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Introducing Chemical Fumigation in the French and British Navies in the Late Eighteenth and Early Nineteenth Centuries: A Comparative Approach

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Abstract

Since antiquity, a common technique to stop epidemics consisted of burning aromatic plants as the beliefs of the time held that odoriferous smokes destroyed contagions. However, late eighteenth-century discoveries about air questioned that idea while the concept of chemical fumigation gained credit. The British physician James Carmichael Smyth and the French chemist Louis-Bernard Guyton-Morveau actively promoted new techniques of fumigation in their respective countries. If they disagreed on the best product to use, they both considered vapours of mineral acids to be the most effective method against miasmas in closed spaces. Ships were prominent among the places where contagions were frequent. Both the Admiralty and its French counterpart – The Ministry of the Navy – decided to tackle this recurring problem by introducing chemical fumigation to their departments. Yet, they developed different policies to achieve that aim. While the Ministry of the Navy only forwarded theoretical treatises to the Prefects, the Admiralty used a teaching-by-example strategy involving the distribution of fumigating materials which led to better implementation of the technique on board British vessels. The divergence of approach resulted from personal relationships as a comparison with a third department – the French Ministry of the Interior – reveals. Indeed, the more links that scientists had within an administration, the more promotion chemical fumigation received.

Keywords

Fumigation, navies, mineral acids; vapours, Louis-Bernard Guyton-Morveau, James Carmichael Smyth.

Introduction

During the seven years he spent on the Guinea Coast, Julien Mallet de la Brossière, an eighteenth-century French surgeon, had the opportunity to closely observe many aspects of the slave trade not just in the way that it limited individual freedom but also the dreadful effects it imposed on individuals. Initially it was the high number of deaths amongst the captives which led him to condemn this form of commercial enterprise. However, as he was unable to bring it to an end, he chose to focus on alleviating some of the worst atrocities. In 1787 he began by sending the Société Royale de Médecine a short treatise focusing on the best means to preserve the slaves' lives during the notoriously dangerous Atlantic crossing.[1] In addition to advocating the improvement of their food and drink, he also stressed the importance of purifying the 'putrid atmosphere', often termed miasmas, of the overcrowded ships in the belief that this was responsible for the transmission of diseases. To achieve this, he recommended throwing gunpowder moistened with vinegar into the fire to obtain a smoke which would purify the air. This technique was already a familiar form of fumigation which promoted the belief that the use of smokes or vapours could be used specifically for both therapeutic and hygienic purposes. Throughout antiquity it is possible to find evidence of sulphur being used in different forms, including gunpowder, to destroy harmful miasmas. In addition to minerals, vegetable substances or animal-related products were also used to create smokes which were used in various forms of medical treatment.

Due to the revolution which took place in chemistry during the late eighteenth century, however, many came to question and openly discredit popular concepts including the efficacy of fumigation. Physicians and chemists such as David MacBride (1726-1778) and later Jean-Antoine Chaptal (1756-1832) questioned the rationale of using only aromatic smokes to suppress miasmas. According to them, this approach only masked bad smells produced by an unhealthy atmosphere. To thoroughly purify the air, other scientists advocated vapours of certain mineral acids. Such ideas were developed in France and in Britain where the chemist Louis-Bernard Guyton-Morveau (1737-1816) and the physician James Carmichael Smyth (1741-1821) respectively saw the advantages of this development as the best way to stop contagions spreading in confined places where stagnant air was a problem, including hospitals, jails and particularly ships.

Crews of many types of shipping often had to endure not only the problems of overcrowding but also the most basic of rations. In such conditions it is not surprising that many fell victim to a range of diseases often first contracted onshore. Sea routes from one continent to another therefore became highly dangerous vectors of diseases. This was especially true in times of war, where the need to mobilise troops became a priority. By the late eighteenth century this causal link between contagion and conflict was a major concern among both armies and navies. One of the most important early examples of this was an epidemic of yellow fever which first appeared in the Caribbean in 1793 and which was exacerbated by the presence of both the French and the British.[2]

[1] Mallet de la Brossière J. Essai sur les maladies les plus communes à Juida sur la côte de Guinée et sur les moyens de conserver les noirs dans leur traversée de la cote de Guinée à nos colonies. 132B file 23, pièce n°2. Société Royale de Médecine.

[2] Blake J. Yellow Fever in nine-Century America. *Bulletin of the New York Academy of Medicine*. 1968; 44: 673-86.

Vessels and their crews then brought the disease back to Europe where it caused further levels of suffering. Well aware of the role of ships in the spreading of contagious disease and acknowledging the necessity to preserve their soldiers' lives if they were to be victorious, between 1780 and 1806 those in charge of both French and English troops therefore spent the period trying to find ways to prevent epidemics on board ships, with most interest being shown in chemical fumigation.

The different approach followed by each country allows an interesting comparative study that involves not just the science and medicine but also the politics of the age. In the following discussion, comparison will focus on the work of James Carmichael Smyth who spent much of his professional career reporting on fumigation experiments in places run by the Admiralty from 1780 to 1799.[3] [4] [5] Simultaneously, Guyton-Morveau's theoretical treatise [6] and supplemental correspondence within the Ministry of the Navy [7] shows what was taking place in France. Such a comparison of this type of body of work provides a valuable insight not only into different ideas relating to methods of promoting chemical fumigation but also factors relating to the context of events taking place in each country.

The emergence of chemical fumigation to improve mariners' health

In 1696 the Scottish physician William Cockburn (1669-1739) wrote the first medical treatise exclusively dealing with diseases specific to seamen.[8] This first publication paved the way for many similar writings, especially in the second half of the eighteenth century, though it was work including Lind's (1716-1794) *Essay on the most effectual Means of preserving the Health of Seamen* [9] and Thomas Trotter's (1760-1832) *Medica Nautica* [10] which had the greatest impact in Britain. Across the channel the French surgeon G Mauran [11] [12] and the physician Antoine Poissonnier-Desperrières (1723-

[3] Smyth JC. *A Description of the Jail Distemper as it Appeared Amongst the Spanish Prisoners at Winchester, in the Year 1780*. London: J Johnson; 1795.
[4] Smyth JC. *An Account of the Experiment Made at the Desire of the Lords Commissioners of the Admiralty on Board the Union Hospital Ship, to Determine the Effect of the Nitrous Acid in Destroying Contagion*. London: J Johnson; 1796.
[5] Smyth JC. *The Effect of the Nitrous Vapour, in Preventing and Destroying Contagion*. Philadelphia: Budd and Bartram; 1799.
[6] Guyton-Morveau LB. *Traité des moyens de désinfecter l'air. 1st Ed*. Paris: Bernard; 1801.
[7] Correspondance au départ des mouvements de la Flotte, an IX. Marine Vincennes BB2 69. Service Historique de la Défense (SHD).
[8] Cockburn W. *An account of the Nature, Causes, Symptoms and Cure of the Distempers that are Incident to Seafaring People*. London: Newman; 1696.
[9] Lind J. *Essay on the most effectual Means of preserving the Health of Seamen in the Royal Navy. 2nd Ed*. London: Wilson; 1762.
[10] Trotter T. *Materia Nautica: An Essay on the Diseases of Seamen*. London: Longman; 1797-1803. 3 vol.
[11] Mauran G. *Essai sur les maladies qui attaquent le plus communément les gens de mer*. Marseille: Mossy; 1766.
[12] Mauran G. *Avis aux gens de mer sur leur santé*. Marseille: Mossy; 1786.

c1793) [13] were also concerned with improving the health of sailors. This concern with such a specific section of the population suggests a deep-rooted concern at the time that seamen showed a particular vulnerability towards illness which had to be rectified at all costs.

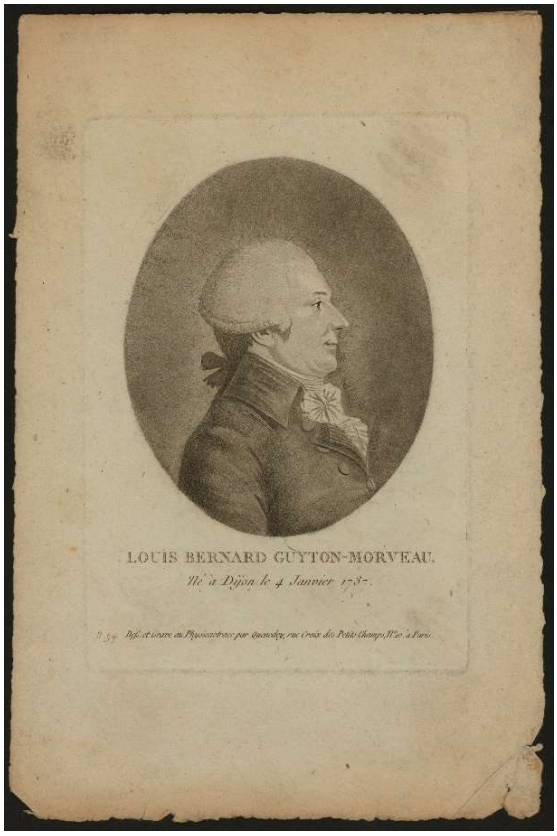
To explain the context of this problem, those medical professionals with an interest in hygiene saw ships as the archetypal model of unhealthy living conditions. A sailor's life was one of continual dampness which created an unpleasant level of humidity retained not just in clothes but in the very fabric of the ship.[14] It is also interesting that the amount of unseasoned wood used in new ships also made them 'more unhealthy' than older craft, a fact noted by Stephen Hales (1677-1761).[15] Smells emanating from vessels also mingled with the odours of putrefying food and decaying cargoes. However, it was the foul emanations produced by cramming crews into small spaces often without any natural ventilation which physicians feared the most. In such places the mixture of excrement and urine combined with the sweat to degrade the air to an extent that few could bear to inhale it for long.

Such was the problem of this foul air that Sebastien-François Bigot de Morogues (1706-1781) tried to analyse its content scientifically and concluded that all such noxious vapours caused a lack of elasticity of the air so making it 'very prejudicial to the health of the crew'.[16] Innovative discussions such as these showed the urgent need to ventilate all parts of the ships to avoid the problem of stagnant air. In addition to environmental issues there were some, for example James Carmichael Smyth, who were prepared to add such factors as the lack of morale which seemed to be prevalent in many sailors and which was often exacerbated by the harshness of life at sea.[17]

While the challenges facing sailors were often unique to their time at sea there were still similar problems when it came to other places which the navies had to run such as prisons and hospitals. The atmosphere in these sites was almost as malignant as on board ships since the same problems of overcrowding and confined spaces applied. In hospitals, the smell of putrefying bodies, plasters and other remedies prevailed. In hospital ships, and on prison ships too, the putrid atmospheres of these different locations combined. The dangerous air in navy-run buildings was indeed well-known and scientists and medical professionals suggested various solutions to overcome it. Some of those proposals applied the new theories of the time regarding the circulation of air. In addition to new ideas such as Hales' ventilating devices,[18] other more traditional, long-established theories were retained, as in the use of fumigation. In 429 BCE, Hippocrates had recommended burning herbs and wood to stop the epidemic

[13] Poissonnier-Desperriéres A. *Traité des maladies des gens de mer*. Paris: Lacombe; 1767.
[14] Corbin A. *Le Miasme et la Jonquille : l'odorat et l'imaginaire social, XVIIIe-XIXe siècles. New Ed*. Paris: Flammarion; 2016.
[15] Hales S. *A Description of Ventilators whereby Great Quantities of Fresh Air may with Ease be conveyed into Mines, Goals, Hospitals, Work-Houses and Ships*. London: Innys; 1743.
[16] Bigot de Morogues SB. Corruption de l'air dans les vaisseaux. *Mémoires de mathématiques et de physique*. 1750; 1: 394-410.
[17] Smyth. *A Description of the Jail Distemper*, 1795 (Note 3).
[18] Hales. *A Description of Ventilators*, 1743 (Note 15).

raging in Athens.[19] By the eighteenth century, physicians were performing the same action but were now justifying it theoretically by claiming that odours opposed atmospheric defects. It was also believed that smells might actually improve the defences of the body while restoring the air quality. Ideas like these helped explain the recommendations to use odoriferous smokes on board ships which were still upheld by eminent scientists of the day. In France, Bigot de Morogues suggested burning sulphur before filling the steerage with smokes of tar and gunpowder moistened with vinegar.[20] The same recommendation was made in Britain thirty years later by Gilbert Blane (1749-1834) who also attributed 'good effects to [vapours of] resinous bodies, such as the woods of fir, spruce, and juniper'.[21]



Portrait of Louis Bernard Guyton-Morveau. Edme Quenedey (engraver), 'Louis Bernard Guyton-Morveau. Né à Dijon le 4 Janvier 1737', between 1790 and 1820. Stipple engraving. Library of Congress Prints and Photographs Division Washington, D.C., LOT 13400, no 56.

[19] Blancou J. Les méthodes de désinfection de l'Antiquité à la fin du XVIIIe siècle. *Revue Scientifique et technique de l'Office national des épizooties*. 1995; 14: 21-39.
[20] Bigot de Morogues. Corruption de l'air, 1750 (Note 16).
[21] Blane G. *Observations on the diseases incident to Seamen*. London: Cooper; 1785.

However, the use of aromatic smokes began to be criticized following the discoveries of pneumatic chemistry. Building on Felix Vicq d'Azyr's (1748-1794) accusation that they only masked bad smells[22], Louis-Bernard Guyton-Morveau chemically justified their inefficacy in *Traité des moyens de désinfecter l'air*. According to him, aromatic vapours only mingled with miasmas without changing their properties, instead of combining with them to produce a new entity presenting different characteristics. He therefore condemned 'the deceitful security' of odoriferous smokes and turned towards mineral acids. He held them to be the only effective substances able to break down contagious elements in the air so that new combinations of matter could happen. However, not all mineral acids were equally effective, and after several experiments, he considered oxygenated muriatic (hydrochloric) acid to be the most effective. Its efficacy relied on the expandable nature of its vapours charged with a large amount of oxygen. The air component to which Guyton-Morveau attributed a medical virtue was essential to break down the various elements composing miasmas. It was also argued that it strengthened the vital forces of the body and made it more resistant to disease. Oxygen was thus a preservative remedy, exceptionally concentrated in the vapours of oxygenated muriatic acids.[23] Despite these scientific explanations, Guyton-Morveau failed to convince James Carmichael Smyth.

The British physician had already run a series of experiments regarding vapours of mineral acids when he heard about Guyton-Morveau's treatise. His opinion on smokes of oxygenated muriatic acid was that they were 'extremely deleterious' especially after he conducted an experiment in which he exposed a greenfinch to them, which then had difficulties in breathing. Notwithstanding this disappointing experiment, he understood the value of mineral acids and believed their vapours to be 'the most powerful agents in nature' but, contrary to the French chemist, he did not attempt to explain scientifically the reason behind this idea. Rather than long theoretical explanations, Smyth preferred experimentation in the hope of finding which smoke of mineral acid was the least dangerous and the most effective against epidemics. He successively exposed a mouse, a greenfinch and even himself and his chemist assistant to several of those vapours. Smyth concluded that smoke of nitric acid ('nitrous vapour') was the most effective due to its penetrating quality and its lack of unpleasant smell. Oxygenated muriatic acid, however, was the worst substance he tested.[24] On this basis Smyth disagreed with Guyton-Morveau regarding the proper mineral acid to use against contagious diseases. A rivalry ensued in which both claimed to have been the first to utilise mineral acids as an anti-contagious remedy. The ease of operating their respective methods of fumigation on vessels was another matter. In that debate, they proudly promoted the safety of their technique as it did not require fire. Though not mentioned in official reports, this argument may have been one of the reasons that led both the French and British navies to develop fumigation using mineral acids on board their vessels.

[22] Vicq d'Azyr F. *Instruction sur la manière de désinfecter une paroisse*. Paris: Imprimerie royale; 1775.
[23] Guyton-Morveau. *Traité des moyens de désinfecter l'air*, 1801 (Note 6).
[24] Smyth. *The Effect of the Nitrous Vapour*, 1799 (Note 5).

Promoting the use of chemical fumigation

In comparison to its French counterpart, the Admiralty in Britain showed an interest in chemical fumigation as early as 1780. By that time, the American War of Independence was raging and a large number of the Spanish soldiers imprisoned by the British during that conflict had jail – or hospital – distemper. The contagion spread so rapidly in Winchester prison that the nearby hospital dealing with the most advanced cases could not cope with the increasing number of sick coming in every day. Concern that the disease might spread to the rest of the population was one of the main contributing factors that led the Commissioners for the Care of Sick and Wounded Seamen and of Prisoners of War (the Sick and Hurt Board) to approach Smyth for advice on containing the epidemic. As physician at the Middlesex Hospital, he had used fumigation with nitric acid along with proposing strict rules of hygiene. This strategy produced some promising results as the sick rate among the prisoners fell from 17.9% on 3 June to 8.5% by 8 July.[25]

Due to this apparent success, the Admiralty approached Smyth in 1795 to contain a contagious fever raging on board the *Union* hospital ship. This time the sick were not prisoners but Russian mariners fighting alongside Britain against the French in the War of the First Coalition. Three months of daily fumigation with nitrous vapour helped to restrain the contagion according to Smyth's report.[26] That experiment was therefore seen as a success. It certainly strengthened the long-term partnership between the physician and the Admiralty and indeed, after the events in Winchester, the Admiralty applied to Smyth every time it was threatened by an outbreak of a contagious disease. In return, Smyth acknowledged the Admiralty for facilitating his experimental approach by dedicating publications to the Admiral of the Fleet.[27,28] This reciprocal exchange enabled the improvement of Smyth's technique, a dynamic which was not possible in France where no direct relation existed between Guyton-Morveau and the Ministry of the Navy.

Though Guyton-Morveau supervised the first instructions mentioning chemical fumigation sent by the Ministry of the Navy to naval hospitals, no collaboration ever happened between the chemist and the Ministry. Indeed, the document produced in 1794 had been ordered by the National Convention; the Ministry of the Navy was only in charge of forwarding it to the medical practitioners over whom it had authority.[29] It was only in 1801 that the Ministry of the Navy promoted chemical fumigation of its own will. By that time, yellow fever was endemic in many countries closely associated with France including Spain and the United States.[30]

To overcome yellow fever and other contagious diseases raging on board vessels, the Minister of the Navy, Pierre Alexandre Laurent Forfait (1752-1807), decided to promote the fumigation technique. However, he did not contact Guyton-Morveau directly. Instead, he only asked the Minister of the Interior to give him the copies of the

[25] Smyth. *A Description of the Jail Distemper*, 1795 (Note 3).
[26] Smyth. *An Account of the Experiment*, 1796 (Note 4).
[27] Smyth. *An Account of the Experiment*, 1796 (Note 4).
[28] Smyth. *The Effect of the Nitrous Vapour*, 1799 (Note 5).
[29] Guyton-Morveau. *Traité des moyens de désinfecter l'air*, 1801 (Note 6).
[30] Lettre du Ministère de la Marine au Ministre de l'Intérieur, Paris, le 6 Nivôse an IX. Marine Vincennes BB2 69, f°257. SHD.

chemist's treatise so that he could forward them to Commanders and Maritime Prefects.[31] Therefore, the Minister did not require the chemist to be an active participant. Not only did that absence of communication between the administrator and the scientist prevent any possibility of fruitful exchange but it also deprived surgeons and physicians of concrete examples of disinfection using chemical fumigation. Instead, they had to deal with a 300-page theoretical treatise written by a member of the Académie des Sciences who mainly addressed a knowledgeable readership. It is mostly composed of the results of experiments and only the last twenty pages are practical.[32] Therefore, the work did not fit the aim of the Ministry of the Navy to develop anti-contagious smokes.

The problems this caused become more apparent when compared to the situation in Britain where, in order to promote chemical fumigation, the Admiralty widely circulated Smyth's report on the experiment made on board the *Union* hospital ship. The 75-page booklet was not only shorter than Guyton-Morveau's treatise but also more practical. By sending it to all those in charge of fumigation processes along with fumigating materials it was likely to be much more effective. The Sick and Hurt Board also asked all medical practitioners to report every use of chemical fumigation on board vessels. Some of these accounts which gave examples of successful implementation were published not only to convince the sceptics but also to follow a teaching-by-example strategy. This also led to improvements in the fumigation technique thanks to responses received: several naval surgeons, for instance, suggested revisions regarding fumigating materials such as a change of construction for the fumigating pot or the addition of iron cups.[33]

The amelioration of chemical fumigation on board vessels was the aim of such proposals. However, other suggestions were more ambitious and intended to extend the technique to the rest of society. One of the most interesting was the example of the surgeon David Paterson who used Smyth's vapours of nitric acid while in charge of the prisoners of war at Forton Hospital. Satisfied with their effects on dysentery, fever and especially ulcers, he tried them on his children who were seized with whooping cough during the summer of 1797, without apparent adverse effects.[34] Though he acknowledged the need of further experimentation, Paterson proposed the extension of chemical fumigation to all of society to overcome contagion. This type of exchange of experiences orchestrated by the Admiralty and the Sick and Hurt Board created a dynamic mood of innovation which would benefit not just the military and naval populations but the whole nation, which was in stark contrast to the situation in France. Indeed, official reports mentioning the use of chemical fumigation on board vessels never existed, and Guyton-Morveau personally deplored the lack of communication. He had to rely instead on word of mouth to find out about the utilisation of his technique. One such instance occurred by chance when a fellow member of the Institut de France informed him of the regular fumigation of ships stationed at Rochefort.[35] This underlines the absence of communication between Guyton-Morveau and the Ministry of the Navy, as well as the government's lack of control over the use of fumigation. It explains in

[31] Lettre du Ministère de la Marine au Ministre de l'Intérieur, Paris, le 3 Messidor an IX. Marine Vincennes BB2 69, f°290. SHD.
[32] Guyton-Morveau. *Traité des moyens de désinfecter l'air*, 1801 (Note 6).
[33] Smyth. *The Effect of the Nitrous Vapour*, 1799 (Note 5).
[34] Smyth. *The Effect of the Nitrous Vapour*, 1799 (Note 5).
[35] Guyton-Morveau. *Traité des moyens de désinfecter l'air*, 1801 (Note 6).

many instances the failure to implement the fumigation technique correctly, so making it ineffective in many French vessels.

Consequently, French mariners did not adopt chemical fumigation as widely as their British counterparts. This was particularly evident in 1797 when the French took over the care of their prisoners-of-war in Britain. Complaining about the cough caused by Smyth's fumigation, the French physicians replaced it with aromatic smokes. They even sent back the fumigating material to the Admiralty under the astonished eyes of the British.[36] The behaviour displayed by the French thus clearly showed their unfamiliarity with chemical fumigation. The British, however had fully integrated Smyth's technique into their practice from the late eighteenth century and the strategy chosen by the Admiralty to promote chemical fumigation was more successful than schemes followed by the Ministry of the Navy. This observation raises the question as to why these two navies chose such different approaches regarding anti-contagious smokes.

The reasons behind the promotion of chemical fumigation

The difference of approach was not so much the outcome of deliberate strategies but was more the inevitable result of different degrees of involvement. By sending fumigating materials to all the vessels, hospitals and prisons under its watch, the British Admiralty was financially committed to developing nitrous vapours. The regular requests of the Sick and Hurt Board for accounts of fumigation also suggests that this was both a time-consuming and costly endeavour and as such could not be seen as being other than effective. The Admiralty and the Board therefore exerted considerable energy in promoting chemical fumigation. However, the French Minister of the Navy displayed no such involvement to the extent that he even refused to buy his own copy of Guyton-Morveau's treatise and instead asked the Minister of the Interior for his personal copy.

As mentioned above, from 1801 to 1805 in France the Ministry of the Interior tried to match the commitment of the Admiralty regarding chemical fumigation. Before this in 1794 the Ministry had released an instruction involving vapours of mineral acids though this was in response to orders from the National Convention. It was only in 1801 that the Minister of the Interior, Jean-Antoine Chaptal, acted independently in favour of chemical fumigation and sent every Prefect a copy of Guyton-Morveau's treatise.[37] In 1803 he once more reinforced his views on the importance of anti-contagious smokes in a pharmacopoeia aimed for use in hospitals, prisons and beggars' asylums. However, these instructions did not have the effects hoped for and in 1805 Jean-Baptiste Nompère de Champagny (1756-1834), following in the footsteps of his predecessor, was forced to send communications promoting the technique. On this occasion he also distributed the new edition of Guyton-Morveau's treatise and two other texts the chemist had sent him. One dealt with the anti-contagious properties of acids whereas the other summarised the fumigating instructions. Most importantly Champagny sent materials to the Prefects of the regions of France directly threatened by the epidemics raging in Spain and Italy. These contained two devices improved upon by Guyton-Morveau himself

[36] Smyth. *The Effect of the Nitrous Vapour*, 1799 (Note 5).

[37] Lettre du Ministre de l'Intérieur Jean-Baptiste Nompère de Champagny aux Préfets, Paris, le 30 Nivôse an XIII, F^8 156 Affaires particulières. Archives Nationales.

working in collaboration with the instrument maker Louis-Joseph Dumotiez (1757-c1820). A small, portable apparatus contained the substances needed to produce vapours of oxygenated muriatic acid for a single person and was an improvement on a larger one designed to fumigate an entire room.[38] Of course, Champagny knew these two devices were not enough for an entire district. That is why he also addressed the importance of Dumotiez's advertising brochure to the Prefects in the hope that this would encourage them to be responsible for buying more apparatus if necessary. Now charged with encouraging the population to use chemical fumigation, it was hoped that the Prefects would send to the Ministry accounts of their progress regarding successes in fumigating their areas. Some took this duty very seriously and even produced shorter versions of Guyton-Morveau's treatise to make it accessible to a broader public.[39] The Ministry of the Interior was, therefore, much more involved in the promotion of the fumigating method. In that regard, it adopted a strategy comparable to the one of the Admiralty, as they both sent fumigating materials and asked for reports.

The comparison of the three bodies certainly illustrates the importance of personal relationships. The existing bonds between members of the administration and scientists advocating anti-contagious vapours proved to be crucial to their implementation. This is seen with Smyth's close connections with the Admiralty in contrast with Guyton-Morveau's lack of relations with the Ministry of the Navy. However, he was a friend of Chaptal, the first Minister of the Interior, who willingly promoted chemical fumigation. It is interesting to note that both were chemists and members of the Académie des Sciences and later of the Institut de France. Together, as well with several eminent scientists including Antoine-François Fourcroy (1755-1809), Claude-Louis Bertholet (1748-1792) and Antoine Parmentier (1737-1813), they directed the journal *Les Annales de Chimie*. Chemistry was not the only interest they shared: they were also ardent defenders of industrialisation. As such, Chaptal and Guyton-Morveau were respectively President and Vice-President of La Société d'Encouragement pour l'Industrie Nationale, and in 1804 they both rejected the concept of the dangerousness of industries for neighbouring populations. Thus, the two men regularly worked together with the same interests in mind. Throughout the Revolution they used their respective positions both in politics and in sciences to protect and promote each other's ideas. Chaptal, as Minister of the Interior took every advantage of his role to spread his colleague's chemical fumigation in the country.[40] [41]

If the relationship between Chaptal and Guyton-Morveau accounts for the dedication to anti-contagious smokes displayed by the Ministry of the Interior, Smyth's extensive network was crucial in Britain. His connections in the Admiralty and the Sick and Hurt Board helps explain the diffusion of chemical fumigation within the Royal

[38] Guyton-Morveau LB, Monge G, Berthollet CL, Fourcroy AF, Adet P, Hassenfratz JH *et al*. Description et usage des appareils de désinfection de M. Guyton-Morveau. *Annales de Chimie*. 1804; 52: 374-52.

[39] Lettre du Ministre de l'Intérieur, le 30 Nivôse an XIII (Note 37).

[40] Le Roux T. *Le Laboratoire des pollutions industrielles: Paris, 1770-1830*. Paris: Albin Michel; 2011.

[41] Le Roux T. Du bienfait des acides. Guyton de Morveau et le grand basculement de l'expertise sanitaire et environnementale (1775-1809). *Annales Historiques de la Révolution Française.* 2016; 1(383): 153-75.

Navy. Indeed, it was thanks to his acquaintance with the physician John Fothergill (1712-1780) that the Board first approached him. Once introduced, Smyth took great care to develop his relationships with influential people, for example Doctor Robert Lulman, First Commissioner of the Board, whom he praised several times in his book about Winchester.[42] In similar fashion, the physician dedicated two of his publications to Lord Admiral George Spencer (1758-1834) to prove his gratitude and preserve his network.[43,44] However, one of the most crucial relationships Smyth developed over the years was with Doctor James Johnston, a Commissioner of the Sick and Hurt Board. They met following a trial of nitrous vapours at Portsmouth. That experiment immediately convinced Johnston of the positive effects of chemical fumigation. From then on he 'became a warm advocate' of those smokes and helped their promotion as much as he could. Johnston was especially crucial in collecting medical practitioners' reports on fumigation experiments. He forwarded those accounts to Smyth who published some of them to keep his technique at the forefront.[45] Smyth's acquaintances were thus essential to developing his work on fumigation, as much as Guyton-Morveau's network was crucial in having the support of the Ministry of the Interior. Lacking connections in the Ministry of the Navy, he was unable to catch the interest of that department. Therefore, the implementation of chemical fumigation within the French and British navies exemplifies the importance of scientists' relationships in the spreading of their ideas; without strong support from politicians a scientist was unlikely to see his innovation promoted even if it was aimed at eradicating the very worst outbreaks of disease.

Conclusion

At the end of the eighteenth century, the French and the British navies both needed a technique to end the recurring diseases raging on board their vessels. The ongoing wars made the necessity to find an anti-contagious remedy even more urgent. However, the two administrations did not pay equal attention to chemical fumigation. In France, the Minister of the Navy merely sent medical practitioners a theoretical treatise written by a qualified chemist. That strategy contrasted greatly with the one adopted by the Admiralty in Britain. By mainly using examples, those in charge aimed to create a willingness to see the benefits of chemical fumigation. To achieve this goal, it sent surgeons both materials and accounts of experiments collected by the Sick and Hurt Board. The involvement of the Admiralty regarding anti-contagious smoke cannot therefore be in doubt although the same cannot be said for its French counterpart. It is difficult to explain the reasons for this without the comparison with another French department which was far more active in the promotion of chemical fumigation and as such invites some degree of comparison with the British Admiralty. Had it not been for the Ministry of the Interior being willing to promote anti-contagious smokes, their use in France would not have been so widespread. The example of chemical fumigation

[42] Smyth JC. *A Description of the Jail Distemper*, 1795 Note (3).
[43] Smyth JC. *An Account of the Experiment*, 1796 (Note 4).
[44] Smyth JC. *The Effect of the Nitrous Vapour*, 1799 (Note 5).
[45] Smyth JC. *The Effect of the Nitrous Vapour*, 1799 (Note 5).

underlines the importance of recognizing the emergence of professional identities, novel scientific developments and personal friendships as factors influencing the production and acceptance of new ideas in medical practice.

Biographical Details

After graduating in History and English at the Université Paris-Sorbonne, Mathilde developed an interest in the interactions between the history of mentalities and the history of science and technology. Currently a PhD student at the Université de Paris, her thesis deals with the use of medical fumigation as an indicator of the changing sensibilities regarding smokes in eighteenth and early nineteenth-century France and Britain.

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