

Match-making in Britain from 1827 to 1910: The Dangers of White Phosphorus in Lucifer Match Production

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Abstract

Throughout the nineteenth century the British match-making industry used white phosphorus in the production of lucifer matches, despite the knowledge that the chemical could cause a deadly disease known as phosphorus necrosis. Until the 1890s, due to cover-ups made by match-making companies, the British government was unaware of the scale of phosphorus necrosis cases and had been led to believe that the chemical was being used safely. However, even after journalists exposed the truth, the British government and match-making companies were still unwilling to ban white phosphorus because of the economic and social consequences of shutting down lucifer match production. It was not until a chemical alternative was found that both the match-making industry and the British government were prepared to ban the use of white phosphorus.

Keywords: phosphorus necrosis, phosphorus, match-making, matchgirls, Bryant & May

Match manufacturing first began using white phosphorus in the early 1830s. The first recorded occurrence of phosphorus necrosis was Marie Jankovitz in Vienna, whose case was published in medical literature in 1838.¹ Often known as phossy jaw, the disease attacked the facial tissue and bones of the jaw and could be fatal. Throughout the next seventy years, phosphorus necrosis thrived in the old, cramped, stuffy factories in London, with few governmental

regulations that made any difference to the frequency of the disease. The only real way to prevent the disease would have been a complete ban of the use of white phosphorus in the manufacturing of lucifer matches. However, this change would have had drastic effects on the match-making industry, and both the major match-making companies and the British government were reluctant to do anything that would harm the booming sales of the lucifer match. In the 1890s it was revealed that multiple companies had been covering up cases of phossy jaw in order to continue production without government interference, yet even after

¹ John Emsley, *The Shocking History of Phosphorus: A Biography of the Devil's Element* (Oxford: MacMillan Publishers Ltd, 2000), 73, 105.

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this revelation the use of white phosphorus continued until it was banned in Britain in 1910.

While the matchgirls who worked in these factories have become popular subjects for labour historians, the history of phosphorus necrosis itself is less documented in scholarly works. Parts of its story are spread throughout articles and books written about matchgirls, labour history, occupational health, and chemical history, mentioned only in passing and almost always focusing on a single match-making company, Bryant & May. John Emsley's book provides information on the history of phosphorus and the chemical side of matchmaking,² Lowell Satre's article covers the 1890s phossy jaw scandals,³ Barbara Harrison writes about the disease from the political viewpoint,⁴ and Jayne Krisjanous provides one of the only articles focusing on a company other than Bryant & May,⁵ but none of these works alone tells the full story. A more complete timeline is needed before the reasoning behind the continued use of phosphorus becomes clear. Because the match-making companies worked so hard to cover up any evidence of phossy jaw, the British government believed that the regulations were being followed and phossy jaw had been eradicated. If the match-making companies had not worked so hard to cover-up the devastating cases of phosphorus necrosis, alternate solutions could have been sought out sooner and many lives would have been saved.

History of Matchmaking

John Emsley's *The Shocking History of Phosphorus: A Biography of the Devil's Element* is a detailed work that goes through the history of phosphorus since it was first produced in 1669.⁶ Emsley dedicates three chapters to the role of phosphorus in the friction match-making industry in the nineteenth century, beginning with a pharmacist named John Walker sold the first friction matches on April 7, 1827. Before friction matches, people used chlorate matches that had to be dipped in sulphuric acid. Walker discovered that a paste of potassium chlorate and antimony sulphide would ignite with a bang when exposed to friction, and began selling the new matches in his shop. But they were not a huge success, so Walker stopped making them

after a few years and did not patent them.⁷ Walker was the first person documented as creating and selling self-igniting matches, but others were making similar products at the time. Sir Isaac Holden had created a friction match around the same time, while in 1828 or 1829 Michael Faraday gave a demonstration of self-igniting matches at a public lecture, and in 1830 Samuel Jones began making the matches and named them 'lucifer' matches, which then became the common term for easy-to-use self-igniting matches. Rival companies began producing the matches as well.⁸ There is debate over who first created lucifer matches containing phosphorus, but most clues point towards Charles Sauria in 1830 in France as being the first to successfully add phosphorus to the potassium chlorate, antimony sulphide, and sulphur mix. But he was not able to fund or patent the invention, which other match manufacturers quickly adopted. Jacob Krammerer in Germany began manufacturing the new lucifer matches in 1833, followed by Stephan Rómer and J. Siegel the following year in Vienna. By 1835, both Germany and Austria had match-making factories that exported the products all over Europe.⁹

These first phosphorus matches used white or yellow phosphorus, but the easy ignitability that made them so popular was also what made them dangerous. Lucifer matches had to be kept far away from children because of the risk of fire and the risk of ingesting the chemicals, and the matches would sometimes ignite if the boxes were shaken, left in direct sunlight, or even just kept in pockets.¹⁰ The solution to these risks was to use red phosphorus, which was a more stable form of the element. Anton von Schrötter, Director of the Austrian Mint, received a gold medal at the Paris Exhibition of 1855 for his work in 1845 with the new form of phosphorus. In these safety matches, the red phosphorus was placed on a strip outside of the match box that had to come in contact with the match in order to light it.¹¹ The Lundström brothers in Sweden were the first to begin manufacturing safety matches successfully. Bryant & May set up its first match-making factory on Fairfield Road with the intention of manufacturing safety matches and the UK granted the company a patent for the production in 1855.¹² However, while red phosphorus matches were safer, they were less convenient than the strike-anywhere lucifer matches made with the other forms of phosphorus. Finland, Denmark, and Switzerland passed laws banning lucifer matches in the early 1870s, so the production of safety matches in those countries was highly profitable. But Bryant & May was

² Emsley, *The Shocking History of Phosphorus*.

³ Lowell J. Satre, "After the Match Girls' Strike: Bryant and May in the 1890s," *Victorian Studies* 26 no. 1 (1982).

⁴ Barbara Harrison, "The Politics of Occupational Ill-Health in Late Nineteenth Century Britain: The Case of the Match Making Industry," *Sociology of Health & Illness* 17 no. 1 (1995).

⁵ Jayne Krisjanous, "Examining the Historical Roots of Social Marketing Through the Lights in Darkest England Campaign," *Journal of Marketing* 34 no. 4 (2014).

⁶ Emsley, *The Shocking History of Phosphorus*, 4.

⁷ Emsley, *The Shocking History of Phosphorus*, 67-70.

⁸ Emsley, *The Shocking History of Phosphorus*, 70-71.

⁹ Emsley, *The Shocking History of Phosphorus*, 73.

¹⁰ Emsley, *The Shocking History of Phosphorus*, 76-77.

¹¹ Emsley, *The Shocking History of Phosphorus*, 77-78.

¹² Emsley, *The Shocking History of Phosphorus*, 79-80.

faced with a British public who were not interested in safety matches and continued to buy the easier to use lucifer matches. By 1880, Bryant & May had become one of the largest producers of lucifer matches made with white phosphorus.¹³

Match-making in the nineteenth century followed the same basic process in factories across Britain, described here by Satre:

Splints of wood, twice the length of a finished match, were heat-dried, dipped in melted sulphur or paraffin, then set in a frame or clamp which could hold several thousand matches. The frame was carried to the "dipper," who dipped the matches in the lighting composition (a mixture of white or yellow phosphorus, glue, chlorate of potash, and coloring substance) spread thinly over the hot dipping table, which had a flat stone or iron surface. The frame was carried to a drying room and the matches, when dry, were dumped from their frames, cut in half, and boxed.¹⁴

According to Emsley, "A skilled dipper could dip 1,400 frames in a ten-hour working day, making more than ten million matches."¹⁵ In the early decades of the match-making industry, box-making was a job done in the homes of employees (which was a clever way for factories to avoid the conditions put in place by the Factory Acts), before the task was moved to the factories.¹⁶ Men and young boys mostly did the mixing, dipping, and drying processes, with women and girls removing the matches from the frames and placing them into the boxes and doing most of the box making as well. In 1897, across twenty-three of the twenty-five match factories, the mixing, dipping, and drying processes employed 237 men and twenty-one women while the boxing processes employed eight men and 1,255 women. There were also 1,613 employees involved in non-phosphorus related activities. The twenty-five match factories across the United Kingdom employed a total of 4,152 people.¹⁷

Box-makers who worked at home were paid 2¼d per 144 completed boxes and had to pay for the glue and string themselves.¹⁸ According to one report from the London Society monthly magazine in the second half of

1888, Bryant & May had moved the box-making onto the premises of its Fairfield works and employed 60 girls in the process, each of which averaged 1,440 to 1,728 boxes per day, sometimes up to 2,160. In the same report, the factory employed about 300 girls in the box-filling room and employed over 1,400 workers total.¹⁹ In Annie Besant's article "White Slavery in London" from June 23, 1888, box-making was apparently still being done in homes. In the factory, those who filled boxes received ¾d per 144 boxes filled, earning anywhere from 4s to 9s a week depending on their skill level. A few of the older women doing other work could earn up to 10s to 13s a week. Besant writes that the girls were subject to a variety of fines that were deducted from their wages: untidiness around workspaces could result in a fine of 3d, leaving matches out while going for a new frame is 3d, being late would result in being shut out for half the day and being fined 5d, even talking could result in the deduction of 3d.²⁰ These fines and the low pay were the basis of the famous 1888 match-girl strike at Bryant & May's.

Match making was an unskilled job that attracted some of the poorest in London, who were usually young and uneducated and unable to do anything about the unfair and dangerous working environment that they faced. The match factories in the city were focused in East London, an area "plagued by unemployment, casual employment, grinding poverty, crime, and drink."²¹ East London was full of unskilled workers who were ideal for factory work, but there were never enough jobs to go around. Even though wages were lower than in other parts of London, a person in East London would take whatever job was offered to them despite any hazards it came with.²² Even ignoring the problems related to white phosphorus, workers in match factories had to suffer with long hours, low wages, and cramped, unclean, poorly ventilated factories.²³ Another risk of working in a match factory was the obvious prevalence of fires. On May 11, 1866, a fire broke out at Taylor & Poe's lucifer match works in Bow and spread to five properties around it.²⁴ Bell & Co's in Wandsworth had fires on May 30, 1877, December 19, 1879, and Oct 8, 1888.²⁵

¹³ Emsley, *The Shocking History of Phosphorus*, 80-81.

¹⁴ Satre, "After the Match Girls' Strike," 8-9.

¹⁵ Emsley, *The Shocking History of Phosphorus*, 87.

¹⁶ Emsley, *The Shocking History of Phosphorus*, 87; George H. Wood, "Report on the Manufacture of Matches," *The Economic Journal*, 12 no. 48 (1902): 557.

¹⁷ Wood, "Report on the Manufacture of Matches," 556-557.

¹⁸ Emsley, *The Shocking History of Phosphorus*, 88.

¹⁹ "Matchmaking," *London Society: A Monthly Magazine of Light and Amusing Literature for the Hours of Relaxation* 54 (July-December 1888), 634-638.

²⁰ Annie Besant, "White slavery in London," *The Link: A Journal for the Servants of Man*, June 23, 1888, no. 21.

²¹ Satre, "After the Match Girls' Strike," 11.

²² Satre, "After the Match Girls' Strike," 11-12.

²³ Harrison, "The Politics of Occupational Ill-Health in Late Nineteenth Century Britain," 29.

²⁴ "Great Fire," *The Times*, May 11, 1866, The Times Digital Archive.

²⁵ "Fires," *Times*, May 30, 1877, The Times Digital Archive; "Fires," *Times*, Dec. 19, 1879, The Times Digital Archive; "Fires," *Times*, Oct. 8, 1888, The Times Digital Archive.

Bryant & May had a fire on May 31, 1881.²⁶ Factory fires were not unusual in London, but match-making factories were at a higher risk.

Prior to the Elementary Education Act of 1870, match factories employed many children. A Children's Employment Commission done in 1843 remarked that "The boys who make lucifer-matches, and who have no fathers, or belong to distressed families, are usually pale and sickly-looking. They are generally badly clothed, and have not sufficient food. This occupation, however is one of the very lowest in London, requiring no previous knowledge, and is a refuge for the most distressed part of the population."²⁷ After 1870 the factories turned to primarily employing young women, who became known as match-girls. These girls were known for their "generosity, independence, and protectiveness, but also for brashness, irregularity, low morality, and little education."²⁸ Due to the rigidity of London's social and economic classes, match-workers never had a chance to work their way up out of poverty and had no choice but to live their lives at the mercy of their employers.

Phosphorus Necrosis (Phossy Jaw)

In 1847, Dr. F. Ernst von Bibra and Dr. Lorenz Geist published their study titled "The Diseases of the Workmen employed in Lucifer Manufactories, and especially the Affection of the Maxillae, produced by Vapours of Phosphorus, considered in their Chemico-physiological, Medico-Chirurgical, and Forensic Relations."²⁹ In their ground-breaking research, Dr. von Bibra and Dr. Geist provide a detailed analysis of the development of phosphorus necrosis. Phosphorus necrosis generally started with a toothache, and some evidence showed that a previous disposition to tooth trouble (dental cavities or other open wounds in the mouth) put a person at a higher risk for developing the disease. This tooth pain would come and go for a period of time before spreading across the affected side of the face and neck. The cheek then became swollen and red as the gums became inflamed and an abscess developed. The abscess discharged pus and the gums retracted from the teeth and jaw, causing teeth to loosen and fall out. Abscesses might form outside of the

mouth as the cheek rotted away and exposed the diseased jaw bone, which could become detached from the rest of the jaw entirely. Alongside all of this were some general flu-like symptoms: fever, loss of appetite, thirst, and intestinal problems (particularly constipation). The disease would continue to affect the flesh of the face until treatment was sought or the patient died.³⁰

The cause of the disease was debated for some time before phosphorus was shown to be the culprit. Some doctors argued that it was arsenic that caused the symptoms, because the sulphuric acid that was used in early match-making often contained traces of arsenic. When the symptoms continued even after pure sulphuric acid became the norm, doctors had to look elsewhere for answers.³¹ It was later proven by Dr. von Bibra through his experiments on rabbits that phosphorus was the real cause. With this discovery it was made clear why some employees were at higher risks for developing the disease. Those employed in the dipping or boxing processes were exposed to the phosphorus, but those who worked in the steps done before dipping the matches in the lighting composition or those who made the boxes were at a lower risk for exposure and infection. Even the layout of a factory could play a part in the people who were infected: if the phosphorus was mixed or the matches dipped on lower levels, the fumes often rose up to affect those working on the floors above.³²

The onset of the disease typically began somewhere between three to four years of working in the match-making factories, and the length of the disease varied. Barbara Keim was twenty-two and had worked in a match-making factory for three and a half years before beginning to develop symptoms, when she died only seventy-three days later.³³ An article published in Dickens' *Household Words*³⁴ in May 1852 gives a few more examples of cases of phosphorus necrosis, using fake names of the patients for their own privacy. Annie Brown started working in a match factory when she was nine and developed the first symptoms of phosphorus necrosis four years later. Brown worked in the boxing process and her clothes, arms, and hands would glow at night, but she was so used to the phosphorus that the lingering smell no longer bothered her. When she was thirteen years old a doctor removed most of her lower jaw, and at the time of the article she was twenty years old and lived with large holes in the side of her mouth

²⁶ "Fire," *Times*, May 31, 1881, The Times Digital Archive.

²⁷ Children's Employment Commission. Second report of the commissioners. p. 140. 1843 (430-342) XIII.307, XIV.1, XV.1.

²⁸ Satre, "After the Match Girls' Strike," 12.

²⁹ F. Ernst von Bibra and Lorenz Geist, "The Diseases of the Workmen employed in Lucifer Manufactories, and especially the Affection of the Maxillae, produced by Vapours of Phosphorus, considered in their Chemico-physiological, Medico-Chirurgical, and Forensic Relations," *British and Foreign Medico-Chirurgical Review* 1 (Jan-Apr. 1848): 446.

³⁰ von Bibra and Geist, "The Diseases of the Workmen employed in Lucifer Manufactories," 451-452.

³¹ von Bibra and Geist, "The Diseases of the Workmen employed in Lucifer Manufactories," 453.

³² von Bibra and Geist, "The Diseases of the Workmen employed in Lucifer Manufactories," 453-454.

³³ von Bibra and Geist, "The Diseases of the Workmen employed in Lucifer Manufactories," 448-449.

³⁴ Charles Dickens, "One of the Evils of Match-Making," *Household Words* 5 (1852).

and no lower jaw. Maggie Black, twenty-three years old, worked in the sorting and counting of matches after they had been dipped and dried. She developed a toothache after three years of working there and since then had undergone five operations and her jaw had been almost entirely removed. The factory still employed her, but she now made boxes and was away from the phosphorus fumes. Robert Smith, twenty-one years old, worked for six years as a dipper before developing phosphorus necrosis, and now had no teeth in his much-destroyed lower jaw. Smith claimed to know of fourteen other people with the disease, two of whom had died. Like Brown, Smith noted that his clothes would glow at night, and that the walls of the factory would glow in the dark as well.³⁵

In their study, Dr. von Bibra and Dr. Geist offered a list of suggestions to limit the disease:

- the drying room should be completely detached from the rest of the factory, or have the drying done at night and leave enough time to air out the rooms before the workers come in the next morning
- the mixing and dipping of the lighting composition should be done in a room detached from the rest of the factory
- the counting and packing room should be well ventilated and not too crowded
- all rooms should be actively ventilated for one hour, three times a day (before work begins, during dinner, and after the work is over)
- a dedicated dining room should be provided that is separate from the workstations³⁶

The most interesting point about these precautions is that Dr. von Bibra and Dr. Geist never suggested 'stop using phosphorus.' It was believed at the time that by following these few precautions, factory owners could largely limit the development of the disease in their employees, without having to stop production or seek out other chemical combinations. A match-making factory in Finsbury had begun using some precautions already and had seen results. The employees were required to wash their hands before and after work in a mixture of alkaline soda water, which was the only way to completely remove the acidic phosphorus from their hands. The dippers wore sponges to cover their mouths and the factory was well-ventilated. The factory employed fifteen girls, fifty boys, and eleven men, some of whom had worked there for ten years, and none of them had developed the disease. One of the girls had

worked exclusively in dipping matches for seven years and was still perfectly healthy.³⁷ Charles Dickens wrote about a visit to Bell & Black's match manufactory in London, noting that the factory was cleanly and well organized with the dipping-house placed 100 yards away from the rest of the works.³⁸ However, while some factories did make attempts to limit the exposure to phosphorus, the majority of factories in Britain were old, cramped and stuffy, and unwilling to make any changes.

In Britain, the 1864 Factory Acts Extension Bill tried to accommodate for some of the worst issues. As a general statement applying to all the manufacturers listed in the act, the bill stated that factories needed to be clean and well ventilated to prevent any health problems from gases, dust, or other impurities. The section that applied specifically to lucifer match-making declared that meals were no longer allowed to be taken in the same rooms that any processing or manufacturing took place in.³⁹ This was a direct attempt to combat phosphorus necrosis, which could be spread from contaminated work stations to the food and then to the mouth. After these few regulations, the government largely ignored the match-making industry. It was mentioned again a decade later, in 1875, where it was written that "the children employed in that trade now work under altogether different conditions. You never hear now of any case of that dreadful disease which used to be so fatal amongst them...that has entirely ceased."⁴⁰ No further mentions were made of the disease over the next couple decades and published reports from factory inspectors rarely mentioned match-making at all. Bryant & May made the headlines in 1888 with the match-girl strike, but the girls were more concerned about wages and fines rather than health hazards.⁴¹ For this period, the answer to the question of why the government or the public never made an effort to ban the use of white phosphorus is simply that they no longer thought that it was a threat to factory workers. The lack of reported cases of the disease indicated that the few regulations put in place had eliminated phosphorus necrosis entirely, and the government was led to believe that an outright ban on white phosphorus was not necessary.

³⁷ von Bibra and Geist, "The Diseases of the Workmen employed in Lucifer Manufactories," 460.

³⁸ Dickens, "One of the Evils of Match-Making," 155.

³⁹ Factory Acts extension. A bill for the extension of the Factory Acts. p. 2, 4. 1864 (55) II.81.

⁴⁰ Factory and Workshops Acts Commission. Report of the commissioners appointed to inquire into the working of the factory and workshops acts, with a view to their consolidation and amendment; together with the minutes of evidence, appendix, and index. Vol. II. Minutes of evidence. p. 6. 1876 [C.1443-I] XXX.1.

⁴¹ Satre, "After the Match Girls' Strike," 10.

³⁵ Dickens, "One of the Evils of Match-Making," 153.

³⁶ von Bibra and Geist, "The Diseases of the Workmen employed in Lucifer Manufactories," 459.

Scandal and Cover-ups

By the 1890s Bryant & May was the largest match producer in England and contemporary writers portrayed it as a model company. The firm contributed to various clubs that tried to instill some discipline in the young match-girls (who were known by their supervisors and the factory owners to be a bit wild and careless) by providing evening lessons, meals, and access to literature. Employees could have unions, were provided with a doctor and dentist in the factories, and were allowed to take holidays, which many girls did in order to go hop-picking and work in jam factories in the summer.⁴² However, in January 1892 the *Star* newspaper learned of a case of phossy jaw that had occurred in one of Bryant & May's factories. The woman had been forced to quit her job as the disease had progressed, but Bryant & May had continued to pay her a pound a week, for thirty-one weeks, until she had been visited by the company doctor and declared cured. However, she was now unable to get her job back at Bryant & May or any other match factory, due to her appearance. Factories did not want to hire a woman who was missing half of her jaw because they did not want to scare the other workers. The *Star* reporter wrote that there were other recent cases of the disease, but that he was unable to speak to any of those who were still receiving a stipend from the company because they feared that if they spoke out, Bryant & May would cut them off and they would have no source of income.⁴³ It appeared that at this time, Bryant & May was the only match-making company with any cases of phosphorus necrosis. The reporter investigated other match factories in East London and found no other reports of the disease, but did come up with some complaints about the operations at Bryant & May's: the dipping rooms were placed below the other working rooms, which (as mentioned earlier) allowed for the toxic fumes to rise into the workspaces above, matches were boxed before being thoroughly dried after dipping, and workers were not provided with any way to clean themselves properly.⁴⁴ Bryant & May denied that any problems existed within its factories and accused the *Star* of publishing lies.⁴⁵

The Home Office investigated Bryant & May and confirmed the allegations put forward by the *Star*, recording eleven cases of phosphorus necrosis. It reported that while the disease was not widespread, those who began to show symptoms were immediately removed from

the workplace and treated at home by the company's physicians, which meant that when an inspector did show up at the factory they would not be able to witness any problems. Despite the obvious cover-up, the government seemed to have been unwilling to confront the company, and instead the report from the factory inspector in 1892 issued a few more regulations for the match-making industry as a whole. These regulations were the same kinds of changes that had been recommended back in 1848: provide separate rooms for the mixing, dipping and drying to prevent the fumes from entering the rest of the factory, provide washing facilities for employees, immediately see to any complaints of tooth or jaw pain and prevent the sick employee from returning to work until they obtain a certificate of good health from a doctor.⁴⁶ In 1895, an official amendment to the Factory Act declared that the Chief Inspector of Factories must be notified of any cases of phosphorus necrosis.⁴⁷ But there was no official talk of banning white phosphorus, despite evidence that it was still causing pain and death over fifty years since it had first been used.

It was not until 1898 that Bryant & May was finally taken to court. On April 28, the *Star* published the discovery of an unreported death from phossy jaw occurring at the company's factories. The company's doctors had believed the death to be from cellulitis, while the independent coroner declared that it was a clear case of phosphorus poisoning.⁴⁸ The *Star* continued its crusade against the working conditions in the Bryant & May factory, finding more victims of phosphorus necrosis who had not been reported and releasing their names and stories to the public. Five of these cases were published in the *Star* between May 6 and May 12, but on May 13 the newspaper announced that they were suspending their investigation until the results of the Home Secretary were released.⁴⁹ The Home Office sent W.H. Seal to visit the match works on May 7 and 8, where it was discovered that there had been forty-seven cases of phosphorus necrosis over the past twenty years, nine of which had proven fatal.⁵⁰ The Home

⁴² Satre, "After the Match Girls' Strike," 15.

⁴³ Satre, "After the Match Girls' Strike," 15-16.

⁴⁴ It is important to note that at this point Bryant & May owned multiple matchmaking factories in East London, and it is unclear at which factory the cases of phossy jaw were occurring. Satre, "After the Match Girls' Strike," 16.

⁴⁵ Satre, "After the Match Girls' Strike," 18.

⁴⁶ Report of the Chief Inspector of Factories and Workshops to Her Majesty's Principal Secretary of State for the Home Department, for the year ending 31st October 1892. p. 32. (1893-94) [C.6978] XVII.65.

⁴⁷ Factories and workshops. A bill to amend and extend the law relating to factories and workshops. p. 10. 1895 (153) III.109

⁴⁸ Satre, "After the Match Girls' Strike," 20-21.

⁴⁹ "Another Case of Phossy Jaw," *Star*, May 6, 1898, The Union Makes Us Strong: TUC History Online; "Yet Another Case of Phossy Jaw!" *Star*, May 10, 1898, The Union Makes Us Strong: TUC History Online; "Another Victim from Bryant and May's," *Star*, May 11, 1898, The Union Makes Us Strong: TUC History Online; "Our Fifth Case of Phossy Jaw," *Star*, May 12, 1898, The Union Makes Us Strong: TUC History Online; "Our Sixth Case of Phossy Jaw," *Star*, May 13, 1898, The Union Makes Us Strong: TUC History Online.

⁵⁰ Satre, "After the Match Girls' Strike," 20-24.

Office was only able to charge Bryant & May for one of the cases, due to the six month statute of limitations, but the company was charged with three violations: failure to report to the factory inspector, failure to report to the certifying physician, and failure to comply with the special factory rules from 1892 and 1895. Bryant & May pleaded guilty to all charges and was given the maximum fines, a total of £25 9s.⁵¹ The trial was covered extensively by the press, and called one of the “worst breaches of the Factory Acts ever brought into court” by the *Daily Chronicle*.⁵² Despite all the press given to Bryant & May due to its size and popularity, it was not the only company that still was facing the problem of phossy jaw. A month after the trial of Bryant & May, another match manufacturer Moreland & Sons was prosecuted for failing to report a case of phosphorus necrosis, with later evidence of at least five more cases since 1896 that the company had not reported.⁵³

Even with the knowledge that phosphorus necrosis had been occurring for decades, the government put forth plenty of excuses to delay banning white phosphorus. It argued that if factories actually followed governmental regulations, the cases of phossy jaw were drastically reduced. This was shown at the match-making factory of Bell & Co, where the mixing and dipping was done on the roof and there had only ever been one mild case of phosphorus necrosis.⁵⁴ The Diamond Match Corporation, an American company that had begun manufacturing in Britain, prided itself on having the first fully automated match-making machines which it argued had eliminated any instances of phossy jaw.⁵⁵ However, these success stories did nothing to fix problems at the old factories, like one of Bryant & May’s where the mixing and dipping was done on the ground floor and fumes rose into the upper levels.⁵⁶ It had already been clearly proven that the government was unable to keep these factories within the regulations. But the British government was very wary of the fallout that could come from an outright ban on white phosphorus at this time. If British companies were forced to stop making lucifer matches, then that could lead to factory shutdowns and loss of jobs in an area where poverty already ran rampant. It could also lead to a loss of export markets overseas and an increase in imports of lucifer matches from countries that still produced them.⁵⁷ The British

government was also cautious about the level of control that they placed on independent industries, especially when it involved powerful companies like Bryant & May. In the end, the only thing that the British government accomplished with these excuses was establishing that it valued business and money over the lives of innocent employees.

The Final Downfall Of White Phosphorus

In 1891, the Salvation Army started a crusade against the use of white phosphorus by opening a factory that produced only the safety matches made with red phosphorus. William Booth, founder of the Salvation Army, branded the matches as “Lights in Darkest England” after his publication on the issues faced by the poverty-ridden in London and the social changes that needed to be made, “In Darkest England and the Way Out.”⁵⁸ Booth launched a social marketing campaign to change the British public’s perceptions of the match-making industry, promoting the matches directly on the fact that they were “manufactured under Healthy Conditions and are Entirely free from the Phosphorus which causes ‘Matchmaker’s Leprosy.’”⁵⁹ Booth’s factory was also an attempt to prove to the rest of the match-making industry that it was possible turn a profit without making lucifer matches, but the closure of the factory a decade later unfortunately proved Booth’s failure on this point. The popular belief is that Booth shut down the factory because he had “made his point,” because some of the match factories had stopped using white phosphorus by 1901.⁶⁰ However, in her article discussing the campaign, Jayne Krisjanous suggests that economics was the real reason for the closure: the combination of paying higher wages and producing a less-popular product at a higher price led to a loss in profits that ended with the shutdown in 1901.⁶¹ While that is a more disappointing story, it does not diminish the fact that the role William Booth played in the history of the match industry “highlights that a social good can be advanced even if in commercial terms the returns are modest.”⁶² Even though the company failed at its goal to turn a profit making safety matches in Britain, its advertising campaign to promote the danger of white

⁵¹ “Phossy Jaw: Bryant and May Have to Pay,” *Star*, June 1, 1898, The Union Makes Us Strong: TUC History Online.

⁵² “Messrs Bryant and May (Limited),” *Times*, July 11, 1898, The Times Digital Archive.

⁵³ Satre, “After the Match Girls’ Strike,” 27.

⁵⁴ Emsley, *The Shocking History of Phosphorus*, 114.

⁵⁵ Wood, “Report on the Manufacture of Matches,” 559.

⁵⁶ Emsley, *The Shocking History of Phosphorus*, 114.

⁵⁷ Satre, “After the Match Girls’ Strike,” 28.

⁵⁸ Krisjanous, “Examining the Historical Roots of Social Marketing Through the Lights in Darkest England Campaign,” 440.

⁵⁹ *War Cry*, July 1891, quoted in Emsley, *The Shocking History of Phosphorus*, 116.

⁶⁰ Dee Gordon, *Little Book of the East End*, (Stroud: The History Press, 2010), 54.

⁶¹ Krisjanous, “Examining the Historical Roots of Social Marketing Through the Lights in Darkest England Campaign,” 441-442.

⁶² Krisjanous, “Examining the Historical Roots of Social Marketing Through the Lights in Darkest England Campaign,” 436.

versus red phosphorus had an impact on the British public, which was surely enhanced by the 1898 scandal. By the turn of the century, despite the government and the match-making industry's stalling, it was clear to almost everyone that white phosphorus would continue to be a health hazard despite regulations set in place by the government.

The real turning point in the journey to ban white phosphorus occurred in 1898. That year, two French scientists discovered a chemical alternative to white phosphorus that could be used to make the strike-anywhere matches. This phosphorus sesquisulphide was not poisonous and was less volatile than white phosphorus.⁶³ The discovery of this new chemical was the best of both worlds for the match industry: factories could keep producing the still-popular lucifer matches without any more worries of phossy jaw. With this development, the support for banning of white phosphorus rose within the match industry. At the annual general meeting of Bryant & May in 1901, it was reported that the company had received the patent for this new chemical and begun using it in the manufacture of their strike-anywhere matches over the past year with "great advantage to the employees and also to the consumers."⁶⁴ The company believed that with this new way of producing the ever-popular lucifer matches, "the time had arrived when the Government should prohibit the use of white phosphorus in this country and the importation of matches from abroad made of this injurious material."⁶⁵ There had still been twelve cases of phosphorus necrosis reported from 1900 to 1907,⁶⁶ likely in the factories that had not been able to gain the patent for the use of the new chemical. In 1902, George H. Wood suggested that a white phosphorus ban would depend on Bryant & May's success with this new formula.⁶⁷ Bryant & May has often been painted as the villain in the tale of the match-workers, but its new support for the white phosphorus ban could indicate that it was truly concerned about its employees and was trying every method it could to eliminate the disease, wanting to prove its place as a leader in the industry. Alternatively, Bryant & May was simply capitalizing on the public's current outrage at phossy jaw and saw a chance to increase its profits while maybe putting some smaller companies out of business by promoting the white phosphorus ban.

In 1906, a special international meeting in Switzerland called the Berne Convention outlawed the use of white phosphorus. Many European countries such as France,

Germany, Italy, Luxembourg, Switzerland, Holland, and Denmark signed onto the treaty. Britain did not, because despite the use of the new phosphorus replacement in Bryant & May factories, many other match manufacturers in London continued to use white phosphorus and the earlier reasons against banning the chemical were still valid. In 1908 another article was published from the match manufacturers of London that "would welcome the entire prohibition of the use of poisonous phosphorus."⁶⁸ The reports of new phossy jaw cases continued to stain the reputation of the match-making industry as a whole, and it seems that the larger companies (specifically Bryant & May, whose managing director was the spokesperson for this article) wanted to put an end to it once and for all. Britain finally passed the White Phosphorus Matches Prohibition Act of 1908 that outlawed the manufacturing, importing, or selling of white phosphorus matches starting on January 1, 1910. Within this bill, a provision was made that allowed access to the patented new methods of match manufacturing for all companies that applied, meaning that they would be able to use phosphorus sesquisulphide and not be forced to shut down. The Act also outlawed importing any matches made with white phosphorus. With these provisions, the British government was finally able to put an end to phosphorus necrosis in match-workers with no fear of factory shutdowns, job losses or loss of international markets.⁶⁹

Alternate Solutions

Nineteenth century Britain was known for its poor working conditions, specifically in the many factories that had become the norm in the industrial cities. Match manufacturers were not the only industry facing problems with diseases or injuries. But the continued use of white phosphorus is notable because its effects were covered up and ignored for such a long period of time. The British government cannot really be blamed for the many cases of the disease in the decades leading up to 1890s because it was the manufacturers themselves who hid the occurrences of phossy jaw from factory inspectors. The companies created a situation where their employees, generally poverty-stricken young girls, were too afraid of losing their medical stipend or their job to speak up about the problem they were facing. Company doctors were following regulations by notifying the companies of the disease, but the companies themselves failed to notify the factory

⁶³ Emsley, *The Shocking History of Phosphorus*, 125.

⁶⁴ "Bryant and May (Limited)," *Times*, Jan. 31, 1901, The Times Digital Archive.

⁶⁵ "Bryant and May (Limited)," *Times*, Jan. 31, 1901, The Times Digital Archive.

⁶⁶ Satre, "After the Match Girls' Strike," 29.

⁶⁷ Wood, "Report on the Manufacture of Matches," 560.

⁶⁸ "The Manufacture of Matches," *Times*, Mar. 26, 1908, The Times Digital Archive.

⁶⁹ White phosphorus matches prohibition. A bill [as amended by Standing Committee A] to prohibit the manufacture, sale, and importation of matches made with white phosphorus, and for other purposes in connection therewith. 1908 p. 2 (383) V.957.

inspectors. The government assumed that the factories had followed its regulations and that phosphorus necrosis had been eliminated, because they had not been presented with any evidence saying the opposite. The blame for the prevalence of phossy jaw during these decades can be clearly placed upon the individual companies themselves. If they had not continued to cover up the disease, it is possible that the government would have realized much earlier that more intervention was needed, and many lives could have been saved.

But what kind of intervention would they have taken, if they had known earlier? Maybe the government would have introduced more regulations, increased match factory inspections, made the reporting of phosphorus necrosis mandatory sooner, and forced harsher penalties for companies that failed to measure up to these standards. But the risk of phosphorus necrosis would always be there if workers were using white phosphorus, no matter what kind of safety systems were in place. Another option would have been to outlaw the manufacture and importing of all matches made with white phosphorus, forcing manufacturers and consumers to use the red phosphorus safety matches. Companies did not make the switch themselves because if lucifer matches were an option, consumers would pick them over safety matches almost every time. The only way to make the production of safety matches viable would have been to eliminate any competition from lucifer matches, both locally and internationally. Clearly this ban was an option, because that is exactly what the government declared in the White Phosphorus Matches Prohibition Act. The loss of export markets for lucifer matches would have been the only problem with that solution. Safety matches did not work as effectively in damper climates, which contributed to the popularity of lucifer matches as an export product. However, the British government could have solved this problem by working together with other countries to ban the product as well. This was the idea behind the Berne Convention. But if companies were truly desperate to continue producing strike-anywhere matches, they could have brought attention to the continued problem of phosphorus necrosis and scientists would have been more motivated to find a replacement for white phosphorus sooner than 1898. There were multiple viable routes that the match-making business could have taken if the factories had not hidden the disease for so long.

Conclusion

The history of the match-making industry is dominated by the story of phosphorus necrosis, a devastating disease caused by the white phosphorus used to create lucifer 'strike-anywhere' matches. The journey to the outlawing of white phosphorus was a long one filled with many sick workers, few government regulations, and multiple company cover-ups. For decades the British government thought that phossy jaw was a disease of the past and never believed that outlawing white phosphorus would be necessary. The truth was revealed in the 1890s that phosphorus necrosis had been a continuing problem since the beginning of lucifer match-making, but the companies had been lying about the new cases of the disease. For a few years the debates for and against outlawing white phosphorus reached new heights, until the creation of a chemical that could replace white phosphorus in the manufacture of lucifer matches in 1898. Bryant & May began using this chemical to make its matches in 1901 and then became an advocate for the banning of white phosphorus. Over the next decade, as more factories began to use the new chemical, they banded together to fight for the outlawing of white phosphorus, which was finally banned in 1910. The story of white phosphorus is long and complicated, and it does not help that most of the information available focuses on other aspects of the match industry. However, when analyzing the sources available leading up to the turn of the century, the story becomes clear. If the matchmaking companies had not been so determined to hide phossy jaw from the government, they could have worked together to find a solution to the problem much sooner.

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