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This writing sample is taken from chapter 3 of my latest book *Blanc de plomb. Histoire d'un poison légal* (Paris: Presses de Sciences Po, 2019). An English translation of this book, which won three academic awards in 2020, will soon be submitted for consideration by Oxford University Press.

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THE COLOUR OF CONTROVERSY.
SCIENTIFIC KNOWLEDGE, THE MARKET AND INDUSTRIAL RISK REGULATION
IN THE NINETEENTH CENTURY

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Should white paint use lead-based or zinc-based pigments? This seemingly arcane question actually rattled Europe’s scientific, industrial, public health and policymaking circles for a century and a half – from the French Revolution until the 1920s. The economic competition between white lead and zinc white (the two most common white pigments used in building paint) cannot be separated from the scientific controversy that they sparked due to their harmful effects: white lead (also known as *ceruse*) was accused of being an insidious poison that harmed the workers who manufactured and used it, whereas zinc white, a latecomer to the market, was promoted as an innocuous substitute. The story of this conflict, which intermingled scientific and public health controversy with economic rivalry, is particularly suited for examining the very timely issue of industrial risks in our contemporary societies. This is a history at the crossroads of the economy, society, science and politics.

The long-run history of this controversy between two white pigments is an excellent vantage point for observing, over the long 19th century, the mechanisms whereby white lead – an indisputably toxic substance – dominated its non-toxic rival on the market. This story stretches across the millennia, alternating highs and lows, with brief periods of fame and longer periods in the shadows – before disappearing from the scene mid-20th century. White lead was known to the Persians and in Ancient Greece. After a lengthy “childhood” during which actors and prostitutes used it to paint their faces, later becoming a celebrated element of pharmacopeia for whitening birthmarks and soothing the painful nipples of nursing women, white lead finally came of age in the early 19th century. At that time, lead oxide was mainly produced as a pigment for building paint – as the building sector grew along with the widescale urbanization of Europe – and for many other industrial sectors (porcelain, wallpapers, glossy paper, artificial flowers, etc.). The method of producing it did not change considerably over time; from the recipe described by Pliny the Elder (1st century BCE) to the process used by Northern European industrialists in the early 19th century, what changed was mostly the scale of production. The industrial manufacturing process – known as the “Dutch process” developed in workshops of

Amsterdam and Rotterdam in the late 18th century – mainly consisted of a slight improvement to the ancient technique, streamlining the space needed for production and increasing the size of workshops: rolled sheets of lead were oxidized by contact with acetic acid (vinegar), heated steadily by horse manure. The process created a very fine white powder, which, mixed with oil, became the white paint that would soon be commonly used for the inner and outer walls of buildings and homes across Europe, as well as carriages and ships.¹ White lead production became significant in Holland in the 1770-80s, then in England and Belgium in the 1800s, in France in the early 1820s and in the U.S. just later.²

Considering this long-term economic cycle, two contradictory biographies of the substance can be written, a light narrative and a dark one: manufactured on an industrial scale, white lead was attributed all the virtues of a paint pigment that enjoyed booming commercial success thanks to its intrinsic properties (whiteness, opacity, resistance, ease of drying and low cost); but it was also, at the same time, criticized as a poison responsible for the sickness and death of thousands of people. In work spaces, white lead is responsible for lead poisoning, a slow intoxication that affects the nervous system, brain and kidneys, causing serious and recurring attacks that can lead to death. In the archives of chemical industrialists, world's fair brochures, and paint manufacturers' accounts, full of orders, we can trace its bright face. Meanwhile, the dark legend loomed in hospital admissions registers, the records of mutual insurance societies that compensated sick workers, physicians' accounts denouncing the ravages of lead poisoning in the working classes, or the workers themselves describing the "slaughterhouses" where they manufactured the deadly substance.

This paper is thus a portrait of white lead as a "serial killer" that remained on the run despite its acknowledged deadly effects. I have addressed elsewhere the comparison between France and the U.S. for the denunciation of the toxicity of white lead and the politicisation of its use.³ There is no doubt that France had a special role in this global picture as this material attracted such scientific, political and public attention early on that France quickly became the largest consumer of white lead in Europe. Therefore, the French case is both exceptional and emblematic, as most other countries that used the substance did not make it a *political* product until its disappearance from the market in the 1950-60s.

Not until the early 20th century did white lead begin to cede its place to zinc white, with the French parliament banning it in 1909 – a ban that was never fully enforced – and the newly-founded International Labour Organization (ILO) passing an international convention on it in 1921, encouraging ILO member states to abandon it in favour of innocuous pigments. Nevertheless, in this defeat of white lead, it is quite difficult to separate out the influence of legal bans, economic competition, changing uses or technical progress: each of these arguments played a part in this narrative, and I will endeavour to pick them apart. I argue that the government's actions, over the 19th century, to respond to and regulate the health hazards of white lead were driven less by medical knowledge (lead toxicity was already known in the late 18th century) than by technical progress, market forces, and the balance of economic and social powers. In addition, this scientific controversy was inherently linked to mechanisms for manufacturing ignorance, or at the very least, for instilling doubt and scientific confusion. During this period, economic and social stakeholders used medical and chemical expertise and

evidence as persuasive arguments. While these mechanisms were unable to silence other stakeholders completely, they nevertheless kept the debate over white lead out of the public eye, “compartmentalizing” it to restricted arenas of experts and policymakers.

For more than a century, the manufacture of doubt was working to create uncertainty about the hazards of white lead or the innocuousness of zinc white, even though both these facts had been scientifically proven a number of times since the late 18th century. In a striking example of how history repeats itself, “merchants of doubt”⁴ were at work in the public health debate, in a process that looks similar to the mechanisms that would later obliterate knowledge or even manufacture ignorance about the toxicity of asbestos or tobacco in the 20th century. Just like white lead in an earlier era, asbestos and tobacco were substances whose toxicity was scientifically proven, yet they were sold on the market for decades, generating significant profits and social acceptance of their risks, both in an occupational setting and in daily life.

The shadows and unspoken parts of this story are quite eloquent if we shine the spotlight of historical investigation on them. Over the very long 19th century covered here, the history of the economic and scientific conflict between white lead and zinc white adheres to a chronology in which scientific and technical innovations, along with political and social events, reshape the long-term economic cycle of the two substances.

Two fundamental facts must be noted. First, white lead’s harmful effects upon the workers who manufactured it or the painters who used it were known in the late 18th century and widely documented from the 1830s. Second, an alternative substance, harmless for the workers who manufactured or used it – zinc oxide – was invented in the late 18th century and came into fierce competition with white lead from the mid-19th century after a new production process made it cheaper and competitive with the latter. Why did these two facts not hamper the massive growth of European and global white lead markets throughout the long 19th century (1780-1920)? Why did the zinc substitute fail to take over the chemical pigment market and to undermine the commercial domination of white lead on the paint market? Why were health concerns pushed aside by industrialists, by the vast majority of paint manufacturers and users, and by consumers in the general public? More specifically, how did technical innovation interact with risk acceptance and the rules governing the market and competition? The history of white lead forces us to set aside a teleological explanation whereby the social body and the government slowly but inexorably evolved to take into consideration health and safety concerns. Instead, it shows the complex mechanisms at work in this conflict that intermingled scientific and technical knowledge on the one hand, and price and economic interests on the other hand. The history of this conflict, mixing public-health debates and economic rivalry, is a perfect prism for analysing industrial risk and its weight in the economic competition between products with diverging qualities. Nevertheless, it is not easy to disentangle which mechanism – legal bans, economic competition or technical advances – prompted the defeat of this long-lived material. I argue that technical factors and the invention of new and improved pigments played as important a role as the development of restrictive legislation against the toxic substance.

1. ENTANGLED WHITES: THE MESSY CHRONOLOGY OF A SCIENTIFIC CONTROVERSY

When it entered into competition with zinc white, white lead raised a long controversy that threatened its lifetime as a commercial product. The first phase occurred in late 18th century. Paduan physician Bernardino Ramazzini had briefly described the use of white lead as a pathogen for studio painters, and French chemist Antoine-François Fourcroy, translating Ramazzini's opus in 1777, blamed the material in a lengthy note on the etiology of lead poisoning.⁵ During this period, the famous chemist and encyclopaedist Guyton de Morveau, assisted by pharmacist Courtois, worked on creating a zinc-based white pigment that would be harmless and could replace white lead. Guyton de Morveau advocated substituting zinc for lead for both health and technical reasons, as lead paint tended to darken when exposed to sulphur vapours, whereas zinc paint appeared unaffected. Their research led to the first large-scale production of zinc white in France, while English chemist John Atkinson claimed this promising innovation as his own and patented zinc oxide in paint as a substitute to lead oxide (1796). Thus, at the end of the 18th century, in France and Britain, the two nations that used the most white lead – due to their early urbanization, as well as their sizeable naval and merchant-marine fleets which used white lead on a massive scale to paint ships – scientists were aware of the scientifically-proven toxicity of the material, and the existence of a safe alternative. Such eminent and renowned scientists as Fourcroy, Berthollet and Vauquelin all enthusiastically supported zinc white, the defects of which “are so slight compared to the disadvantages of using white lead, that its adoption cannot be *reasonably* refused.”⁶

However, the relatively high price of zinc white – three times more expensive than white lead at the time – overshadowed the health arguments and prevented the chemical innovation from becoming an industrial success. Conversely, white lead was widely promoted by industrial concerns (Société d'encouragement pour l'industrie nationale, Comité consultatif des Arts et Manufactures, etc.) and by the highest public health bodies in France (Conseil d'hygiène et de salubrité, as well as the prefectures and municipalities, which were responsible for enforcing health rules), in order to foster domestic production over imports from Holland, Belgium and England that weighed on the national budget. As a result, white lead, albeit acknowledged as a deadly poison to experts, kept its dominant position in the paint pigment market during the first half of the 19th century.

In the mid-19th century, another French innovation rekindled the economic rivalry and the scientific controversy. After several years of experiments, Jean-Edme Leclaire (1801-1872), a former painter who owned a paint company and was influenced by Saint-Simonianism, perfected a manufacturing process for zinc white that would allow for industrial-scale production and filed for a patent in 1845. Leclaire had witnessed the workers in Paris write the word “slaughterhouse” on the white lead workshop door, and had at first stood by powerless to prevent the health effects of the “white poison” on his own workers. But from 1849, Leclaire's factory on the River Seine, a few miles downstream from Paris, was able to produce 6,000 kilograms of zinc white a day. Leclaire's zinc white was higher quality than previous versions, more weather resistant, and its lower production cost made it a contender for industrial-scale use – which turned the economic equation upside down because it was sold at the same price as white lead. Leclaire soon formed a partnership with the Société des Mines et Fonderies de la

Vieille-Montagne,⁷ the world leader in zinc mining based in Liege, Belgium, that had a powerful distribution network. He brought an industrial innovation to European markets that was a true competitor to white lead producers:

“It was a revolution in the habits of the trade; people were divided into two sides: those who remained attached to their old routine and used the poison, with gaunt, pale and sickly workers; and on the other side, the advocates of zinc white, whose personnel were plump, hearty men, with rosy cheeks and a winning appearance.”⁸

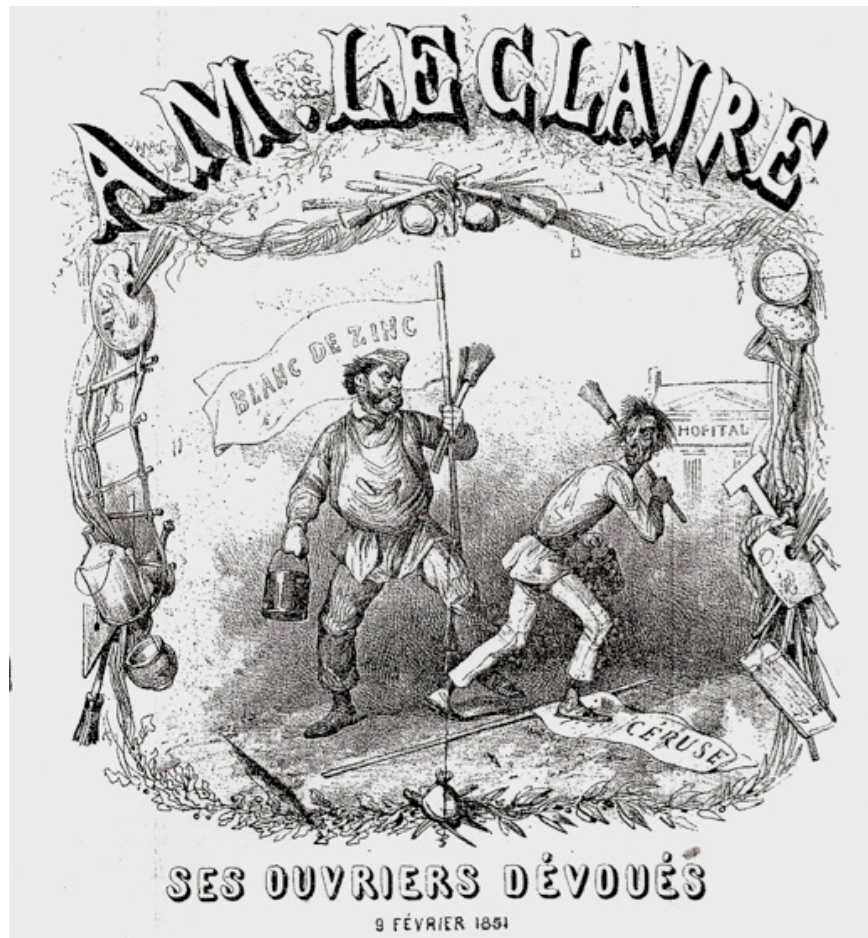


Fig. 1 — Lithograph given to Jean Leclaire by his workers, 1851, all rights reserved.

Of course, this description, appearing in an etching given to Jean Leclaire by his grateful workers in 1851, was biased (fig.1). The competition between the two products threatened the undisputed domination of white lead, depicted in this caricature as the sickly painter heading to the hospital, whereas his rival, who uses zinc paint, is hearty, haughty and healthy, proudly showing off the tools of his trade. The mid-19th century saw an increase in publications by reputed hygienists and professionals, such as Alphonse Chevallier (a member of the Paris Hygiene Committee) and the famous architect Viollet-le-Duc, in favour of zinc white.⁹ In 1849, Jean Leclaire was awarded a gold medal by the Société d’Encouragement pour l’Industrie nationale, and the following year, he received the Prix Montyon from the Academy of Sciences,

followed by the Legion of Honour, the highest civil distinction in France. Ambitious public action coincided with this series of awards. In August 1849, while hygienist periodicals agreed that the manufacture and use of zinc white were harmless, a Decree, soon followed by a government circular in February 1852, called for zinc white to be used for all public building works at the *département* and municipal levels.

At mid-century, all events suggested that white lead would thus soon disappear. Yet, a cloak of silence fell again on the dangers of white lead, which, like the many-headed Hydra, regained its strength even though it had been beheaded. I argue that the economic sector of the white lead chemical industry invented a new narrative to resist competition during this period and succeeded to make the issue dormant for nearly 50 years, before the issue of industrial poisons returned to the political debate at the turn of the 20th century.

Just after the 1898 Act establishing employers' liability for work-related accidents, the workers' movement to obtain compensation for occupational illnesses focused its efforts on industrial poisons. This chapter of the biography of white lead did not revolve around technical innovations, but was driven much more by changes in the labour movement, which enjoyed unprecedented ties with the political authorities under the French Republic. From 1900 to 1909, when the first law banning white lead paint was passed after years of parliamentary meanderings, white lead's public notoriety was at a peak, becoming a symbol. Labour leaders and journalists, high-ranking politicians such as Viviani and Clemenceau, public health experts and members of parliament worked together to make the perennial issue of industrial poisoning a major political "cause." In the French law passed just after World War I (Act of 25 October 1919), lead poisoning in painters was the occupational disease *par excellence* and its causes and effects were perfectly known by the general public, as newspapers were full of the health risk of using it and of economic rivalry of the two whites.

Back in the spotlight in 1921 in a transnational context, the conflict between lead-based and zinc-based paint briefly flared up again, as the 3rd International Labour Conference in Geneva debated an international convention banning white lead in building paint. France was clearly a pioneer on the topic, as the first country to have (partially) banned lead paint in buildings in 1909, and it was a leader in the ILO – whose first director was socialist Albert Thomas. The vigorous debates on white lead in Geneva read like a retrospective of the previous century: all the medical, technical, economic, health and humanist arguments were repeated in a single time and place. This repetition betrayed a collective amnesia making it necessary to review all the data already debated over the prior century: white lead was not dead yet. The 13th International Convention banning lead paint (1921), ratified by France, Belgium and a dozen other countries by 1926, gave a final twist to this debate, showing the powerful "manufacture of doubt" when assessing whether materials in the workplace are hazardous or innocuous.

2. BETWEEN INVISIBILITY AND COMPARTMENTALIZATION

For a century, the risk of industrial poisoning attracted sporadic attention from scientists, political authorities, experts and public opinion. Sometimes carefully documented, proven, debated, and partially dealt with, the risk was in other times overshadowed or denied. The

agnotological approach has been enhanced in recent social science research in the field of public health, and has shown that the invisibility of a public health issue is due not necessarily to deliberate concealment efforts, but most often to compartmentalization that prevents information from circulating outside limited, or even marginal, social spaces. The latter is a valuable perspective for casting light on the economic and scientific battle between white lead and zinc white, as periods of bright light and deep knowledge on the one hand and periods of limited circulation of the information on the other hand alternate during a century.¹⁰ Thus, rather than speaking of periods of silence, one can identify periods of compartmentalization. Each time the white lead controversy returned to centre stage during the 19th century, stakeholders' apparent amnesia regarding the material was quite surprising, as if the scientific and technical knowledge from previous episodes had been forgotten, as if new experts, chemists and physicians had to be brought onboard to prove the dangers of the material, and new paint experts to demonstrate that zinc white could replace white lead.

The first "silent period" on the issue of lead poisoning (1800-1845) in France was definitely part of the "erasure of the worker's body," a historical process identified by Le Roux in the dismantling of worker protections during the revolutionary period, giving rise to an industrialist mindset.¹¹ Prior to 1820, however, the economic stake was weak: production in France was still on a small scale and most white lead was imported from Holland, Belgium and (to a lesser extent) England. As a result, a small number of physicians and chemists regretted a health issue affecting a small number of people. The public authorities gave their full support to the first attempt to produce white lead on an industrial scale and looked favourably on the factory built in 1809 in Clichy, on the outskirts of Paris. Given the French Empire's enthusiasm for industrial and chemical innovation, the white lead factory in Clichy fuelled France's hopes of asserting its economic independence from rival countries. The support given to this enterprise from the outset was indicative of the overt collusion between politicians, industrialists and eminent public health experts, such as Chaptal, Thenard and Roard (the director of the Clichy white lead factory).¹² Despite the development of white lead manufacturing in the 1820s and the subsequent increase in lead poisoning cases, which became apparent in the corridors of hospitals – especially in Paris and Lille, the two cities were the centres for France's white lead industry – the message of the material's dangers was restricted to the narrow spheres of public health. These health hazards were documented in the *Annales d'hygiène publique et de médecine légale* but found few echoes outside this specialist publication. Furthermore, the fact that no alternative material could compete with white lead in terms of quality or price meant that the "white poison" dominated the paint industry: despite a few isolated cases of experts deploring the "white poison", it was not until Leclair developed his industrial process for zinc white in the 1840s that this public health issue gained strong visibility.

Once again, after the mid-century flurry of public action to establish a ban (1849-1852), a second period of heavy silence began, lasting a half-century. Three major factors were behind this period of waning controversy. First, the white lead industry formed a powerful lobby group under the Second Empire. Mainly operating behind the scenes, this pro-lead coalition became very active in the mid-19th century to fend off the government's attempts to ban white lead. French white lead manufacturers were few in number (around a dozen nationwide), but were very concentrated geographically (Lille, Paris and Tours). These industrial powerhouses were

strengthened with cross-shareholdings and often backed by family ties – especially with the powerful textile industry in Northern France – and were well-organized to exert their influence on decisive regional and national stakeholders such as the Chambers of Commerce and Industry. In a market that was opening up and becoming more international, they constantly called on the government to change its customs duties on raw and finished materials in order to fend off imports and protect the national market, notably during the negotiation of free trade agreements in 1860-61. These industrialists viewed these free trade agreements as the death knell for their material, which would lose out to British and German competitors. The lobby's influence on the Second Empire's economic institutions was undoubtedly strong enough to explain why white lead production continued in the latter half of the 19th century despite opposition to the material.

The Third Republic opportunistically supported the white lead industry, thanks to the efforts of Charles Expert-Bezançon, who was the leading white lead industrialist in Paris, an influential member of French industrialist circles and senator for Paris *département* (1900-1909). He was a spokesman, or even a tribune, for the powerful white lead lobbying group over several decades, which invested considerable efforts in publications and public events to foster doubts about the toxicity of white lead and the capacity of zinc white to be an effective substitute. Refusing to consider the rosters of sick workers treated in hospitals, challenging any attempts to quantify the lead poisoning epidemic, denying that white lead could be dangerous when it was handled with all the “desirable” precautions, the white lead industrialists echoed hygienist arguments that workers were negligent in protecting themselves. They also skilfully fuelled confusion about other toxic materials or other sectors responsible for lead poisoning that did not use white lead (printing, plumbing, battery manufacturing, etc.). Boasting their industry's technical advances since the mid-19th century, they endeavoured to cast doubt on the validity and the hidden motives of the campaign against white lead, whose assertions were considered baseless and in no way related to epidemiological reality.¹³ From a technical standpoint, the white lead industry sought to prove that lead-based paint was superior to its zinc-based rival by shifting the debate to industry experts and away from physicians or the general public, considered uninformed about opacity, ease of application, drying, and resistance of the paint over time. From a political standpoint, the approach repeatedly sparked suspicion about the true motivations of the opponents to white lead, accusing physicians, unionists and politicians of being corrupt and “anti-patriotic,” allegedly being paid by the Belgian or German zinc industry to destroy the French white lead industry. This argument occasionally drifted into an anti-parliamentarian, xenophobic and anti-Semitic diatribe.¹⁴

Lastly, from a medical standpoint, the white lead industry attempted to manipulate the nascent clinical knowledge about lead poisoning. Substantial research focused on lead poisoning after 1830, but the findings were largely limited to a scientific audience. Following Tanquerel des Planches (1834, 1839) and Grisolle (1835), clinical knowledge in the late 19th century specified the many symptoms and pathologies all connected to lead – designated without a doubt as a violent poison. Similar statements were made in Britain, where the growing white lead industry in Newcastle-upon-Tyne caused waves of illness and even death among women workers: Dr Charles T. Thackrah had early on denounced the serious intoxications linked to the use of lead in industry and described the main symptoms allowing the disease to

be diagnosed and patients to be distanced from the source of poisoning (1831), as had Henry Burton, who stated that a greyish coloration of the gums was an unmistakable symptom of lead poisoning, then known as the “Burtonian line” (1840). More attempts to give a conceptual and practical framework to the disease were made in the same period in Italy and Germany. These facts illustrate how knowledge was being built up on a European scale about what was the main industrial work-related disease at that time. However, this clinical knowledge and the medical controversies were inherently technical, remaining somewhat invisible to the general public. Only at the turn of the 20th century did the medical and political fields partly become synchronized, notably through networks of republicans and Free Masons, such as Paul Brouardel, a friend and follower of Louis Pasteur and professor of forensic medicine and an eminent member of the Academy of Medicine. During the 1900-1910 decade, medical expertise on occupational lead poisoning found an audience outside the hospital sphere: in the political arena of the Third Republic, the interconnected but contradictory demands of personal freedom and social justice brought scientific experts back into the political spotlight that they had partially deserted during the 19th century.¹⁵

The labour movement in the latter half of the 19th century was not yet mature enough to publicize the health issues of industrial poisons and to demand about occupational health conditions in the chemicals industry. There were no official labour unions in white lead factories. In Paris, where white lead factories employed around a hundred workers in the 1880s, there are no traces of a union in the sector. In Lille, white lead workers were three or four times greater in number, there are no signs of a trade organisation or of workers’ demands regarding health conditions in this small but powerful part of the local chemical industry. Over the previous decades, hygienist journals had published a fairly large number of articles about arsenic, lead and mercury poisoning, but the topic was nearly ignored by the nascent labour movement, which was mostly focused on achieving political and doctrinal unity, and emphasized fundamental demands for higher wages and reduced working hours. It was not until 1900, when house painters began to organize as a trade (they were the main users of white lead), that labour unions started to refer to lead poisoning as a “cause.” It remained nevertheless a secondary topic, quickly set aside when not considered useful for building a unified labour movement.¹⁶ In the end, labour movements making demands for the “victims” joined forces with medical professionals to bring the issue of lead paint poisoning into the public sphere, just as French republican officials were focusing on social matters. The distance separating the various arenas was reduced: no longer confined to the side lines after a half-century, white lead entered the spotlight thanks to the convergence of the labour movement, scientists speaking out about public health, social policy being promoted by government leaders, and the press’s new-found interest in publicizing this cause, designing a new “regime of perceptibility”.¹⁷ This convergence of influences gave rise to new national rules, with the 1909 act that banned the use of white lead in building paint and attempted to eliminate the risk for house painters. This was only partially successful, however, because the ban, scheduled to take effect on January 1, 1915, was overtaken by the outbreak of World War I.

After the Armistice, the efforts to fuel doubts about zinc white as a possible substitute for white lead reappeared during the heated debates at the 3rd International Labour Conference, starting the international career of the product. The recently-founded ILO (1919) quickly

addressed the issue as a sign of its determination to set standards for sanitary working conditions in order to draft an International Convention banning white lead. However, even a century and a half after Guyton de Morveau's demonstrations, the qualities of the two materials were again addressed for several weeks in Geneva, suggesting that a scientific debate was still legitimate and unsettled. As Albert Thomas, director of the ILO, noted at the time, the advocates of white lead insisted on "undermining the authority of the scientific demonstrations on which [the convention] was based! It is therefore important [...] that the experts [...] defend the truth against those who wish to adulterate it."¹⁸

3. WHEN POISON ENTERS THE MARKETPLACE

As we have seen, scientific and technical arguments held great sway in this century-long battle. This conflict was chiefly an economic confrontation between two materials on a very lucrative market, governed by rules that were upended by new health and moral considerations. Endorsing the liberal anti-interventionist credo that the marketplace should act as the "site of veridiction,"¹⁹ the advocates of white lead opposed government intervention for the sake of open economic competition, which they claimed revealed its true value and thus should be the sole determinant: "When the railways were built, the stage coaches disappeared; they died a timely death. If zinc white is truly superior to white lead, it will kill us in the marketplace, but the government should not intervene."²⁰ These were the words of Expert-Bezançon, in his February 1903 deposition to the parliamentary committee examining the bill for banning lead-based pigments in paint. Among the industrialists, the debate was essentially about political economy and free enterprise, and the denied right of the State to remove a product due to drawbacks extrinsic to the market.

However, several factors disrupted the competitive landscape shaped by the invention of the manufactured zinc white as an alternative product to the poisonous white lead. White lead's longer presence in the paint market was a major advantage for the material. It had been a luxury good, before being manufactured on an industrial scale inundating the Western European markets for paint for artists and decorations. When Leclaire's zinc white entered the market as of 1845, white lead held a dominant position, having reigned supreme in the building paint markets under its many avatars: Venetian ceruse, Meudon, Spanish, Champagne or Troyes whites, all derivatives of the original pigment, named according to the proportion of white lead content. Zinc white would have to overtake white lead. Beginning in the 1840s, Belgian firm Vieille-Montagne – leader in the European zinc market – implemented a clever strategy to win over the paint market. It acquired and filed for patents, built subsidiaries, carried out various experiments, made verbal and secret agreements to buy out competitors, all in an attempt to defeat white lead. However, the white lead industry enjoyed substantial private and political support under the Second Empire, even though the French government put a legal – but never implemented – ban in public works projects in 1849. Despite the financial firepower of the Vieille-Montagne, which manufactured and sold zinc white in the French, Belgian and German markets, zinc white struggled to challenge white lead in the paint market until the 1920s. Similar in price to its competitor, zinc-based paint nevertheless required painters to work differently. It was slightly more difficult to handle than lead paint, requiring the worker to give "greater

attention to even out his painting. A certain amount of training [was] needed, as for any change in occupation”, a “turn of the wrist” that took some time to learn, although specialists said it came rather quickly.²¹ While many painters were opposed to this change, this is also because it favoured skilled workers, with more technical experience, whereas in the final decades of the 19th century, growing numbers of unskilled labourers took up painting on building sites, in a proletarianization process of the trade. These unskilled workers commanded lower wages and were preferred by many unscrupulous business owners. However, such workers struggled to use zinc-based paint, which “lathered up” less with the paint brush. Lastly, the switch to zinc-based paint made it more difficult to “cheat” on the quality of paint because zinc white is harder to mix with adulterated substances (such as chalk, flour and other white powders, often used in the mixing instead of pigments) than white lead. Since such fraudulent practices were common among building companies, this also explains professional painters’ opposition to zinc-based paint. Thus, despite its harmlessness and because of this unwanted technical turn in the workers’ know-how, zinc white was rejected by most paint professionals.

In the end, however, the health argument won out – at least in public opinion. The health argument or, again, a matter of price? The social cost of illness became a strong argument for zinc white in the court of public opinion, unsettling market rules. While estimates of the number of occupational lead poisoning victims had been imprecise and very incomplete, by the mid-19th century, several publications revealed the financial cost of these diseases for society, in addition to the images of people suffering. Figures showed the growing number of white lead workers and painters suffering from poisoning, giving them a new-found visibility in hospital wards: 948 patients hospitalized in Paris for lead poisoning over a period of 942 days (from September 1849 to March 1852), costing the Paris hospital administration some 19,000 days of care to lead poisoned patients.²² Crippled men with arm and leg paralysis unable to work and depending on charity for life, weak and disabled children born to lead-poisoned mothers, families forced into penury by the early death of fathers: it eventually appeared that including the health and social cost of chronic lead poisoning in the calculation made white lead much more expensive than its substitute. In the latter half of the 19th century, references to the cost of treating lead poisoning victims and taking care of the disabled for life became a leitmotiv of those arguing that zinc white should be preferred “in the interests of humanity *and the state*.”²³

Ultimately, this socio-technical controversy raises the basic question of competition in the marketplace between two materials whose qualities and value were built under different criteria, along different timelines. On the one hand, technical knowledge determined the chemical makeup, utility and price of each material. On the other hand, medical knowledge and expertise assessed each material’s harmfulness for human health. Thus, the purely industrial and commercial motives were overshadowed by the health issues, and the resulting regulatory standards impacted the markets by changing the notion of quality and thus also market conditions. Consumers’ “choice” – the famous *routine* – had little to do with defining quality.²⁴ White lead’s commercial resilience was attributable less to its supposed intrinsic technical qualities (ease of application and drying, opacity, weather resistance, etc.) than to the qualities attributed to it in a specific historical context: its centuries-old reputation, national production capacity, and “traditions” in the painter’s trade, all underpinned by an unprecedented public lobbying campaign and much concerted effort by stakeholders. Conversely, during the periods

when the health argument prevailed as a driver of public action (namely, late 18th century, 1849-52 and 1900-1930s), the material's alleged merits were completely overshadowed by its harmfulness that somehow swept away the economic conflict by asserting that human life was more important than the market. As Justin Godart, French delegate to the ILO, claimed in 1921:

“Faced with all these private interests defending themselves [...], we must consider a higher interest: human interest. I believe that by protecting human life [...], we serve the general economy and commonwealth more usefully than by allowing white lead to be used, *even if* it is an established fact that it provides longer protection to the materials it covers, *even if* its cost is lower.”²⁵

In these circumstances, public health and free competition appear to be two irreconcilable facets of economic growth. Nevertheless, a transnational system of standards was crafted in an attempt to reconcile these two values in favour of public health – but proved to be widely unsuccessful.

CONCLUSION

The controversy between lead and zinc whites in the 19th and 20th centuries exemplifies the strong interconnections between economic, social, technical and political factors that determine the life and the identity of materials in the long run. White lead came to be seen as an industrial poison rather than as a useful and common chemical product after a complex process involving scientific research (in medicine and chemistry), technical debates, economic rivalries and political sparring. For more than a century, self-proclaimed experts who would later be known as “merchants of doubt” maintained a fog of social and political doubt about the dangers of white lead and the innocuousness of zinc white. Even though the latter had been scientifically established by the end of the 18th century, they did not hinder the continued commercial dominance of white lead for more than a century. In order to disentangle the mesh of converging interests interweaving the alliance between white lead and industrial societies, scientific evidence may be necessary but is by no means sufficient. Industrial and social stakeholders use mechanisms for manufacturing ignorance or, at the very least, perpetuating doubt about medical and chemical expertise thus creating scientific confusion and thus breaking the market rules. Powerful public and private actors thus participated in the elaboration of a regulation of the toxic substance which, while relying on the elaboration of a protective legal norm for people, permitted the resilience of the material and the social acceptance of a risk inherent in the industrial society of “progress”. On this topic, the case of the white paint pigments used on a massive scale during the rapid urbanization of Europe is a valuable historical angle to identify long-lasting mechanisms which can be seen even today, when certain political and economic interests vocally challenge scientific knowledge.

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