

## Spreading the Revolution: Guyton's Fumigating Machine in Spain. Politics, Technology, and Material Culture (1796-1808)

*Elena Serrano*

Salve Morvó! [sic]  
 Your inquiring mind  
 Made a sweet breath of life [...]  
 Which flying into the atmosphere  
 Purifies and destroys at once  
 The corrupted germ of death.<sup>1</sup>



In 1806, the Spanish poet Rosa Gálvez (1768-1806) published a seven-page poem celebrating the lawyer, chemist and politician Louis-Bernard Guyton de Morveau (1737-1816). During the first years of the century, an epidemic of yellow fevers caused thousands of deaths on the Spanish coasts. Guyton had arguably fabricated a gas that destroyed the agents of contagion that stubbornly remained in the atmosphere and goods for years. This “sweet breath of life” as the poet called it, was the controversial oxy-muriatic gas.

Guyton was a champion of oxy-muriatic gas. He not only wrote about its properties, but also with the prestigious French instrument-makers the Dumotiez brothers, he developed a machine that released the gas.<sup>2</sup> The fumigating machine embodied two essential features of Lavoisier's system of chemistry: the theory of acids and the theory of combustion.<sup>3</sup> As is well known, Lavoisier believed that all acids contained oxygen (including muriatic acid,

1 Rosa Gálvez, “Oda en elogio de las fumigaciones de Morvó [sic],” *Minerva o el Revisor General* 52 (1806): 3-10, on 8. My translation.

2 The reports do not distinguish between the two brothers, Louis Joseph and Pierre François. See Maurice Daumas *Les instruments scientifiques aux XVII et XVIII siècles* (Paris: Presses Universitaires de France, 1953), 378-79.

3 In Spanish it is often referred as *Máquina fumigatoria*; in French as *Appareil de désinfection*.

which Humphry Davy later demonstrated to be composed of hydrogen and chlorine). According to Guyton, the fumigating machine supplied a highly oxygenated compound of muriatic acid – oxy-muriatic acid– which destroyed contagious particles in a process akin to combustion.<sup>4</sup> The machine was intended to prevent gangrene in soldiers' wounds and to disinfect the air of poisonous sites such as jails, hospitals, theaters, churches, and ships. It was also widely used during epidemics of yellow fevers in Europe.

This essay focuses on the fumigating machine as a means to explore how beliefs and attitudes became embedded in societies and also inversely, how ways of interpreting nature, society, and politics became embedded in artifacts. It will show, first, how the machine served to spread the new French chemistry; second, how it came to embody a new relationship between citizens and the state, and third, how this artifact was imported by the Spanish absolutist state, appropriated, and used for its own propaganda. It thereby adds to this volume's general argument against simplistic narratives regarding the intellectual foundations of the chemical and industrial revolutions and argues against a "linear model" of technological development.<sup>5</sup> By focusing on a chemical artifact, it shows a historically more complex and significant interweaving of theory, material culture, and politics.

Simon Schaffer and Ken Alder have shown how instruments and technological artifacts are deeply political, moving beyond the view that instruments simply embody theory and visions of nature.<sup>6</sup> Schaffer has stressed the links of eudiometers with dissenters' political agendas, while in his classic book *Engineering the Revolution: Arms and Enlightenment in France, 1763-1815* Alder confronts the question of the politics of revolutionary guns.<sup>7</sup> He argues that a

4 Ruth Ashbee, "The Discovery of Chlorine: A window to the chemical revolution," Hasok Chang and Catherine Jackson, eds., *An Element of Controversy: The life of chlorine in science, medicine, technology, and war* (London: British Society for the History of Science, 2007), 15-40; William A. Smeaton, "Guyton de Morveau, Louis Bernard," Charles C. Gillispie, ed., *Dictionary of Scientific Biography* (New York: Scribner, 1976), 600-4.

5 See the essay by John Christie in this volume for a statement of this argument.

6 Simon Schaffer, "Measuring Virtue: Eudiometry, enlightenment, and pneumatic medicine," Andrew Cunningham and Roger French, eds., *The Medical Enlightenment of the Eighteenth Century* (Cambridge: Cambridge University Press, 1990), 281-318; On the relationship of instruments and theory, Trevor H. Levere, "The Role of Instruments in the Dissemination of the Chemical Revolution," *Éndoxa: series Filosóficas* 19 (2005): 227-42; Bernadette Bensaude-Vincent, *Lavoisier: mémoires d'une révolution* (Paris: Flammarion, 1993); John Tresch, *The Romantic Machine. Utopian science and technology after Napoleon* (Chicago: University of Chicago Press, 2012).

7 Ken Alder, *Engineering the Revolution: Arms and enlightenment in France, 1763-1815* (Princeton: Princeton University Press, 1997); Charles C. Gillispie and Ken Alder, "Exchange: Engineering the revolution," *Technology and Culture* 39 (1998): 733-54.

new, intimate relationship between politics and technology was forged during this period. Alder recognizes the interaction of artifacts and politics at different levels. The most obvious concerns the way in which technologies were bound up in struggles over sovereignty, over foreign policy, and over relations with different political groupings. The relationship between the oxy-muriatic acid fumigation and the politics of the Spanish state has been analyzed in these terms. During the 1970s, Spanish scholars construed the polemic between followers and detractors of acid fumigations as an example of the impossibility of pursuing authentic science in an authoritarian political regime.<sup>8</sup> It may be useful to recall that at that time, Spain was moving away from Franco's dictatorship, a regime notorious for its purges of scientists and its censorship practices. Recently, José Ramón Bertomeu and Antonio García Belmar have argued for a more nuanced view, in which a broad consensus about the efficacy of fumigation was fabricated not by the Government alone, but with the cooperation of other groups that shared academic and economic interests in fumigation.<sup>9</sup>

Artifacts could also be "potent icons."<sup>10</sup> For instance, Alder identifies the pick as a symbol of the revolutionary power of the French people. But his most important contribution from the viewpoint of this analysis is his turn to politics for an explanation of the design and functioning of artifacts. Rather than using technological or social determinism to explain why particular objects take the form they do at particular times, he stresses the political dimension of choices: "the deep structural level of politics necessarily shapes the way material objects and technological knowledge are organized and directed."<sup>11</sup> The essay will explore how the practices of fumigation afforded changes in the relationship between the citizen and the power of the state.

We must, however, be aware of the dangers of over-emphasizing the agency of artifacts on one hand, and of considering them as "empty vessels to be filled

8 Luis García Ballester and Juan L. Carrillo, "Un ejemplo de represión de la ciencia en la España absolutista: la supresión del capítulo 15 de la 'Breve descripción de la fiebre amarilla' (1806) de J.M. Aréjula," *Revista de Occidente* 134 (1974): 205-11; Juan L. Carrillo, Pedro Riera Perelló, and Ramón Gago, "La introducción en España de las hipótesis miasmática y prácticas fumigatorias. Historia de una polémica (J.M Aréjula – M.J Cabanellas)," *Medicina e historia* 67 (1977): 8-26; Luis García Ballester and Juan L. Carrillo, "The repression of Medical Science in Absolutism Spain: The case of Juan Manuel de Aréjula, 1755-1830," *Clio Medica* 9 (1974): 207-11.

9 Antonio García Belmar and José Ramón Bertomeu, "España fumigada. Consensos y silencios en torno de las fumigaciones ácido-minerales en España, 1770-1804" (in progress). The author was unable to consult this source before this essay was completed.

10 Gillispie and Alder, "Exchange," p. 745 (see note 7).

11 *Ibid.*, p. 743.

with meanings” on the other.<sup>12</sup> To avoid this danger, this essay approaches the fumigator through the study of its affordances. According to Susan J. Douglas, affordance may be defined as, “what certain technologies privilege and permit that others don’t.”<sup>13</sup> The concept of affordance has a relational ontology, and thus the affordances of objects change as their historical context changes. Affordance refers to “those functional and relational aspects of technology that frame but do not determine the possibilities for action in relation to an object.”<sup>14</sup> The analysis that follows takes into account this dynamic and relational construction of artifact-meanings. It is divided into two sections. The first deals with Guyton’s fumigating machine, while the second follows the instrument’s journey to Spain and the complex history of this relocation.

### Guyton’s Fumigating Machine

The disinfection apparatus that Guyton and the Dumotiez brothers designed basically consisted of a closed vessel that stored oxy-muriatic acid gas ready to use. Figs. 4.1 and 4.2 show the 1805 version for disinfecting big rooms. The machine ensured a controlled emission of the gas by way of an ingenious method of keeping it under moderate pressure in a glass bottle, which was housed in a wooden frame. A large screw held a wooden cap (H) that was pushed over a thick tap of glass (I) to keep the bottle closed. When the screw was loosened, the cover rose up under pressure from the gas, which escaped into the room. Notice that the piece (H) was specifically designed to engage with the columns (B), so it could easily be slipped through the columns. When one needed to refill the apparatus, the screw (E) was loosened, so that the bottle could be removed from its setting onto the surface of the board (D). Even when the apparatus required moving around the room while emitting the gas, the bottle remained safely in place.

12 Francesca Bray, *Technology, Gender and History in Imperial China: Great transformations reconsidered* (London; New York: Routledge, 2013), 8.

13 Susan J. Douglas, “Some Thoughts on the Question ‘How Do New Things Happen?’” *Technology and Culture* 51 (2010): 293-304, on 293; Ian Hutchby, “Affordances and the Analysis of Technologically Mediated Interaction,” *Sociology* 37 (2003): 581-89; Idem, “Technologies, Texts, and Affordances,” *Sociology* (2001): 441-56.

14 From Brian Rappert criticizing Ian Hutchby, in Brian Rappert, “Technologies, Texts, and Possibilities: A reply to Hutchby,” *Sociology* 37 (2003): 565-80, on 566; For an insightful discussion of the types of affordances, see Mats Frindlund, “Affording Terrorism: Idealists and materialities in the emergence of modern terrorism,” Max Taylor and P.M. Currie, eds., *Terrorism and Affordance* (London: Continuum, 2012), 73-92.



FIGURE 4.1  
A large disinfection apparatus for military hospitals and other public spaces. Museo Galileo's Photographic Archives: Pressure receiver (Inv.3778). COURTESY OF MUSEO GALILEO, FLORENCE.

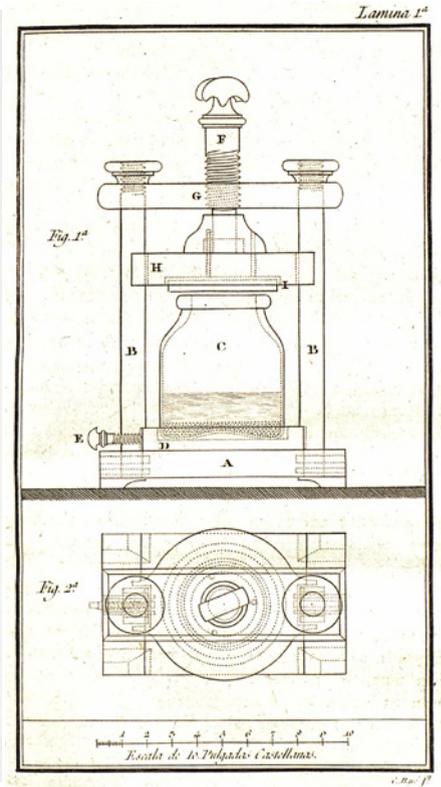


FIGURE 4.2  
Sketch of the large version of Guyton's disinfection apparatus as published in the *Semanario de Agricultura y Artes a los Párrocos*. COURTESY OF BIBLIOTECA DEL REAL JARDÍN BOTÁNICO, CSIC, MADRID.

No metal parts were used because the acid gas would corrode them. Once the apparatus was filled with reagents, one needed only to unfasten the screw, let the fumes of the oxy-muriatic acid flow, and fasten the screw back. For disinfecting hospitals, this was to be done once or twice a day, for a period of two to six minutes, dependent upon the size and occupancy of the ward. According to the leaflet that accompanied the machine, the gas lasted six months if used daily. In addition to the large version, the Dumotiez brothers also designed machines of a smaller size (Figs. 4.3 and 4.4). This latter was designed for carrying— with the caution of keeping it upright — in order to visit the sick, attend funerals, concerts, theaters, and masses.



FIGURE 4.3  
A portable version of Guyton's disinfection apparatus. COURTESY OF SCIENCE MUSEUM, SOUTH KENSINGTON, LONDON.

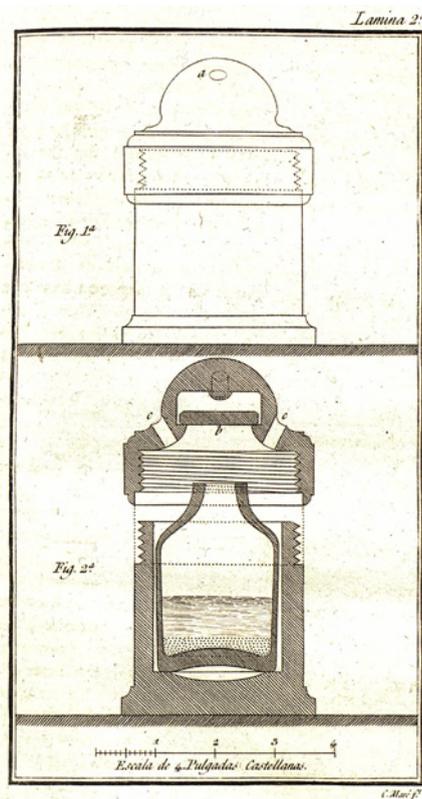


FIGURE 4.4  
Sketch of the portable version of Guyton's disinfection apparatus as published in the *Semanario de Agricultura y Artes a los Párrocos*. COURTESY OF BIBLIOTECA DEL REAL JARDÍN BOTÁNICO, CSIC, MADRID.

Although the fumigating apparatus might look simple, its construction involved a great deal of material research.<sup>15</sup> The system that confined the gas with the wooden screw was decided upon after models using ground-glass stoppers failed because the gas corroded them. The bottle was made with a new technique of grinding glass developed by Guyton. It also needed to have thick borders to resist the pressure of the screw and the gas. In addition, the

15 William A. Smeaton, "Platinum and Ground Glass: Some innovations in chemical apparatus by Guyton de Morveau and others," Frederic L. Holmes and Trevor H. Levere eds., *Instruments and Experimentation in the History of Chemistry* (Cambridge, MA; London, England: MIT Press, 2000), 211-37.

glass disk that sealed the bottle needed to be flat, as did the edge of the bottle, to allow perfect contact and avoid leaks of gas. The Dumotiez brothers recommended following the same technique as in the pneumatic machine.<sup>16</sup> The machine required construction by skillful craftsmen. In Spain, a Guyton-style machine was made by a gifted artisan and member of the Barcelona Academy of Sciences, Pelegrín Forés y Madaula (1775-1841).<sup>17</sup> The fact that this was highlighted in Forés y Madaula's obituary indicates the high prestige that constructing such an apparatus supposed. Indeed, one of the biggest issues faced during attempts to replicate the machine on a large scale in Spain was precisely the lack of specialized glassmakers and turners available to perform the work.<sup>18</sup>

Guyton's machine in its various forms was just one part of a spectrum of fumigation techniques performed with everyday gadgets and materials. Since ancient times, people had evaporated fumes of odoriferous stuff, including thyme, rosemary, juniper, wormwood, myrrh, incense, and vinegar, simply by heating pots.<sup>19</sup> Contemporary treatises on domestic economy included recipes for disinfecting with sulfuric, muriatic, and nitric acid, in which no special devices were needed.<sup>20</sup> To fumigate using sulfuric acid for instance, the Spanish agricultural magazine *El Semanario de Agricultura* suggested filling a normal clay pot with salt and putting it on a portable oven full of coal embers. The salt was stirred with a simple stick until one felt the heat, and then the sulfuric acid was carefully poured on.<sup>21</sup> In the fumigation of the Russian hospital ship *Union*, doctor Archibald Menzies heated sand in a clay receptacle, inserted a teacup containing sulfuric acid, and added powdered niter to produce fumes of nitric acid.<sup>22</sup> This raises the question of how contemporaries justified buying special-

16 Louis-Bernard Guyton de Morveau, *Traité des moyens de désinfecter l'air* (Paris: Bernard, 1805), 388.

17 Carlos Puig-Pla, "Els primers socis-artistes de la Reial Acadèmia de Ciències i Arts de Barcelona (1746-1842)," Agustí Nieto Galán and Antoni Roca Rosell, eds., *La Reial Acadèmia de Ciències i Arts de Barcelona als segles XVIII y XIX. Història, ciència i societat* (Barcelona: Institut d'Estudis Catalans, 2000), 287-310, on 300.

18 Levere, "The Role of Instruments" (see note 6).

19 Antonio Pérez de Escobar, *Avisos populares médicos y domésticos* (Madrid: D. Joachin Ibarra, 1776), 74-5; Félix Martínez López, *Reflexiones del Dr. Félix Martínez López sobre las enfermedades* (Valladolid: En la oficina de la viuda e hijos de Santander, 1788), 13; Marie Armande Jeanne Gacon-Dufour, *Moyens de Conserver la santé des habitants des campagnes* (Paris: Buisson, 1806), 165.

20 Miguel José Cabanelles, *Observaciones sobre los gases ácido-minerales* (Cartagena: Manuel Muñiz, 1802), 18-22.

21 Anon., "Medicina Doméstica," *Semanario de agricultura y artes* 1 (1797): 70-2.

22 Juan Manuel Aréjula, *Memoria sobre el modo y ocasiones de emplear los varios gases para descontagiar los sitios epidemiados* (Sevilla: Imprenta Mayor, 1800).

ized precision instrumentation to do something that could be done with pots and pans.<sup>23</sup>

The fumigating machine was part of an explosion of contemporary gadgets aimed at transforming the “atmosphere” of densely populated cities, which people of the last decades of the century felt were becoming alarmingly contaminated.<sup>24</sup> Frightening warnings about urban airs were heard almost everywhere. In Barcelona, for example, members of the Royal Academy of Medicine vividly described how Barcelona air, being “full of fetid particles, corrupted, acrid, corrosive, and poisonous”, damaged health.<sup>25</sup> Thomas Garnett, of the Royal Institution in London, described English city air as a, “chaos of eternal smoke and volatile corruption from the dead, the dying, sick’ning, and the living world.”<sup>26</sup> A British leaflet announced the sale of fumigating ingredients for removing the “foetid smells, stagnated and putrid air” which were “the cause of many dreadful diseases [...] which so frequently prove fatal.”<sup>27</sup> In this climate of anxiety the fumigating machine provided an easy, quick, and handy way of disinfecting.

Oxy-muriatic gas became an object of consumption, a commodity. The fumigating machine was marketed as a reservoir of a potent disinfectant ready to use, which provided a standardized, reliable means of fumigating.<sup>28</sup> It offered educated urban elites a new optimistic feeling of controlling contagion. Chemists succeeded in enclosing hermetically (or almost hermetically) a powerful new gaseous substance. Designed with the latest material technology, filled up with kits of ingredients prepared by chemists or pure ingredients purchased in apothecaries the fumigating machine fostered the authority of chemical – mostly male – experts, and nourished the prestige of the new chemistry.

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- 23 On the adapted use of household items, see Simon Werrett’s essay in this volume.
- 24 Vladimir Janković, *Confronting the Climate: British airs and the making of environmental medicine* (New York: Palgrave Macmillan, 2010); Candance Ward, *Desire and Disorder: Fevers, fictions, and feelings in English Georgian culture* (Lewisburg: Bucknell University Press, 2007).
- 25 Academia Médico-Práctica de Barcelona, *Dictamen de la Academia Médico-Práctica* (Barcelona: Carlos Gibért y Tutó, 1784), 26.
- 26 Thomas Garnett, *A Lecture on the Preservation of Health* (Liverpool: J. M’Creery, 1797).
- 27 Gerard William Groote, *Fumigating Ingredients, to Remove Offensive Smells, Foul, Putrid and Stagnated Air* ([London], [1780?]).
- 28 That was probably the reason why in 1807 the Spanish Government spent 258 *Reales de Vellón* on two fumigating machines for disinfecting La Corte jail. Archivo Histórico Nacional (AHN): Consejos, 1397, folio 375.

## Empowering Oxygen

In 1801, disappointed by the city of Genoa's management of the fever epidemic of 1800, Guyton published his *Traité des moyens de désinfecter l'air* (Treatise on the Means of Purifying Infected Air).<sup>29</sup> The *Traité* enjoyed three editions (1801, 1802, and 1805), and was translated into English, Spanish, German, and Italian.<sup>30</sup> Furthermore, it was widely publicized in journals, magazines, and domestic economy manuals. The way in which Guyton demonstrated in the *Traité* the superiority of the acids, and particularly, the oxy-muriatic acid, is revealing of the epistemic and moral affordances that the fumigating machine offered to contemporaries.

Guyton described his experiments for testing the disinfectant properties of different substances with a kind of chemical miasma-test that he developed. The miasma-test constructed the authority of oxy-muriatic acid as the supreme disinfectant, and so it is worth describing it in detail. Guyton made three assumptions. First, he elaborated on the relation of "fetid and pernicious" odors (supposedly caused by maladies within bodies), and concluded that they could only come from some constituent of the body.<sup>31</sup> Second, he logically argued that since odors were part of bodies, and a body only remained the same while it preserved all its properties, it followed that to destroy the odor was to destroy the body – a dangerous challenge.<sup>32</sup> Here Guyton made a crucial distinction between chemists and lay people. Lay people many times confounded "destruction" with "masking"; only the knowledgeable chemist could determine when a disinfectant was working. With these assumptions, Guyton put into practice his test. He left three samples of meat under a glass bell until it became "perfectly putrid" after six days. Then he kept the pestiferous odor in a bottle, which he connected to another one that contained the supposed disinfectant.<sup>33</sup> If the disinfectant destroyed the foul odor, it meant that it might also destroy the miasmas.

Guyton tried perfumed waters and mineral acids and concluded that only mineral acids had the power to destroy the odor, and therefore, the miasmas. Now, seeking for a chemical rationale to explain why acid destroyed putrid

29 Louis-Bernard Guyton de Morveau, *Traité des moyens de désinfecter l'air* (Paris: Bernard, 1801).

30 For quotations in English, I use the English translation, Louis-Bernard Guyton de Morveau, *A Treatise on the Means of Purifying Infected Air*, trans. R. Hall (London: J. & E. Hodson, 1802).

31 Guyton, *Traité*, p. 92, point 59 (see note 29).

32 *Ibid.*, p. 93, point 60.

33 *Ibid.*, pp. 68-9.

miasmas, Guyton argued that miasmas could not be simple bodies because simple bodies could not reproduce. Miasmas should then be organic bodies, from which it followed that miasmas could be destroyed by fire. Using a dramatic image for his readers, Guyton asked “When the clothes or furniture of a person dead of the plague are burned, does any one suspect that the virus, with which they were infected, can be found entire in the ashes?”<sup>34</sup> For the very same reason then, miasmas could not resist the “condensed oxygen” of the mineral acids, which produced the combustion of organic bodies, in Guyton’s words “the most astonishing of combustions.” Guyton celebrated the power of the oxy-muriatic acid with these words: “Such are the properties of oxygen, of super-oxygenants, of acid fumigations, and, above all, of the oxygenated muriatic acid gas.”<sup>35</sup>

The oxygenated muriatic acid was thus construed as a product of chemical research, based, according to Guyton, on “the most exact experiments”, “the application of principles the most evident,” and “the consequences of observations drawn from the most authentic sources.”<sup>36</sup> Modern chemistry discovered that fumigating with acids, especially with the oxy-muriatic acid, had the same purifying effect as fire: “Such is the grand instrument of disinfection which modern chemistry has brought to our knowledge.”<sup>37</sup>

### Moralizing Fumigations, Empowering Citizens

Four years later, Guyton went even further. In the 1805 edition of the *Treatise*, fumigating with oxy-muriatic acid acquired a moral dimension. Guyton had already received the Napoleonic *Legion of Honour*. According to the award letter (published in the *Treatise*), the reasons were not only his numerous writings that advanced chemistry, but also the discovery that fumigations with muriatic acids could stop the contagion of yellow fevers, “the rival of the plague.” Moreover, the letter continued, he had invented a fumigation apparatus that was “very useful.”<sup>38</sup> In addition to including three sketches of the fumigating machines, Guyton concluded the *Treatise* with a meaningful paragraph. After stressing that he had provided all kind of proofs of the efficacy of mineral

34 Guyton, *Treatise*, p. 218 (see note 30); Guyton, *Traité* p. 263 (see note 29).

35 *Ibid.*, p. 268.

36 Guyton, *Treatise*, p. 221 (see note 30); Guyton, *Traité* pp. 267-8 (see note 29).

37 Guyton, *Treatise*, p. 223 (see note 30); Guyton, *Traité*, p. 266 (see note 29).

38 Guyton, *Traité*, p. viii (see note 16); The apparatus were sold in Dumotiez’s shop at 12 Rue des Jardinets.

fumigations, the theoretical principles on which their action was grounded, the ways to apply them, and even the instruments for making the practise easy, Guyton stated, in upper case: "THE CONTAGION CANNOT BE BORN AND SPREAD IF NOT BY THE MOST CULPABLE NEGLIGENCE."<sup>39</sup> Fumigating was no longer a personal choice, but a moral responsibility. Thus, the disinfection machine embodied the conceptual and moral power of the new chemistry, warranting chemists' intervention in both the private and the public spheres for the sake of the whole of society.

The machine also embodied the changing relationship between political power and the citizenry. Epidemics expose how power is exercised and how deep social inequalities may be. The control of the contagion implied a tight control of the population. The traditional way of fighting epidemics resembled traditional forms of conquest. Troops sent by the sovereign besieged the infected city. Quarantines and Lazarettos served to isolate populations at the discretion of the authorities.<sup>40</sup> The city doors were closed and a tight military *cordon sanitaire* prevented traffic between the infected city and the outside.<sup>41</sup> No one could travel without a sanitary passport, except the rich, who as soon as the epidemic was declared, fled the city.<sup>42</sup> Sick poor indigents were moved to hospitals, those suspected of being sick to the lazaretto, while the dead were buried with quicklime. Prisoners were forced to conduct the carts of corpses.<sup>43</sup> Cannon were fired in infected neighbourhoods in the belief that this dispersed

39 Ibid., p. 596.

40 Mercedes Pascual Artiaga, "La ciudad ante el contagio: medidas políticas y administrativas dictadas en la epidemia de fiebre amarilla de 1804 en Alicante," *Asclepio* 54 (2002): 125-53, on 133-4; On the *cordon sanitaire* in Malaga see *Gaceta de Madrid* 71 (04/09/1804): 791; See also *Gaceta de Madrid* 77 (25/09/1804): 857-9. The Government forbade the people of Madrid to communicate with Málaga, Vélez, Antequera, Montilla, and Alicante under punishment of five years of exile for nobles and prison for lay people.

41 Anon., *Edicto general comprehensivo de todas las reales provisiones* (Barcelona: Manuel Texéro, 1800), 202-10; See also Capitanía General Cádiz, *Cerciorado ya de que la enfermedad que reina en Málaga* (S.l., 1803?). <<http://bdh-rd.bne.es/viewer.vm?id=0000070734&page=1>> Accessed 6 December 2015.

42 Juan L. Carrillo, and L. García Ballester, "El comportamiento de las clases y grupos sociales de Málaga en las epidemias de fiebre amarilla," *Cuadernos de la historia de la medicina española* 11 (1972): 88-95; See also Juan Manuel Aréjula, *Breve descripción de la fiebre amarilla padecida en Cádiz* (Madrid: Imprenta Real, 1806), Figure 6, in which he numbered the people who fled the city of Malaga.

43 Andrés Pérez Baylón, *El templo de la muerte* (Malaga: Francisco Martínez de Aguilar, 1804).

the infection.<sup>44</sup> Those who dared to escape from the lazarettos were shot, as were burglars of contaminated houses. Commerce was strongly controlled and smuggling was punished with the gallows. The cost of the epidemic was huge. Military and the other expenses were great, while commerce withered. Ships from infected ports were quarantined and not allowed to anchor in other ports.<sup>45</sup> Once the epidemic was over, goods suspected of being infected – bed-clothes, wool, furniture and books – were burnt or buried with limestone. “Only fire, gold, and gallows cure the fevers,” a medical saying stated.<sup>46</sup>

In contrast, the fumigating machine fought the contagion in a profoundly different way. The wellbeing of the whole community was assured by fumigating with gas that, arguably, democratically disinfected the houses of poor and rich identically. Unlike military violence, this manner of stopping the contagion appealed to citizens’ moral responsibility, by asserting their responsibility for their own health and that of their peers. Citizens were thereby empowered but were also culpable if infected. The discourse shifted from a state that assured control of epidemics and the population by means of force to a more subtle register, in which it assured control through its own citizens, who were now responsible for protecting themselves and their peers.

In 1804, the Spanish Prime Secretary Manuel Godoy (1767–1851) decided to manufacture thirty thousand fumigating machines for distribution among the population of southern Spanish towns suffering from yellow fever epidemics.<sup>47</sup> The Spanish ambassador in Paris sent three models (large for hospitals, medium for households, and a portable version) to guide production.<sup>48</sup> However, it soon became apparent that massive and rapid replication was impossible. Guyton’s apparatus proved too expensive and sophisticated to be produced on this scale. As other essays in this volume argue it was often a process of elaborating and extending already known procedures rather than

44 Six cannon shots were fired in Malaga over two days in 1803. AHN: Consejos, 11975. “Junta de Sanidad: Sobre las precauciones con motivo de la enfermedad de Málaga.”

45 Archivo Histórico de la Univesidad Complutense (AHUC): “Reglamentos Navales” in *Providencias generales*, artículo 93.

46 Anon., *Reflexiones acerca de la epidemia que Reyna [sic] en Cádiz* (Madrid: Imprenta Real, 1800), 46.

47 In 1800, the Cadiz fever epidemic killed 7,387 people (population 48,520), in Seville 14,685 (population 80,568); in Malaga 1803, 6,887 (population 51,7459); in 1804, 11,486. The 1804 epidemics extended to Alicante (2,472 dead people, population 13,212), Antequera (2,948, population 14,5779), Velez Málaga (5,245, population 12,700), Córdoba (400, population 40,000), Cádiz (28,92, population 54,899), and Cartagena (11,445, population 33,222). Aréjula, *Breve*, figures 1-6 (see note 42).

48 Anon., *Mercurio de España* (15/4/1805): 69-71.

radical innovation that solved problems posed by large-scale production.<sup>49</sup> The royal apothecary, entrepreneur, and chemistry professor Pedro Gutiérrez Bueno (1745-1822) responded in this case with a new model of Guyton's machine, rendering it easier to replicate.

### The Fumigating Machine Travels to Spain

Gutiérrez Bueno's ability to move comfortably between artisanal, fashionable, and academic milieu was the key to establishing the Spanish fumigating machine's authority.<sup>50</sup> Educated as an apothecary, in 1788 Gutiérrez Bueno translated the *Méthode de nomenclature chimique* of Lavoisier, Guyton de Morveau, Fourcroy and Berthollet.<sup>51</sup> He taught chemistry in the surgeons' college of San Carlos (1801-1804) and was director of the Royal Laboratory of Chemistry from 1787. Situated in the center of Madrid, the laboratory hosted his popular chemical classes which were frequented by craftsmen, apothecaries, and aristocrats.<sup>52</sup> Gutiérrez Bueno was close to influential people, such as the poet and politician Leandro Fernández de Moratín, who called him "Petrus Bonus", and the editor Juan Antonio Melon, who published Gutiérrez Bueno's treatise on dyes and glass making.<sup>53</sup> In 1790, Gutiérrez Bueno famously accom-

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- 49 See the essays by Christie and Simmons, this volume. Thomas P. Hughes, "The Evolution of Large Technological Systems," Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch eds., *The Social Construction of Technological Systems: New directions in the sociology and history of technology* (Cambridge, MA: MIT Press, 1987), 51-82, esp. 57-58; Thomas P. Hughes, *American Genesis: A century of invention and technological enthusiasm, 1870-1970* (Chicago: University of Chicago Press, 2004), 53 ff.
- 50 Paula Carrasco Jarabo, "Vida y obra de Pedro Gutiérrez Bueno," *Boletín de la Sociedad Española de Historia de la Farmacia* 15 (1964): 154-69; 16 (1965): 10-24; 71-86; 101-18 and 153-77; Carrasco transcribes a document in the Archivo General del Palacio Real de Madrid (Leg. 490, Exp. 26), in which Gutiérrez Bueno listed his merits ((1965): 113-14). He prepared the acids for fumigating, the machines, and the leaflets to be sent to Granada, Cádiz, Valencia, and other villages.
- 51 Louis-Bernard Guyton de Morveau et al., *Método de la Nueva Nomenclatura Química* (Madrid: Don Antonio de Sancha, 1788).
- 52 Antonio García Belmar and José R. Bertomeu Sánchez, "Pedro Gutiérrez Bueno, los libros de texto de química, y los nuevos públicos de la química en el último tercio del siglo XVIII," *Dynamis* 2 (2001): 351-74; José R. Bertomeu Sánchez and Antonio García Belmar, "Pedro Gutiérrez Bueno (1745-1822) y las relaciones entre la química y la farmacia durante el último tercio del siglo XVIII," *Hispania* 208 (2001): 539-62.
- 53 Melon published the journal *Semanario de Agricultura y Artes*, in which Gutiérrez Bueno's daughter María Antonia collaborated.

panied an aristocratic female association, the *Señoras de las cárceles*, to analyze the Madrid prisons' air.<sup>54</sup> He was also keen to participate in public health issues. He discussed the quality of Madrid airs and waters and the proper way of coating pots for preventing certain type of fevers.<sup>55</sup> In addition, some of his entrepreneurial activities were closely related to the oxy-muriatic acid.<sup>56</sup> He directed the production of sulfuric acid in a manufactory beside the Manzanares River. In 1790, he translated Berthollet's treatise on the use of oxy-muriatic acid for bleaching, and employed Berthollet's method in the Royal Manufactory of San Idelfonso. He even designed a domestic machine, which according to him, easily bleached cloth at home with oxy-muriatic acid.<sup>57</sup>

It was this acquaintance with materials, devices, and large-scale production that allowed Gutiérrez Bueno to substantially cheapen Guyton's models. This he did using low-cost wood, substituting round forms for square boxes (which were easier to mold), and inventing a new system for holding the gas (see Fig. 4.5). Instead of screws, Gutiérrez Bueno used wedges. To release the gas, one opened the box by pulling up the cover and dragging out the wedge. Gutiérrez Bueno also developed a large apparatus similar to Guyton's, minus the round forms and screw, which was both simpler and easier to repair. If the wedges came loose, one only needed to add another piece. In addition, the bottles that held the gas could be cheaper, since the system of sealing the glass did not require as much pressure as the Parisian ones. Finally, the Spanish portable machines apparently lasted longer than some of the Guyton models, because the wood did not directly suffer from the corrosive effect of the gas.<sup>58</sup> The

54 Elena Serrano, "Chemistry in the City: The scientific role of female societies in late eighteenth-century Madrid," *Ambix* 60 (2013): 139-59.

55 Pedro Gutiérrez Bueno, "Informe," *Memorial Literario*, Agosto (1790): 73-8; Pedro Gutiérrez Bueno, *Análisis de las aguas de Madrid* (Madrid: Imprenta de Villalpando, 1800); Pedro Gutiérrez Bueno, *Método práctico de estañar las vasijas de cocina* (Madrid: Imprenta de Villalpando, 1803); See also Carrasco, "Vida y obra", pp. 107-114 (see note 50).

56 Pedro Gutiérrez Bueno, *Instrucción práctica para destilar las aguas fuertes* (Madrid: Don Blas Román, 1787).

57 Pedro Gutiérrez Bueno, *Memoria sobre el blanqueo del lino, algodón y otras materias* (Madrid: Don Antonio de Sancha, 1790).

58 Anon., *Memoria sobre las disposiciones tomadas por el Gobierno para introducir en España el método de fumigar* (Madrid: Imprenta Real, 1805), 8, footnote; The author explained that out of his thirty-five French portable models, the wooden cases of twenty-four were cracked. For the models sold by Gutiérrez Bueno, see *Descripción y uso del aparato permanente para desinfectar el ayre [sic]* (Madrid: Imprenta de Villalpando, 1805).

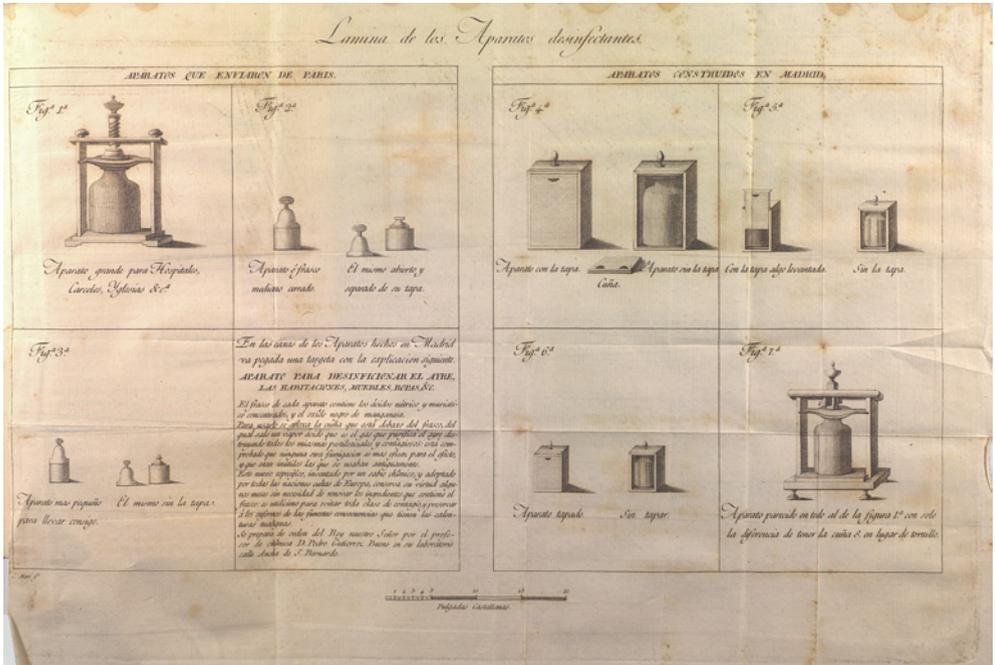


FIGURE 4.5 *Fumigating machines made in Paris alongside those made in Madrid. Anon., Memoria sobre las disposiciones tomadas por el Gobierno para introducir en España el método de fumigar (Madrid, 1805). COURTESY OF BIBLIOTECA DE CATALUNYA, BARCELONA.*

Spanish machines were first distributed in 1805 for the “complete disinfection” of Cartagena.<sup>59</sup>

### Marshalling with Enlightened Reformers

The Spanish fumigating machines were construed as material proof of the providence, enlightenment, and effective *oeconomic* policies of the Government. In her poem about Guyton’s fumigations mentioned at the beginning of this essay, Rosa Gálvez not only praised Guyton, but also the Prime Secretary Manuel Godoy for popularizing fumigation in Spain. In Galvez’s words, Godoy was a “beneficent hero”, who destroyed envy, false piety and vile superstition (referring to clergymen who refused to fumigate churches).<sup>60</sup> In fact, the

59 Anon., *Memoria*, p. 9 and pp. 27–32 (see note 58).

60 Gálvez, “Oda”, p. 10 (see note 1).

Government issued substantial propaganda promoting its role in stopping the yellow fevers. In 1805, it published a two hundred-page treatise, comprised of an extensive narration and supporting documents, the *Memoria sobre las disposiciones tomadas por el Gobierno para introducir en España el método de fumigar* (*Memoire on the dispositions taken by the Government for introducing in Spain the fumigating method*).<sup>61</sup> These included descriptions of experiments, readers' letters from the infected cities to local newspapers, correspondence between Godoy and the Supreme Health Board (*Junta Suprema de Sanidad*) and translations of foreign documents, such as the Napoleonic regulations of military hospitals.

As illustrated in figure five, the treatise presented the Spanish machines side by side with the Parisian ones, in a way that encouraged comparison.<sup>62</sup> The image suggested that the king had done a great service to the Spanish population by promoting the benefits of oxy-muriatic disinfection. Moreover, on the label that accompanied the bottles, the reader learned that the apparatus was "invented by a wise chemist [...] adopted by all the educated nations of Europe" and prepared by order of the "King, our Master."<sup>63</sup>

At that time, Spain endured great economic and political turmoil. The weakness of the Monarchy was evident to Spaniards and foreigners alike. Alliance with France in 1797 pulled the country into conflict with Great Britain with devastating consequences for colonial commerce and state finances. The changing relationship with France seriously damaged the uneasy equilibrium between Spain's three traditional political forces, namely, the church, the so-called aristocratic party of the Count of Aranda, and the reformers. The Inquisition gained power and former members of the Government were now prosecuted. Defending the mineral acid fumigations for combating the contagion was a convenient way for Godoy and the Spanish Crown to align with the reformers, without thereby taking on additional political risks.<sup>64</sup>

61 Anon., *Memoria* (see note 58).

62 *Ibid.*, figure 1.

63 *Ibid.*, p. 9.

64 Emilio Lparra López, "La inestabilidad de la monarquía de Carlos IV," *Studia histórica. Historia Moderna* 12 (1994): 23-34; Jean René Aymes, *España y la revolución francesa* (Barcelona: Crítica, 1989); Claude Morange, "Las estructuras de poder en el tránsito del Antiguo al Nuevo Régimen," Joseph Pérez and Armando Alberola, eds., *España y América entre la Ilustración y el liberalism* (Alicante; Madrid: Casa de Velázquez- Instituto de Cultura Juan Gil-Albert, 1993), 35-7; Emilio LaParra, *La Alianza de Godoy con los revolucionarios* (Madrid: Consejo Superior de Investigaciones Científicas, 1992); Emilio LaParra, "Ilustrados e Inquisición ante la Iglesia constitucional francesa," *Revista de Historia das Ideias* 10

Disinfecting public spaces such as jails and hospitals was deeply connected with new ideas about the role of the state in public welfare. In Spain, from the 1780s onwards, societies of “friends of the country” and scientific associations translated foreign treatises and experimented on the disinfecting properties of different acids. The Royal Academy of Medicine of Madrid translated Jean Janin’s *L’antiméphitique* and tested the disinfection power of vinegar. In Barcelona, Carles Gimbernat championed disinfection with nitric acid. He invented a heating lamp for evaporating the fumes of the acid, and translated Smyth’s account of the disinfection of the Russian ship *La Union*.<sup>65</sup> The bishop of Barcelona, Pedro Díaz Valdés a cleric with sympathy for the Spanish Jansenist movement, ordered the printing and distribution of Guyton’s disinfection method.<sup>66</sup> Valentín de Foronda, a member of the Economic Society of Vascongadas and author of numerous essays on political economy, translated Guyton’s article from the *Encyclopédie Méthodique*.<sup>67</sup>

The Government took a very active role in promoting oxy-muriatic acid disinfection. In particular, it promoted public experiments. As scholars have shown, engaging audiences was an effective means to circulate ideas and practices, selling instruments, gaining adepts, and legitimating experts.<sup>68</sup> In July 1805, a commission of prestigious savants did experiments at three different sites: the pharmacy of Gutiérrez Bueno, the Real Casa Hospicio, which hosted Madrid vagabonds and poor people, and its stables.<sup>69</sup> The conclusion was that fumigation with oxy-muriatic acid could be safely applied to goods, people, and animals. These experiments were projected as crucial for the Spanish economy. To prove the advantages that the practice of fumigation would bring, the *Memoria* included the orders that the Supreme Board of Health (*Junta*

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(1988): 359-74; Gonzalo Anes, *Economía e ilustración en la España del siglo XVIII* (Barcelona: Ariel, 1969).

65 Jean Janin, *El antiméfitico* (Madrid: Imprenta Real, 1782); James Smyth, *Relación de los experimentos hechos por Mr. Menzies* (Madrid: Viuda de Ibarra, 1800).

66 Joaquim Puigvert, ed., *Bisbes, Il·lustració i jansenisme a la Catalunya del segle XVIII* (Vic: Biblioteca Universitaria, 2000); Juan Bada, “Don Pedro Díaz de Valdés, obispo de Barcelona (1798-1807),” *Anthologica Annua* 19 (1972): 651-74.

67 José Manuel Barrenechea, *Valentín de Foronda, Reformador y Economista Ilustrado* (Álava: Diputación Foral, 1984).

68 Bernadette Bensaude-Vincent and Christine Blondel, eds., *Science and Spectacle in the European Enlightenment* (London: Ashgate Publishing, 2005); Geoffrey Sutton, *Science for a Polite Society: Gender, culture, and the demonstration of enlightenment* (Denver: Westview Press, 1995); James van Horn Melton, *The Rise of the Public in Enlightenment Europe* (Cambridge: Cambridge University Press, 2001).

69 Anon., *Memoria* “Informe de los Facultativos,” pp. 37-40 (see note 58).

*Suprema de Sanidad*) circulated in Malaga in 1804, and those circulated in Cartagena in 1805 for readers to compare. The Malaga orders involved older methods used to disinfect the city after the *cordon sanitaire* period ended.<sup>70</sup> For four months, goods could not be taken out of the city and houses that sheltered sick people had to remain closed. Mattresses, linen and clothes were burnt or buried in the waste grounds with lime. In the ports, quarantine was imposed on all goods. Textile goods were hung in the sun and air for weeks; other merchandise was kept in storehouses for months, or burnt. In contrast, the measures employed in Cartagena in 1805 used machines designed by Gutiérrez Bueno. Twice daily, neighbourhood directors carried out domestic fumigations.<sup>71</sup> The disinfection was completed in a month.

In a way, the acid fumigating technology revived the circulation of goods and people halted by the infection. The doctor Miguel Cabanellas designed special fumigating machines for disinfecting clothes in the lazaretto of San Joseph, Cartagena (figures 4.6 and 4.7). The first was a kind of big closed box with a grid in the middle for letting the gas pass through the textiles. The second was a kind of hut in which one sat while the fumes of the oxy-muriatic acid percolated from below, and which included a breathing-tube for persons worried about inhaling oxy-muriatic acid (item k in Fig. 4.7).

Cabanellas also designed a lazaretto that can be understood as a chemically-based plant for recycling people and goods back to normal circulation (Fig. 4.8). The lazaretto was separated from the city by ditches and walls. It was organized in individual cells where the sick were placed for recovery.<sup>72</sup> Special units for disinfecting clothes and objects were strategically situated. Mattresses, bedclothes, furniture, animals, and people were properly disinfected before being returned to the other side of the ditch. Fumigating allowed goods to be safely reintegrated in the ambient sociomaterial environment.<sup>73</sup>

There is one puzzling question that must be asked. Did the oxy-muriatic acid work? A partial answer may be found in an apparently trivial comment of Cabanellas. While fumigating the mattresses of the Cartagena lazaretto, he noted that all the bedbugs and cockroaches died.<sup>74</sup> The insecticide properties

70 Ibid., "Número Sexto," pp. 33-5; Artiaga, "La ciudad," (see note 40); Mariano Peset and José Luis Peset, *Muerte en España. Política y sociedad entre la peste y el cólera* (Madrid: Seminarios y Ediciones, 1977); Esteban Rodríguez Ocaña, "La cuestión del lazaretto marítimo permanente en la España del siglo XVIII, de Cádiz a Mahon," *Asclepio* 40 (1988): 265-76.

71 Anon., *Memoria* "Número Quinto," pp. 27-32 (see note 58).

72 Quim Bonastra, "Los orígenes del lazaretto pabellonario. La arquitectura cuarentenaria en el cambio del setecientos al ochocientos," *Asclepio* 60 (2008): 60-61.

73 On sociomaterial environments, see Lissa Roberts and Joppe van Driel, this volume.

74 Miguel Cabanellas, *Defensa de las fumigaciones ácido-minerales* (Madrid: Repullés, 1814).

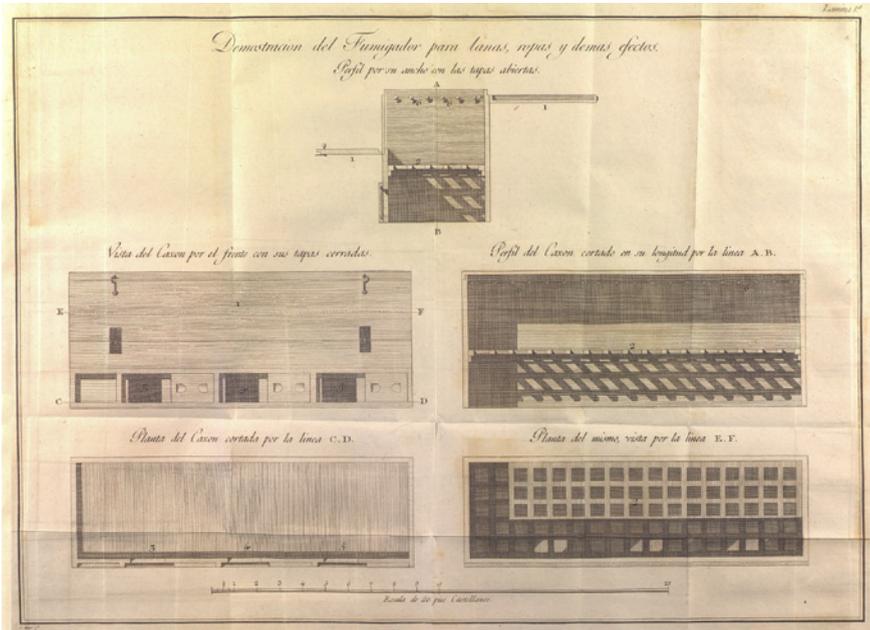


FIGURE 4.6 *Fumigating machine for objects in Anon., Memoria.* COURTESY OF BIBLIOTECA DE CATALUNYA, BARCELONA.

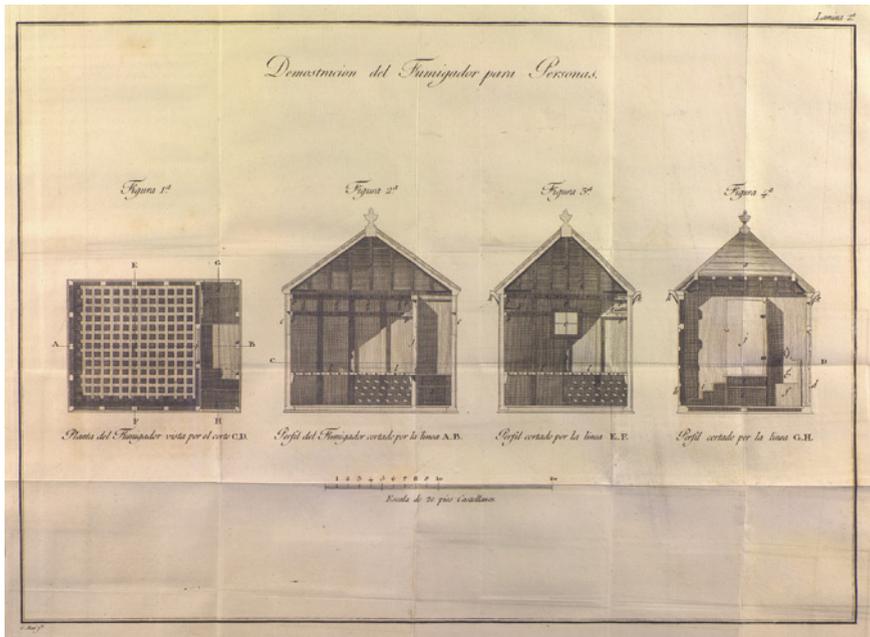


FIGURE 4.7 *Fumigating machine for people in Anon., Memoria.* COURTESY OF BIBLIOTECA DE CATALUNYA, BARCELONA.

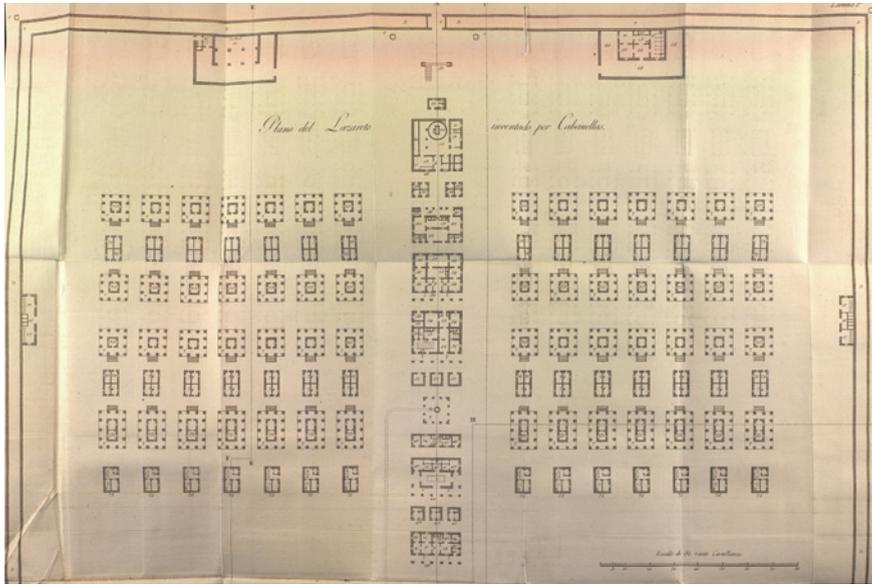


FIGURE 4.8 *Ideal Lazaretto. Memoria*. COURTESY OF BIBLIOTECA DE CATALUNYA, BARCELONA.

of the oxy-muriatic acid were also described in other cases. So fumigations may have been effective after all. As is well known, the virus that provoked yellow fever is transmitted by the bite of a tropical mosquito. The infectious mosquito crossed the Atlantic in American ships, and due to the mild and humid conditions of some Spanish towns, easily reproduced. The oxy-muriatic acid (chlorine) may have inhibited the cycle of infection when used in isolated environments, such as the closed neighborhoods of some southern Spanish towns.

### Making Political Propaganda

The fumigating machine was pictured by the Government as a political weapon that could be wielded to win a battle that Spain had been forced to wage “in the middle of its sorrows and calamities”. The *Memoire on the dispositions taken by the Government for introducing in Spain the fumigating method* mentioned in the former section finished with the following paragraph:

People around the world! The annihilation of the last germ of the yellow fever is in your power. The Peruvian Bark and the mineral fumigations

can achieve that important victory, and when you celebrate it, turn your thankful eyes to Spain, which had such a great role in assuring it to you, and who in the middle of its sorrows and calamities, enjoyed the advantage of having the firm, noble and prudent character of the Prince of Peace [ie. Godoy].<sup>75</sup>

Political propaganda was also disseminated through other media. In 1806, the *Semanario de agricultura y artes* published several articles on acid fumigation and on the crucial role of the Government.<sup>76</sup> The official *Mercurio de España* circulated the letter in which the Ministry of War recommended the use of fumigations in hospitals, lazarettos, jails, and military quarters.<sup>77</sup> Moreover, the Government censured opinions opposed to acid fumigations.<sup>78</sup> There was the notorious case of physician Juan Manuel Aréjula, director of the Health Board in Malaga, who had to cut out a whole chapter on the uselessness of the oxy-muriatic acid for disinfection in his treatise on yellow fever.<sup>79</sup> In December of 1803, the Government ordered the closure of the popular journal *El Correo de Madrid*, and arrested the publisher, owing to the way it depicted the Malaga epidemics.<sup>80</sup>

Nonetheless, some sense of the medical opposition to fumigations may be gained through the *Libro de Juntas* of the Royal Academy of Medicine in Madrid, which contains the minutes of its weekly meetings. With a membership including the most prominent doctors of the time, one of the academy's functions was to advise the Supreme Board of Health.<sup>81</sup> In May of 1804, the academy was consulted on whether the cases of fevers that appeared in Malaga

75 Anon., *Memoria* p. 71 (see note 58).

76 "Extracto de la Memoria que acaba de darse al publico", *Semanario de Agricultura y Artes* 20 (1806): 65-72; 89-94; 99-102; 121-128; 141-144; 159-160; 172-176.

77 Anon., *Mercurio de España* 15/8/1806: 177-80.

78 Ballester and Carrillo, "Repression" (see note 8); Belmar and Bertomeu "España fumigada" (see note 9).

79 The chapter was in Aréjula, *Breve descripción*, (see note 42). He published it when the Government changed: *Memoria sobre la ninguna utilidad del uso de los gases ácidos* (Esparaguera: Imprenta del Gobierno, 1821). See Juan L. Carrillo, *Juan Manuel de Aréjula (1755-1830). Estudio sobre la fiebre amarilla* (Madrid: Ministerio de Sanidad y Consumo, 1986); García Belmar and Bertomeu, "España fumigada" (see note 9).

80 AHN. Consejos, 1975: Junta de Sanidad. 26-December- 1803. All the volumes were forbidden.

81 Luis Granjel, *Historia de la Real Academia Nacional de Medicina de Madrid* (Madrid: Real Academia Nacional de Medicina, 2006).

constituted an epidemic or not.<sup>82</sup> The long discussions that followed spotlight the lack of agreement on the origin, treatment, and prevention of fevers that existed in eighteenth-century medical circles.<sup>83</sup>

In 1805, the Government encouraged the academy to respond “judiciously” to foreign works that denied the contagious character of yellow fevers. In particular, the Government specified works from “Anglo-Americans who wanted to confuse us.”<sup>84</sup> Notwithstanding this opposition, the Academy made honorary fellows of the physicians Benjamin Rush from Philadelphia and Samuel Lathan Mitchill from New York.<sup>85</sup> The former defended the opinion that yellow fever was not contagious, while the latter defended a doctrine of infection incompatible with prevention by acids. Medical correspondence between physicians who worked in the infected cities also suggested disagreement on the uses of fumigations.<sup>86</sup>

A closer look to what lay people thought about fumigations is provided by the irreverent manuscript *Diálogo de los muertos* (*Dialogs of Dead*) written in Malaga in late 1803, when the city was still cordoned off.<sup>87</sup> The *Diálogo* narrates a conversation held by eight dead people – French, English, Portuguese, Italian, Catalan, Muslim, a Malaga citizen, and a “sensible-man” called Salomon. It is an exceptional document, which openly criticizes the perceived arbitrary and corrupt behavior of the authorities. The story reflects the inhabitants’ fears of being unjustifiably secluded in the lazaretto, their animus against the prohibition of masses and religious parades, and their anger against bribed authorities who allowed ships to skip quarantines and facilitated the spread of contaminated merchandise. But above all, the story expressed anger with governmental measures, which the inhabitants of Malaga would later have to pay. Anger was especially directed against fumigations: “they robbed the people with the

82 Archivo de la Real Academia de Medicina de Madrid (ARAM): Junta Extraordinaria del 2 de Mayo de 1804.

83 Ward, *Desire* (see note 24). See also José Manuel López, “Dos textos epidemiológicos ineditos de Antonio Amodóvar Ruiz-bravo (1763-1823),” *Gimbernat* 2003 (39): 55-67.

84 ARAM, *Diario de Juntas*, 19 September 1805.

85 ARAM, *Diario de Juntas*, 24 October 1805.

86 José Antonio Coll, *Apuntes sobre la fiebre amarilla de Cadiz* [Manuscrito]. Biblioteca Histórica Universidad Complutense Madrid, BH Mss 853 (3). Doctor Jose Antonio Coll wrote from Cadiz on the methods for preventing the contagion, including a handkerchief of vinegar applied to the nose, quarantines, isolation of the sick, but he did not mention fumigations.

87 Juan L. Carrillo, Jesús Castellanos and María Dolores Ramos, *Enfermedad y sociedad en la Málaga de comienzos del siglo XIX: El diálogo de los muertos en la epidemia de Málaga (c.1803)* (Malaga: Universidad de Málaga, 1980), 7-11.

fumigations in the port and in the town.” The French character as the stereotype of a revolutionary, proclaimed: “When the rights of the citizen and the free man are so greatly attacked, [...] it is an heroic act to break the chains of so shameful and vile a slavery.”<sup>88</sup>

These opinions forcefully expressed in the *Diálogo* suggest that people did not in fact universally perceive fumigations as either useful or liberating. Some saw them instead as a burden. Ultimately it was the people of the villages who had to pay for the cost of fumigations, mainly in the form of council taxes, so that fumigations were perceived as a new form of corruption among the authorities, as an excuse to generate wealth. Governmental propaganda was clearly not universally persuasive, and may even have had a negative effect on people’s opinions.

### Conclusion

The fumigating machine embodied the power of the ‘new chemistry’, both in its materiality – newly-formulated, manufactured gases, the thick glass of the bottle, the pneumatic techniques used for sealing its cover and controlling gas emission – and in its conception, which was grounded on the oxidation properties of acids, a feature of Lavoisier’s chemistry. The machine also embodied the belief that the agents of contagion were chemically sensitive entities, the miasmas. Although their precise nature was unknown, they could be combated chemically. The choice of the oxy-muriatic acid above other acids was construed as the product of intelligent chemical design and careful experiments. Moreover, Guyton stressed that the experiments were done by a trained chemist who distinguished between “destroying an odour” and “masking it”, emphasizing the distance between the muriatic oxygenated acid and other domestic methods of fumigating.

The machine was thus presented as a scientific device, whose authority as such was initially supported by its external appearance (expensive woods, convincing technology, precision of manufacture and use) and the fact that it was sold by famous instrument makers in Paris. It was advertized as a *reliable* means of fumigation. The user did not need to bother about the quantities of ingredients and time of fumigation because the machine provided a standard way to proceed. It was a ready-to-use device, and so was pictured as giving lay people operational independence from apothecaries and other knowledgeable people. However, it simultaneously contributed to increasing the gap

88 Carrillo, Castellanos and Ramos, *Enfermedad y sociedad*, p. 8 (see note 87).

between lay people and savants. As Simon Werrett argues in this volume, it was a common practice for natural philosophers to work in domestic settings, and ingeniously use everyday objects for their research. Fumigation with mineral acids could probably have been done with adapted domestic devices. But introducing a ready-to use machine eventually detached the knowledge of fumigating techniques from domestic users, so that the knowledge became a matter of expert production and commodity consumption, encouraged – to a degree enforced – by government. Thus the supposed independence of the newly responsible, operative citizen was mediated through an alienation brought about by expert manufacture, and through new degrees and forms of political-administrative control afforded to governmental and municipal authorities. Godoy and the Spanish Bourbon court effectively transformed the machine into a political tool.

Scholars have accounted for the changes that occurred in the eighteenth-century in health policies as a general strategy of power. Using the Foucauldian concept of biopower, they have documented the new practices that linked the care of the individual and the social body to the processes of state formation. However, as Claudia Stein has pointed out, it “was not a straightforward linear process replacing sovereign power [by biopower], but rather, a matter of struggle and contestation within the eighteenth-century absolutist state.”<sup>89</sup> It was certainly the case in Spain that degrees of intra-elite contestation and popular resistance to the new regime of disinfection and public health were visibly present, despite the propagandist efforts of government, despite the figuring of the machine to convey values of patriotism, dedication and *oeconomy*, and despite the public writings and public demonstrative experimentation of chemists and physicians.

Finally, this essay has highlighted the importance of material culture for explaining the embedding of knowledge in society. The fumigating machine probably did more for spreading the new chemistry of acids and gases than any textbook. The machine afforded a particular understanding of how knowledge should be produced, a particular view of contagion and sickness, of the connections between body and environment, chemistry and life, and of sickness and social responsibility. Because it possessed these affordances, it also helped to forge a new relationship between the power of the state and the citizen.

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89 Claudia Stein, “The Birth of Biopower in Eighteenth-Century Germany,” *Medical History* 55 (2011): 331-37, on 335.

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