the techniques and technologies of maritime sanitation. As such it enacts doctrines, policies, and principles of maritime trade, national security, and hygienic modernity. As we have already mentioned, the principal fumigation technology under examination in this book enabled the flow of goods and people and hence catalyzed state intervention into trade without posing obstacles detrimental to the livelihood of commerce. But it also reinstated the global territorial orders of the time in terms of hygienic separation: by keeping apart the imagined modern salubrity of the West from the epidemic constituency of the rest of the world. As exposed across this book, the Clayton machine and its reflections and projections can be best understood as an integral element

of a larger scheme, a plan or a set of strategic interventions, through which quarantine was supposed to be relegated to the museum of medical and technological history.

Such history of the Clayton can hardly ever be just the history of a technology, or the history of global health, or indeed the history of applied chemistry.[47] Rather, we take the invention, development, experimental negotiation, and successive global distribution of the Clayton machine to be a history in which a political and social economy of maritime sanitation developed against the pressure of epidemic threats and toward the desire for a hygienic, disease-free future. The Clayton machine, and the systems of disinfection in the technoscientific context of which it was invented, applied, and developed, should thus be seen as what Simon Schaffer, David Serlin, and Jennifer Tucker have recently called "sites of complex and socially charged forms of embodied labor and knowledge."[48]

Instruments and technological artifacts like the Clayton machine do not just embody a theory or vision of this hygienic utopia. Instead, as a deeply political entity, of the kind that Simon Schaffer has described, the Clayton developed links with political agendas, mobilized pioneers and defenders of germ theory, enabled proponents of free trade and liberal rights, and emboldened imperial interest as much as it weakened quarantine regimes and their underlying commercial warfare.[49] Furthermore, the Clayton also forged an intimate relationship between the past of globalized approaches to health regulation, as witnessed in the sanitary conferences, and the future of an emerging framework of global health. It hence presents us today with a paradigmatic example of the kind of technological intervention that would eventually come to characterize much of the twentieth-century's regime of global health, built as this is on the foundations of colonial and tropical medicine.[50]

Sulphuric Utopias then presents a story that is as much dedicated to the traditions of a history of technology, as it owes its analytical framework to historical epistemology. We come to think of the fumigation apparatus as an instrument in which epidemic crisis and hygienic utopianism converge. The Clayton machine translated doctrines, scientific principles, and epidemic pressures into concrete material practices, catalyzed by schematic drawings, industrious designs, and experimental systems. At the same time, its application and integration into global trade, quarantine systems, and port authorities consolidated newfound etiologies about cholera, yellow

fever, and plague, as their vectors and hosts moved into the focus of prophylactic practice. The practical usage of the apparatus encouraged modernized, scientific visions of epidemic disease, while propagating hygienic modernity as state doctrine. As such the Clayton takes up a position of a lever, with which modernization, globalization, maritime sanitation, imperial interests, and national identities were forged in intersectional ways.

In recent years, in science and technology studies (STS) as well as in medical anthropology, considerable attention has been put to the examination of what, in their article on the Zimbabwe Bush Pump, Marianne de Laet and Annemarie Mol identified as "fluid technologies."[51] On the one hand, these studies have advanced an understanding of devices as "actors" in broader sociotechnological landscapes. For de Laet and Mol, the colonial water pump under examination is not simply an object with history or histories, but a "fluid object" with agency. Thus sharing a broader understanding of objects as equipped with agency within network-like relations (as advanced by the dominant STS framework of Actor Network Theory) but replacing the "network" metaphor for a "fluid" one, they problematize machines or devices on the basis of their ability to do, irrespective of their designers'/engineers' intentions or "authorship/ ownership," and instead in relation to their environment of application.[52]

In this book we make no claim that the Clayton or any other machine was an "actor." This is not because we believe that this category should be a monopoly of humans, but because we consider the political philosophy underlining the very notion of "action" problematic in the first place. Unfashionable as this may be, we will thus not follow authors like de Laet and Mol (and the broader Latourean paradigm) in reclaiming the agency of the hygienic machines we study.[53] This does not mean that these machines in themselves lacked in fluidity, entanglement, mobility, or any of the other characteristics that within the analytical frameworks of Actor Network Theory seem to qualify nonhumans for agency. These attributes were very much part of fumigation technologies like the Clayton. Although these may be seen as "heroic," in the sense of them being far from the "modest contraptions" imbued with affection (as Peter Redfield has shown) by STS scholars, they were in fact far from "heavy" or cumbersome machines, as they may appear to us today.[54] Instead they were hailed and experienced as highly mobile, trotting the globe on rails and sails, as well as being open to reinvention and adaptation.

Tellingly, the Clayton machine was simultaneously a disinfecting and a fire-extinguishing machine. Moreover, it shared a characteristic identified by de Laet and Mol as key to understanding what they see as fluid technologies: "that whether or not its activities are successful [was] not a binary matter."[55] Rather than examining maritime fumigation technologies from the perspective of if or where they "worked" and if or where they "failed," we should here take Deleuze and Guattari's broader understanding of the machinic aspect of capitalism seriously: as something that works only to the extent that it breaks down.[56] Hence, from our analytical perspective, rather than being passports for some ontological rehabilitation in the narrow confines of twenty-first-century academia, the Clayton's fluidity traits should be seen as an invitation for understanding social, economic, political, and technological processes as they were experienced and performed at the time.

In this study we adopt a historical-ethnographic approach in the sense that the analytical and indeed theoretical conclusions we draw on our subject are drawn from its social reality at the turn of the nineteenth century as this may be reconstituted from the archive. In doing so, we reconstruct the contours of the global experimental system built around the Clayton machine. Our account follows the historical trajectories of French, German, and British bacteriological approaches in tropical medicine and traces their impact into North and South American contexts. The historical geography of the story at hand and its global network is built from maps of references, collaboration, and communication as they emerged from the archives. Without any claim to an exhaustive account of fumigation and maritime sanitation around the globe, this book offers an account of the transnational, transoceanic, and thus global history of developing, testing, and implementing maritime sanitation.

Ultimately, this history forbids its own narration as a story of the modern-day overcoming of epidemic threats, or a saga of the successful installation of enduring maritime stability. Instead, the story told in this book has many disastrous trenches. Chemical warfare would rely heavily on the knowledge established through the experimental improvement of fumigation in the service of maritime sanitation. And, in the end of our story, the Clayton machine was eventually moved out of service and into the archive only when a much more powerful, cyanide-based agent was developed—a chemical that decades later found its atrocious implantation

in the service of the Third Reich: Zyklon B. As is well known, accompanying the particular compound's exterminating properties, a whole range of terms, metaphors, and practices originally developed as part of the sanitary processes examined in this book were adapted in the Shoah as means of concerted dehumanization.

Organization of This Book

In the first chapter of *Sulphuric Utopias*, we draw an outline of the historical conditions that made the Clayton machine thinkable and possible by the end of the nineteenth century. As a technology, it assembled different histories and practices, which we sketch out to emphasise the technological appropriation of older ideas about fumigation, disinfection, and quarantine. Fumigation, the chapter shows, was shaped by a long double history: on the one hand, as a therapeutic and, on the other hand, as a preventative technology, owing to its palpable association with bad air, noxious vapors, and miasma. Chapter 1 also examines quarantine, with its roots in the history of the Black Death, as a cause of concern in the sanitary debates of the nineteenth century. These revolved around a series of international sanitary conferences, which brought into dialogue commercial interests, medical theories, and the role of the circulation of goods and merchandise in infection. Chapter 1 thus proceeds by dislodging the history of disinfection from its bacteriological underpinnings. It draws a genealogy of fumigation as a practice that was deeply associated with the development of mechanical contraptions and machines, long before it acquired its modern significance and bacteriological application.

Chapter 2 explores in depth the historical conditions under which the Clayton machine was developed in New Orleans, Louisiana. With a focus on the perceived vulnerability of the city's harbor in the American South to the onslaught of yellow fever and against the background of a failing system of detention and suspension of movement of goods and humans, we describe experiments conducted by members of the Louisiana Board of Health. Chapter 2 gives an account of how Joseph Holt designed and realized his vision of a sophisticated system of maritime sanitation in the 1880s. It explores how Holt created an exemplary hygienic barrier against bacteria, insects, and rodents, while providing a highway to global trade. The chapter demonstrates how his invention would then be picked up

by the farmer, engineer, and short-time Board of Health member Thomas A. Clayton, who eventually filed his patent for a fumigation and fire-extinguishing machine in 1898, before advancing a global commercial career in the new century.

As an invention on its pathway to global success, by the dawn of the twentieth century, the Clayton machine was confronted by fierce competition in the shape of carbon-based fumigation methods designed in Germany and the Ottoman Empire. Chapter 3 examines how these methods developed around the rat as a probable key vector in the transmission of bubonic plague. The chapter explores the efforts of Pierre Apéry in Istanbul and of Bernhard Nocht in Hamburg to gain control over rats in their visions of maritime sanitation. While the Ottoman Empire persisted in its skeptical position toward any reliable system of fumigation, Germany maintained its own technological invention and continued to protect its harbors and citizens through the application of CO_2, in spite of the risks and problems posed by the invisible and odorless product of Nocht's "Gasgenerator."

Chapter 4 charts out the global success of the Clayton machine and focuses on its integration into what began to take shape as political project of defending Europe against epidemics. The chapter points out how the Clayton was adjusted and grafted to existing disinfection regimes in England and France, and draws out the international politics of standardizing conditions and requirements of disinfection for European trade and commerce. In particular, we examine the neglected role of Ottoman pressure on international trade, via quarantine maximization in the Mediterranean and the Red Sea, and the way this came to charge sulphuric alternatives to rat control with geopolitical implications and consequences.

Chapter 5 seeks to capture the conditions under which fumigation with the Clayton apparatus became a standardized and experimentally stabilized practice. Overcoming differences, aligning chemical, mechanical, and most of all hygienic standards was the key concern of international deliberations at the 1903 Sanitary Conference in Paris. The chapter examines how, despite the failure of reaching a clear consensus, the Clayton continued its pathway to global success and how, in the first decade of the twentieth century, it achieved the character of a gold standard as a technology capable of maintaining the hygienic state of the ports it was applied to.

Chapter 6 examines an applied limitation of Clayton as a fumigation technology and a key alternative that arose in response. Considering the

example of Buenos Aires in Argentina as a place in which a technology, designed to protect against the import of infectious disease became adapted and subsequently integrated into the urban fabric, the chapter turns its attention to land-based fumigation. It explores how in unprecedented campaigns, Argentina's hygienists transferred the principle of maritime sanitation into the vision of an urban hygienic utopia. Chapter 6 shows that this relied on the technological development of a key competitor to the Clayton method, the Aparato Marot, or as the Argentineans have called it since 1906, the "Sulfurozador."

Chapter 7 examines in detail the reasons why the Clayton machine's path to global distribution and lasting success was cut short. Since the first decade of the twentieth century, a new compound had fascinated health officers and quarantine officials: cyanide and its gaseous form, hydrocyanic gas. The chapter demonstrated that, as they began to replace sulphur-based systems after World War I, cyanide-based methods represented a symbolic departure from the sulphuric utopia of total hygiene. Proven to be relatively harmless to most bacteria, the increasing prevalence of HCN fumigation marked a shift toward vector control and ecological consideration, leading eventually to the introduction of sprayers and the application of DDT. But on the other hand, its most infamous variant, Zyklon B, would eventually translate the metaphorical content of maritime sanitation, disinfection, and disinfestation into the systematic extermination of millions under the Nazis.

Sulphuric Utopias

A History of Maritime Fumigation

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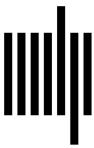

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