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## Manure-Related Accidents: The Historical Perspective

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Andreas Knoblauch, Salma Mughrabi, Peter Boyle

### Summary

Liquid manure is an important element in modern intensive agriculture. However, its handling and storage present acute risks in the form of toxic or explosive gases and large storage containers, access to which is often inadequately secured. In recent years occupational medicine and accident prevention experts have begun the task of systematically identifying the sources of risk and formulating safety guidelines. The present paper, a byproduct of research into the epidemiology of manure-related accidents in eastern Switzerland, explores the history of this type of accident. The historical record shows that in centuries past such events were an urban rather than a rural phenomenon. The main sources of risk were the cesspits in which domestic, hospital and prison waste was collected, cemeteries and church crypts where the dead were laid to rest and even the holds of ships transporting cargos of dried excrement intended for use as agricultural fertiliser. Historical accounts indicate that then, as now, there was often inadequate awareness of the dangers of such installations, despite the many (often dramatic) contemporary reports of accidents and fatalities caused by failure to institute and observe basic safety rules.

### Introduction

#### *The significance of manure in agriculture*

Manure is a mixture of animal dung and urine and straw, substances encountered wherever domestic animals are kept and crops raised. For the farmer, working with manure is part of the daily routine. Depending on the

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region, each animal barn has an accompanying manure pit or dung-heap. Liquid waste is piped from the pens into the manure pit via a system that includes devices to prevent the backflow of gases, while dung has to be transported mechanically to the dung-heap. Manure pits can have a capacity of anything from a few hundred litres to many hundred cubic metres. In spring and autumn the spreading of manure on fields can occupy farmers for many days at a time, and the time they devote to the management of manure reflects its importance. It is a major fertiliser, used to maintain the productivity of the soil. It is therefore only natural that farmers see it as a valuable substance. In an interview published by the *Neue Zürcher Zeitung* in 1993, Ernst Gfeller, an 80-year-old retired farm labourer, described his daily activities in a retirement centre for agricultural workers in Oeschberg, central Switzerland: “The first year I was here I was the dairyman. Then I took care of the cattle and the horses and the dung-heap.” Referring to a practice common in some parts of Switzerland, he went on: “I wove a nice pattern with plaited straw on the dung-heap. One day the manager, Mr Kopp, came back from the village and said, ‘Did you know, Ernst, that our dung-heap is the talk of the village?’”<sup>1</sup>

The importance of manure is also reflected in works of literature dealing with farming life, such as those of Jeremias Gotthelf, a popular 19<sup>th</sup> century Swiss author noted for his depictions of rural life. When Jakobli, the main character in Gotthelf’s novel, *Anne Bäbi Jowäger*, decides to expand his farm, the first action he takes is to enlarge the manure pit<sup>2</sup>.

While dung is already mentioned in the Old Testament (5<sup>th</sup> century BC)<sup>3</sup>, in Switzerland the storage of animal and human excrement in the form of *liquid* manure was probably first practised in the area around Zurich in the early 18<sup>th</sup> century<sup>4</sup>. In 1816 Johann Nepomuk Schwerz, a pioneer of agricultural science in Switzerland, who was later to become director of the experimental farm and agricultural college at Hohenheim, learned of the advantages of liquid manure as fertiliser during a visit to the property of Emanuel von Fellenberg at Hofwyl, near Berne, and described it as a ‘precious substance’<sup>5</sup>.

1 «Gfeller E., Knecht, pensioniert», «Arbeit» *NZZ-Folio – Die Zeitschrift der Neuen Zürcher Zeitung*, Nr. 9 (September 1993) 25: «Hier auf dem Oeschberggut habe ich ein Jahr den Melker gemacht und dann zu den Gusti geschaut und zum Rössli und den Miststock gezöpft. Ich habe einen schön gezöpften Miststock gemacht. Einmal ist Herr Kopp, der frühere Heimleiter, aus dem Dorf heimgekommen und hat gesagt: «Du Ernst, unser Miststock ist das Dorfgespräch.»»

2 J. Gotthelf, *Anne Bäbi Jowäger II*, ch. 7 (Diogenes Taschenbuch 1978).

3 Jeremiah 9.21 (22), 16.4.

4 A. Hauser, «Güllewirtschaft und Stallmist – zwei grosse Erfindungen der Landwirtschaft»; *Schweizerische Landwirtschaftliche Forschung* 13:1/2 (1974) 15–26.

5 J. N. Schwerz, *Beschreibung und Resultate der Fellenbergschen Landwirtschaft zu Hofwyl* (Hannover 1816); quoted from Hauser 1974 (n. 4) 16.

In the course of centuries agriculture was organised in such a way that the growing of crops for food and animal feed, on the one hand, and animal husbandry, on the other, complemented each other: feed production enabled the keeping of cattle, which in turn produced natural fertiliser for pasture and wheatfield. The introduction of manure management systems meant that farmers were able to exploit this natural resource to the full, turning their farms into self-sufficient ecosystems in the process<sup>6</sup>. Farmers who made the effort to improve their manure management were more successful than those who did not.

Gotthelf also recognised this and even saw a sectarian side to it:

[...] they did not know that in regions that had joined the Reformation dung had supposedly been changed and improved. There are Catholics who say that they know only too well why Protestant land is better than that of the Catholics, that it is because the Protestants do not observe Lent and thus eat more meat, which makes their manure richer. Perhaps we should send two sachets to Professor Liebig [an expert on soil fertilisation] in Giessen, one of Catholic and one of Protestant dung – he'd soon help us to clarify the matter<sup>7</sup>.

City-dwellers had a rather different attitude to excrement. Their main concern was to prevent the masses of waste they produced and the associated odours from overwhelming them. For centuries it was sold to farmers as fertiliser, making municipal waste-removal services profitable enterprises.

The establishment of the infrastructure that now guarantees virtually odour-free waste removal in cities and towns throughout the western world was a long and difficult process, involving the struggle of new ideas against traditional ways and thinking and the investment of enormous sums of money. The cities' need to dispose of large quantities of human excrement and other remains, so often described in the literature, and the use of urban waste as agricultural fertiliser were the basis for yet another side in the many-faceted relationship between urban and rural populations. The actual arrangements varied widely, reflecting local particularities and changing historical circumstances. Around Zurich, for example, the collapse of wheat prices around 1870 forced many farmers to turn from grain growing to cattle

6 Hauser 1974 (n. 4).

7 Gotthelf 1978 (n. 2): «... sie wussten nämlich nicht, dass in der Reformation der Dünger verbessert und anders geworden sein soll. Es gibt nämlich Katholiken, welche sagen, sie wüssten wohl, woher es komme, dass das Land der Reformierten viel besser sei als das der Katholiken, es komme nämlich daher, dass die Reformierten keine Fasttage hätten, darum täten sie viel mehr Fleisch essen, und daher sei ihr Dünger viel bschüssiger. Weiss nicht, man sollte dem Professor Liebig in Giessen (Spezialist für Düngerfragen, Anmerkung des Autors) zwei Druckli schicken, eins mit katholischem Dreck und eins mit reformiertem Dreck, der hülfe einem bald aus dem Gwunder.»

raising. As a result they became self-sufficient in manure and stopped buying human waste from the city. The increasing availability and attractiveness of artificial fertilisers also contributed to declining prices for the previously highly regarded 'town manure', and the city's waste removal service was soon operating at a deficit. This and other factors forced the city administration to abandon the old system of waste collection in buckets and begin the costly process of installing a modern sewerage system<sup>8</sup>.

### *The hazards of manure*

Apart from the issues of hygiene and smell, collections of human and animal waste pose other, more acute, risks, particularly once the process of decomposition has set in. Stored manure presents three types of risk. Firstly, there is the danger of falls into storage containers through faulty or inadequately secured covers. Equally important is the risk of poisoning from at least two of the noxious gases produced in manure by bacterial decomposition, hydrogen sulphide (H<sub>2</sub>S) and ammonia (NH<sub>3</sub>). Low concentrations of hydrogen sulphide produce the familiar rotten egg odour. Medium concentrations cause irritation of exposed mucous membranes, with conjunctivitis a particular problem, and repeated exposure may even lead to blindness. High levels of the gas cause progressive loss of consciousness. At extreme concentrations, such as those present in manure pits after agitation of the contents, a single deep breath can produce unconsciousness and respiratory paralysis. It is this dramatic form of hydrogen sulphide poisoning that is responsible for most fatal manure-related accidents on farms. Exposure to ammonia, whose pungent odour is characteristic of animal enclosures and liquid manure, can result in anything from mucosal irritation to pulmonary oedema. The third source of danger is methane, also a product of biodegradation, which is highly flammable and may explode if ignited. Burning manure gas, usually ignited by carelessly discarded cigarette butts, is a frequent cause of fires on farms. To understand the mechanisms of manure gas accidents, it is important to appreciate that potentially dangerous amounts of gas are set free whenever manure is disturbed, as happens whenever it is pumped into or out of a container or agitated, particularly at warm ambient temperatures and in still air. The gas concentration in a freshly emptied manure pit, for example, is likely to be particularly high.

<sup>8</sup> M. Illi, *Von der Schissgruob zur modernen Stadtentwässerung* (Zürich 1987) 87.

The origins of the present essay can be found in a case series presenting 61 major manure-related accidents<sup>9</sup> and an epidemiological study of manure-related accidents in eastern Switzerland<sup>10</sup>. As we examined the background and circumstances of these often tragic events we realised that there is also a historical dimension to the phenomenon, and that this is as yet largely unexamined. We began to follow up historical references in the literature on manure-related accidents and chanced upon Alain Corbin's historical treatise, *The Foul and the Fragrant*<sup>11</sup>, which itself proved a valuable source of information and further reading. Here, we present some of the information gathered from these sources. It is by no means an exhaustive study. In fact, it can claim only to be an introduction, to give an inkling of the rich field of information to be harvested by scholars willing to undertake historical studies of the subject.

### **Human and animal waste – a universal problem**

Wherever humans live in groups, the waste they produce must be disposed of if noxious odours are to be avoided. This can be experienced in certain third-world cities, where collections of rubbish, human and animal excrement and rotting animal cadavers are responsible for a widespread, nauseating stench. Historical records show that even as late as the early 19<sup>th</sup> century stench was a dominant feature of European cities. It was not until that time that people started to recognise bad smells for what they were and associate them with outbreaks of disease. The 'hygiene revolution' began, and heated debates were conducted about things that had previously been taken for granted, such as the all-pervading stench or the lack of hygiene in hospitals and prisons. In Paris in 1794 the first university chair of public hygiene was established. One of the duties of its first incumbent, Jean-Noël Hallé, was an inspection of some 10 km of the riverbanks along the Seine for the purpose of recording and cataloguing the odours of the city. During this exercise Hallé was accompanied by his friend Boncerf, another medical scientist. At the point where the dreaded effluent from the Gobelin tapestry factories was

9 A. Knoblauch/B. Steiner, «Manure-related accidents. A case series of 61 major accidents», *International Journal of Occupational and Environmental Health* (forthcoming).

10 A. Knoblauch/B. Steiner/S. Bachmann/G. Trachsler/R. Burgheer/J. Osterwalder, "Accidents related to manure in eastern Switzerland: an epidemiologic study", *Occupational and Environmental Medicine* 53 (1996) 577–582.

11 Alain Corbin, *Le miasme et la jonquille. L'odorat et l'imaginaire social XVIII<sup>e</sup>–XIX<sup>e</sup> siècle* (Paris 1982) [A. Corbin, *The Foul and the Fragrant. Odor and the French Social Imagination*, Leamington Spa/Hamburg/New York 1986].

discharged into the Seine, Boncerf was walking through the mud at the water's edge, with the wind in his face:

Monsieur Boncerf, who at this point had turned more directly into the southeasterly breeze and had descended to the riverbank, was overcome by a biting, alkaline, stinging, and stinking odor. It affected his respiratory system so badly that his throat began to hurt within half an hour and his tongue became noticeably swollen. Affected by these poisonous vapors, he warned me to return to the road straightaway [...]<sup>12</sup>.

In about 1788 Arthur Young, a British traveller in France, described the French city of Clermont in the following terms:

The contention of nauseous savours, with which the air is impregnated, when brisk mountain gales do not ventilate these excrementitious lanes, made me envy the nerves of the good people, who, for what I know, may be happy in them<sup>13</sup>.

In 1780 Lavoisier, the famous chemist and discoverer of oxygen, noted that Berne was the cleanest city he had ever seen. Gangs of convicts, he reported:

drag large four-wheel carts through the streets every morning, chained to a pole; longer, lighter chains bind hardened female criminals to the same cart [...] half of these women sweep the streets, the other half load the rubbish onto the cart<sup>14</sup>.

A French author, writing in 1789, says of Paris:

The need is pressing, the capital is nothing more than a vast cesspool, the air is putrid there ... In some [districts] it is already so foul that the inhabitants can hardly breathe<sup>15</sup>.

Nor was the air inside the houses any cleaner:

Also, when moving about in a large city from one house to another, one often does nought but exchange one fetid and disgusting atmosphere for another, yet more foul and disagreeable. This is easily perceived by those with delicate chests and above all by anyone newly arrived in a large town<sup>16</sup>.

12 J. N. Hallé, *Procès-verbal de la visite faite le long des deux rives de la rivière Seine, depuis le Pont-Neuf jusqu'à la Rappée et la Gare, le 14 février 1790*, Histoire et memoires de la Société Royale de Médecine (Paris 1790) LXXXVI. Quoted from Corbin 1986 (n. 11) 2.

13 A. Young, *Travels in France during the years 1787, 1788, 1789* (London 1789) 383. Quoted from Corbin 1986 (n. 11) 58.

14 A. L. Lavoisier, *Œuvres* 3 (Paris 1844) 496. Quoted from Corbin 1986 (n. 11) 93.

15 A. Tournon, *Moyen de rendre parfaitement propres les rues de Paris* (Paris 1780) 60. Quoted from Corbin 1986 (n. 11) 57.

16 M. Géraud, *Essai sur la suppression des fosses d'aisances et de toute espèce de voiries, sur la manière de convertir en combustibles les substances qu'on y renferme, etc.* (Amsterdam 1786) 93.

In the 1827 annual report of the Paris public health committee we read:

Go out of Paris today and choose whichever road you will, you will not fail to meet a fair number of rubbish carts, and at any moment find yourself to leeward of a real rubbish dump. The approaches to the capital are already and from all sides heralded by the putrid vapors breathed there ... Soon the sense of smell gives notice that you are approaching the first city in the world, before your eyes could see the tips of its monuments<sup>17</sup>.

The following year the report states, “the soil surrounding Paris is impregnated by this malodorous muck to a great distance”<sup>18</sup>.

Cesspits were ubiquitous: almost one for every house. They were periodically emptied by professional refuse collectors. As already mentioned, human excrement was a valuable commodity that was processed into fertiliser and sold. For around 100 years the profitability of this trade prevented the introduction of a hygienic sewerage and drainage system in Paris. In 1834, for example, Paris produced 102,800 cubic metres of excrement, and the annual income from the huge refuse dump at Montfaucon alone was half a million francs. According to calculations published in the *Journal de Chimie Médicale* in 1857, the discharge of 332,000 tonnes of effluent into the Seine would have meant the loss of 275,600 tonnes of manure<sup>19</sup>.

#### *The dangers posed to public health by effluent*

These 18<sup>th</sup> and 19<sup>th</sup> century records bear impressive witness to the omnipresence of refuse and effluent in cities and towns at that time. In view of this, and given that most buildings had their own cesspits, it seems only logical to assume that, in contrast to the modern situation, in which such events are almost exclusively a rural phenomenon, disease and accidents related to collections of effluent or manure also occurred in the urban environment. And, as we shall see, there is no lack of contemporary reports to confirm this conclusion.

Writing in 1786, Mathieu Géraud, a member of the Paris faculty of medicine and campaigner for improvements in public health, described the dangers of the domestic latrine in drastic terms:

It is most common, in Paris and the other great cities, for the privy to be placed in a closet that receives very little fresh air, or none at all. If persons visiting the closet keep the door closed during their sojourn there, they put themselves in grave danger. They may suffer attacks of *mitte* or *plomb*, a sharp burning in the eyes followed by inflammation, a tightening in the throat, a suffocating cough, involuntary laughter, delirium and convulsive asphyxia,

17 V. de Moléon, *Rapports généraux sur les travaux du conseil de salubrité* (Paris 1828) 46. Quoted from Corbin 1986 (n. 11) 115.

18 V. de Moléon 1828 (n. 17) 75. Quoted from Corbin 1986 (n. 11) 115.

19 Corbin 1986 (n. 11) 116.

and death may ensue if rescue is not prompt. When these vapours emanate with force from the privy, they occasion [all manner of maladies] in those imprudent enough to remain on the seat or near to it – particularly if the latrine has recently been emptied<sup>20</sup>.

It is easy to imagine the suffering caused to city dwellers by the chronic effects of stench and reeking fumes when one reads the report prepared in 1866 by the Zurich city engineer, Arnold Bürkli:

Thus, there are at present numerous houses in the city whose corridors and bedrooms receive no light or air, save from the ‘fore-ditch’ [a narrow passage separating neighbouring houses, and into which the latrines emptied], from where it is quite impossible to promote a proper draught, else the whole house be filled with emanations from the ‘fore-ditch’. Indeed, it were perilous to open the dingy windows even for washing, since these must serve as a barrier to splatterings of excrement. It is impossible for the inhabitants of such dwellings to thrive; they grow accustomed to dirt and filth, and this cannot fail to adversely affect their cultivation and morals<sup>21</sup>.

### *The particular dangers of prisons, hospitals, churches and ships*

Prisons, hospitals, churches and the holds of ships were notorious for their unbearable stench. Finkelnburg, a professor in Bonn, describes an instance of poisoning in a German prison due to cesspit gas in 1874. Fourteen prisoners who had been employed making brushes in the prison cellar were admitted to hospital. An investigation revealed that the cesspit had been emptied the day before, a process that, as already mentioned, releases large amounts of toxic fumes into the ambient air. The building apparently had no effective facilities for excluding this gas from occupied quarters, a conclusion supported by the author’s observation that the affected area was subject to repeated flooding by back-flow from the cesspit<sup>22</sup>.

A French observer, writing in 1788, described conditions in the famous Hôtel-Dieu hospital in Paris: the excrement that everywhere seeped into the wooden floors; the walls marked by sputum; and the palliases and feather beds of the dying, soaked with all manner of bodily fluids. As in prisons, the latrines spread a pestilential stench. The 583 patients confined in the hospital’s three rooms had only five latrines at their disposal, into which pans of waste were also emptied.

20 Géraud 1786 (n. 16) 37.

21 A. Bürkli, *Kanalisation der Stadt Zürich. Nachtrag zum Berichte A. Bürkli über die Anlage städtischer Abzugskanäle und Behandlung der Abfallstoffe* (Zürich 1866) 3. Quoted from Illi 1987 (n. 7) 74.

22 Finkelnburg, “Massenvergiftung durch Kloakengas im Gefängnis”, *Vierteljahresschr. f. gerichtl. Med. u. öff. Sanitätsw.* (1874) 20.

You climb onto the seats: filth is piled up there, the chance arrival sits down next to you; the filth moves along the floor as far as the door, which only the thickness of the wall separates from the casualty ward<sup>23</sup>.

Cemeteries and church crypts were another major source of stench and, under certain circumstances, also of mortal danger. In the late 17<sup>th</sup> century residents began to complain about the 'exhalations' from certain Parisian cemeteries<sup>24</sup>. Accidents in cellars of shops bordering the cemetery of the Innocents<sup>25</sup> finally led to a concerted campaign among local residents for its closure, which eventually succeeded in 1780<sup>26</sup>.

By the middle of the 18<sup>th</sup> century strong objections were also being voiced about the practice of laying the bodies of the well-to-do to rest in the crypts of their parish churches, where they were left to rot until the space had to be requisitioned for more recent arrivals. As a result, churches were filled with the smell of decomposing corpses<sup>27</sup>. The opening of tombs was regarded as a hazardous undertaking, with the principal risk doubtless due to the toxic gases generated by the processes of decomposition<sup>28</sup>.

On ships the dangers of a certain cargo were inescapable and sometimes extreme. In 1818 the cargo ship *Arthur* was found drifting off Point-à-Pitre, Guadeloup. The vessel had sailed from Rouen, France, and become derelict after an outbreak of disease at sea had killed half the crew and left the remainder seriously ill. The stevedores who subsequently unloaded the ship also became ill. The cargo consisted of *poudrette*, dried human excrement processed into fertiliser at the Montfaucon refuse dump, that was on its way to French colonies in Central America. Years of intensive agriculture by the colonists had depleted the local soils to the extent that crops could be grown only with the aid of large quantities of fertiliser. In an incisive report on the incident, read before the *Académie Royale de Médecine*, the official investigator, Alexandre Parent-Duchâtelet, showed that the fumes given off by the cargo were the cause of the disaster. He first visited the Montfaucon dump, where he observed the production of *poudrette* by anaerobic fermentation of enormous piles of excrement. During a visit to Nantes harbour he witnessed the unloading of a cargo of *poudrette* from a small freighter just in from La Rochelle. When he interviewed the crew, he learned that the voyage had been a nightmare:

23 J. R. Tenon, *Mémoires sur les hôpitaux de Paris* (Paris 1788) 208. Quoted from Corbin 1986 (n. 11) 52.

24 Corbin 1986 (n. 11) 59.

25 Ibid. 30.

26 Ibid. 59.

27 Abbé Charles Porée, *Observations sur les sépultures dans les églises* (Caen 1749) 4–6.

28 Corbin 1986 (n. 11) 53.

All of them, five in number, were in the best of health as they set off from La Rochelle; three days later they noticed a mild headache that gradually worsened and intensified due to the heat and gas given off [by the cargo]; they soon had no appetite, their tongues turned white; they were tormented by frequent nausea, with several of them actually vomiting bile. These troubles were joined by generalised aching and sharp pains in the limbs and joints, and eventually by fever, and all the symptoms of that grave malady known as adynamic fever. One man and a child were additionally afflicted with severe diarrhoea, from which they had still not recovered when I saw them. It appears that the distress and illness these five men experienced were most severe, as they spoke angrily, cursing their ignorance of the effect such a cargo would have on them and swearing never to take another like it<sup>29</sup>.

After observing the unloading for some time he entered the hold himself:

I descended into the half-emptied hold, with the thermometer showing sixteen degrees Réaumur; but it was impossible to remain there for long; and although all the hatches had been open since morning, the temperature I found there seemed equal to that of a steamroom at 36 to 40 degrees; from the remnants in the bottom of the boat rose a vapour so intense that it was impossible to distinguish objects placed five or six feet away; the odour of this vapour was not that of faecal matter; it was more sickly, enervating and putrid; among a multitude of other odours one could recognise those of ammonia and hydrogen sulphide [...]<sup>30</sup>.

Parent-Duchâtelet established that *poudrette* continued to ferment in warm, humid surroundings and showed that the resulting fumes were responsible for the deaths among the crew of the *Arthur*, identifying hydrogen sulphide as the probable cause<sup>31</sup>.

### *Dangerous occupations – cesspit clearers and drain cleaners*

At particular risk were those whose occupations revolved around waste. Géraud, in his campaign for better public hygiene, drew attention to the plight of the cesspit clearers, whose work it was to empty cesspits:

But the most terrible blows dealt by cesspits are those felt by the cesspit clearers. Who can tell us how many of these unfortunates have perished at their work, and how many others have been subject to infirmity and disease [...]<sup>32</sup>

Masons were also aware of the dangers and dreaded having to work on cesspits:

29 A. Parent-Duchâtelet, *Recherches pour découvrir la cause et la nature d'accidents très graves, développés en mer, à bord d'un bâtiment chargé de poudrette* (Paris 1821) 21–22.

30 Ibid.

31 Ibid.

32 Géraud 1786 (n. 16) 39.

It is well known how much masons detest repairing or renovating cesspits. Little accustomed to their emanations, they are at that moment even more endangered than the cesspit clearers<sup>33</sup>.

Such occupations were regarded with distaste even in Roman times, as shown by instructions given by the emperor Trajan to his governor, Plinius, to have the cesspits cleaned by criminals, as such work was little short of being a punishment<sup>34</sup>.

An alarming spate of accidents among cesspit clearers in the mid 1770's prompted the authorities in Paris to appoint a commission of inquiry, made up of members of the college of pharmacists<sup>35</sup>. In the preamble to its report, which was discussed by the *Académie Royale des Sciences* in July 1778, the commissioners detailed the awful conditions in which these unfortunates were obliged to work:

The ever-present noxious fumes make of the emptying of pits an undertaking whose risks are not limited to the liberation into the atmosphere of emanations that exert a most dire effect on the cleanliness of the air; the emptying of pits is also, for the workers whose poverty obliges them to perform this frightful service, the source of illnesses to which humanity cannot remain indifferent. This station, already most deplorable for the humiliation it involves, is all the more so on account of its dangers. Fortunate is the cesspit cleaner who, in the theatre of his travail, does not dig his own grave. One example, among thousands, is the recent case in which three of these men perished while clearing the cesspit of a house in the rue Saint-Louis, in Marais<sup>36</sup>.

Certain cesspits were particularly feared by the cesspit clearers. One such was located in the house of a dissector who prepared anatomical specimens:

One pit, situated in the rue Galande, at the corner of the rue des Anglais, was notorious throughout the neighbourhood and among the cesspit clearers for the number of lives it had taken; up until then, say Messrs Cadet, Parmentier and Laborie, its clearance had often been commenced but never completed. Quite recently, a master cesspit cleaner, who had just left the pit after a night of toil, in the course of which several labourers had taken ill with the *plomb*, perished miserably. The ventilator undertakes the emptying of the fatal pit: the lavatory is raised and the keystone removed, revealing the enormous quantity of anatomical debris that made this pit so dangerous<sup>37</sup>.

The cesspit clearers were fully aware of the dangers and had developed their own nomenclature for the clinical signs and symptoms of hydrogen sulphide intoxication. They distinguished two main categories of poisoning, *mitte*

33 Ibid. 40.

34 Plinius the Younger (62–114 AD), *Epist.* 10,32,2 [German transl.: André Lambert, in: C. Plinius Caecilius Secundus, *Sämtliche Briefe*, Zürich/Stuttgart 1969, 387].

35 Laborie/Cadet le jeune/Parmentier, *Observations sur les fosses d'aisance* (1778).

36 Ibid. 3–4.

37 Ibid. 79–80.

and *plomb*. *Mitte* is a syndrome in which the mucous membranes become inflamed, with especially painful effects on the eyes (see below):

*Mitte* first affects the nose; nasal congestion is soon joined by pain deep in the eye, spreading to the frontal sinuses; the eyeball and eyelids become red at the same time; up to this stage, the condition is simple *mitte*. However, they also distinguish a second type, which they call *grasse*, and which spreads a sort of veil over their eyes and plunges them into a complete blindness for one or two days, accompanied by considerable inflammation and pain<sup>38</sup>.

*Plomb* involved a complex of 17 symptoms (equal to the number of lead compounds - hence the name):

A tightening of the throat, involuntary and sometimes singsong cries, which cause the labourers to say that *plomb* makes them sing; a convulsive cough, sardonic laughter, delirium, asphyxia and death are the varied ills visited upon the cesspit clearers by *plomb*.

Death or sudden asphyxiation is all too often the first effect of a leaden pit on a cesspit cleaner; and these ills do not fail to follow the other effects if a labourer who senses their attacks does not promptly seek the remedy of breathing fresh air<sup>39</sup>.

The late 18<sup>th</sup> century was the age of the theory of miasma, which held that evil-smelling fumes were the cause of a multitude of ills, including such diseases as typhus and diphtheria. However, instead of disposing of the offending substances by devising adequate means of storage or organising their removal, numerous attempts were made to ‘de-odorise’ the effluent or mask its smell. For example, gunpowder was detonated in an attempt to disperse the smell of rotting corpses that emanated from the crypts of French churches. These experiments were not without risk. Corbin describes a tragic accident that occurred in Paris, during the demonstration of a new antidote against excremental odours:

On March 23, 1782, the most famous experts in hygiene and chemistry gather in front of the Hôtel de la Grenade in the rue de la Parcheminerie. The cesspool of the building is to be cleaned out. The fatal character of its effluvia is well known. Moreover, the landlady is certain that the medical students have buried beneath the feces arms, legs, and other parts of the human body by the bucketful [...]. The Académie Royale des Sciences has dispatched the academicians Lavoisier, Le Roy, and Fougereux to make an on-the-spot inspection. The chemists Macquer and Fourcroy and the duc de La Rochefoucauld, the abbé Tessier, and Jean-Noël Hallé have come by order of the Société Royale de Médecine. They all are supposed to test the effectiveness of a new antimephitic substance; its inventor, Sieur Janin, has daringly asserted that it will destroy foul smells and quell miasmas.

It is a cold day, a mere two degrees Réaumur around noon. The wind is blowing from the north. There has been a heavy snowfall during the morning. In short, meteorological conditions appear favorable. While Janin sprinkles his substance, Jean-Noël Hallé and Abbé Tessier climb up and down ladders in order to measure the varying intensity of the stench. For hours the experiment, which began between eight and nine in the morning, proceeds without incident. Then, around three in the afternoon, comes a dramatic turn of events: one of

38 Ibid. 9–10.

39 Ibid. 12.

the cesspool cleaners suffers a fit of asphyxiation and slips off the ladder into the cesspool. He is pulled out with extreme difficulty. The onlookers lean over the mortally ill cleaner. A young man tries in vain to save him by administering artificial respiration<sup>40</sup>.

Nowadays, accidents involving intoxication by manure gas receive wide publicity because of the chain-reaction that often occurs: would-be rescuers are themselves overcome, resulting in multiple deaths. An early account of a serial accident caused by cesspit gases is to be found in an expert report prepared in France in 1873:

Here is the sequence of events: On the night of May 12 to 13, 1873, two farmers from the outskirts of Grenoble, H..., aged fifty, and D..., aged forty-two, experienced in the clearing of cesspits, were engaged in clearing a cesspit belonging to Mr B...: they were assisted in their work by H...’s son, aged seventeen, and by L... Having removed almost all the material with the aid of a sump, after the manner of the region, H... snr descended into the pit and filled two tubs, which he passed to D..., who had remained at the edge of the pit. After a few moments H... snr collapsed with asphyxiation, whereupon D... descended into the pit to come to his aid. H... jr descended in his turn, and, while attempting to lift his father’s body, also collapsed with asphyxiation. L..., who had gone to get help, tied a rope around his chest and descended into the pit; he was fortunate enough to rescue the half-asphyxiated H... jr, who was brought back to life by skilful attentions. He lowers himself into the pit a second time, and, attempting to take hold of H... snr, loses consciousness; taken from the pit, he was also revived. But the other two, H... snr and D..., could not be saved<sup>41</sup>.

The case became the subject of a coroner’s enquiry, the aim of which was to determine who was responsible. The emptying of cesspits was subject to safety regulations that had been in force in Grenoble since 1834. They were similar to others that had been introduced throughout France, mostly modelled on those formulated by the Paris city administration. The regulations provided for detoxification with iron sulphate before any emptying was undertaken. While one expert witness testified that 5 kg of iron sulphate per cubic metre of effluent was sufficient to produce complete precipitation of the sulphur and found that the accident had occurred because this precaution was omitted, another was of a different opinion:

In Paris, not a year passes without one or more lamentable deaths, in pits that have not only been disinfected but also ventilated with the aid of a Dalesme stove<sup>42</sup>.

The conclusion is still pertinent today:

It cannot be repeated often enough: whatever preliminary or concurrent decontamination measures are applied to any cesspit whatsoever, there is no safety for the labourer who enters it unless a gang is employed.

40 Corbin 1986 (n. 11) 2–3.

41 M. Chevallier/M. Hallé, “Asphyxie double par le vuilage d’une fosse d’aisance”, *Annal. d’hyg.* 43 (1875) 430.

42 Chevallier/Hallé 1875 (n. 41) 439.

Historical reports of similar accidents in German-speaking Europe also exist:

In 1861, here in Cologne, a mason descended into a cesspit to see to an inlet pipe that was blocked. He was barely half-way down when he let his head droop, fell into the liquid and then lay quite still. A second labourer immediately climbed into the pit to aid the victim, but hardly had he reached the bottom when he collapsed in a dead faint. The same fate befell a third labourer. A fourth was lowered, with a rope tied around his body. Barely had he reached the middle of the pit when his head drooped, whereupon he was pulled out, suffering from asphyxia. He alone was saved<sup>43</sup>.

The author noted that similar poisonings could occur in crypts and cemetery vaults. In 1871 a certain Dr Harbordt, registrar in Frankfurt am Main, delivered a paper at a meeting of the local medical society in which he describes a serial accident that occurred during drain cleaning operations:

Upon closer investigation at the scene of the accident, and from the doctor who had been called, I discovered the following: The canal where Rühl and his brother and brother-in-law, G., were carrying out cleaning operations is a side branch, several feet high and lower towards the back, into which effluent from a large house and a brewery flows. The strong current from the latter, carrying the effluent from the house with it, had in time led to the formation, several feet from the far end of the canal, of a dam made up of dirt, food scraps and the like, holding back a stagnant pool, which could not fail to promote decay and gas formation. When G., who was at the front, lying on his stomach, broke through this dam, the stagnant liquid rushed over him. Rühl crawled over him in order to lift his head out of the sediment but immediately lost consciousness. His brother, who was behind him, sensed the presence of toxic gas, extricated himself and went for help. The victims were pulled out by means of a rope attached to the undermost of the two<sup>44</sup>.

It is not generally known that several hours' exposure to low concentrations (20–50 ppm) of hydrogen sulphide results in irritation of the mucous membranes. Cases of rhinitis, laryngitis and bronchitis have been described, but the most serious effect is keratoconjunctivitis, a painful condition that can progress to blindness with repeated exposure. Such subacute exposure was described in detail in a monograph on occupational medicine by Bernhardi Ramazzini, professor of medicine in Padua, that was published in 1700. The relevant chapter is devoted to the diseases of the drain cleaners:

Since the various districts of the city are quite populous, which is why the houses there are very crowded and tall, it is usual that the gutters that go through the streets to every house are cleaned every three years. When this was done in my house I saw a workman doing his work in this noisome ditch in fear and trepidation; when I asked him kindly why he worked so busily, and did not go easier that he might not become too fatigued, he answered me from the ditch, saying, "No one who has not done this work can imagine how hard it is to stay in such a place for four hours; for it is as if one would go blind." After he had come out of the gutter I looked at his eyes and observed how red and dull they were. And when I pressed him further to tell me what means drain cleaners employed against such ills, he replied that they went home as soon as possible, as he was about to do, closed themselves in a dark room and

43 H. Eulenberg, *Die Lehre von den schädlichen und giftigen Gasen* (Braunschweig 1865) 302.

44 Harbordt, "Über Mephitis", *Berliner klin. Wochenschr.*, No. 25 (19 June 1871).

remained there until the next day, occasionally washing their eyes with lukewarm water, which afforded some relief from the pain. I further asked him if they did not also feel some burning in the mouth, or have difficulty breathing, or if the stench did not get into the nose and cause nausea? None of these, he replied, and that no part of the body, other than the eyes, was injured from this work; and if he were to continue this work he would soon go blind, as had befallen others. All this he told me, and, when he had taken his leave of me, he held his hand in front of his eyes and went home. I have subsequently seen very many of these labourers, partially or completely blind, begging in the city. I do not wonder that such noisome vapours do insult the delicate structure of the eyes<sup>45</sup>.

In modern times hydrogen sulphide-related eye diseases have been encountered among workers on the oilfields of the southern United States, where the crude oil contains high levels of sulphur compounds, and a condition known as ‘gas eye’ is common<sup>46</sup>.

### *Multiple causes*

An accident which combined a cesspit fall and gas intoxication occurred in 1805 in Florence, where a small child died of asphyxiation after falling into a pit. An adult attempting to save the child died in the same way, and, finally, the same fate befell a dog that was thrown in, apparently in a last, desperate effort to effect a rescue<sup>47</sup>.

### *Methane*

Historical documents also contain reports of methane fires and explosions, with Mathieu Géraud, for example, listing a whole series:

But it is irrefutable that, of all noxious fumes, the most powerful and dangerous are those from cesspits, whose unhealthiness is universally recognised. These cloacae, which were devised and built in times when human health was little understood, and which custom has preserved to this day, are at once wasteland and most harmful. It is astounding that no scientist has yet cried out against the frightful practice of keeping in the home an agent of greater or lesser nuisance, disease and death, *which may suddenly destroy an entire house*: for that which has happened at a grocer’s shop at Gros Caillou and a wine merchant’s in the rue Saint-Antoine can happen again, if a flame or sometimes even an ember is uncautiously brought too close to the opening of a cesspit at a moment when, through whatever cause, the flammable vapours are expelled suddenly and with force from the cloaca<sup>48</sup>.

45 B. Ramazzini, *Untersuchungen von den Krankheiten der Künstler und Handwerker*, German transl. of the Padua 1700 edition (Leipzig 1705) 86–96.

46 W. P. Yant, “Hydrogen Sulphide in Industry. Occurrence, Effects, and Treatment”, *Am. J. of Public Health* (October 4, 1929) 598–608.

47 Y. L. Moreau (ed.), *Œuvres de Vicq-d’Azyr t. 6: Sciences physiologiques et médicales* (Paris 1805) 319.

48 Géraud, 1786 (n. 16) 26–27 (italics added).

## Conclusion

As these examples show, the historical record contains abundant evidence of accidents related to collections of human waste. The three mechanisms familiar to modern researchers are well documented: gas poisoning, falls and methane fires or explosions. These hazards concern modern occupational medicine almost exclusively in an agricultural context, as manure-related accidents. In a survey supported by the *Swiss National Research Foundation* we were able to show that each year one in 33 farms is the scene of such an accident. Most of these either do not result in serious human injury or involve animals only. Accidents with tragic outcomes are 15 times less frequent, but these are the only category that arouses public interest. There are no reliable historical figures on the frequency of manure-related accidents since the use of liquid manure and its storage on farms became widespread. Comments by some of the early investigators quoted above show that they, too, were aware of a similar information gap in relation to the urban variety of such accidents, the frequency of which must have been incomparably higher, given the populations exposed. Dr Harbordt, for example, states at the end of his report on the accident involving the unfortunate Rühl:

There is no doubt that accidents of this type are by no means infrequent. A brother of Rühl's, together with a colleague, was killed by cesspit gas in autumn 1869. However, as it appears to be the rule that either death is swift or a mild intoxication ensues that resolves quickly in fresh air or through administration of the usual stimulants, medical observation or treatment of such cases is rare. This is probably the reason for the paucity of relevant publications<sup>49</sup>.

This opinion echoes the sentiments expressed in the 1778 report of the French commissioners, Laborie, Cadet le jeune, and Parmentier, already cited above:

*One example, among thousands*, is the recent case in which three of these men perished while clearing the cesspit of a house in the rue Saint-Louis, in Marais<sup>50</sup>.

These documents present a situation that is in stark contrast to that familiar to the modern city-dweller, who can rely on a reticulated water supply and sophisticated sewerage and drainage system to efficiently remove effluent and thus eliminate the associated health risks. The examples presented above show clearly that in earlier times 'manure'-related accidents were an urban rather than a rural phenomenon. And it is notable that we were unable to discover a single historical report of an agricultural accident of this type.

49 Harbordt 1871 (n. 44).

50 Laborie et al. 1778 (n. 35) 6 (italics added).

The manure accident is only the most dramatic form in which fermenting animal or human waste can impair health. It was not until the onset of the 'hygiene revolution' that the danger to public health posed by 'evil-smelling matter' really became an issue. Decomposing corpses in church crypts, the cesspits of hospitals and prisons, and cargos of manure in the holds of ships were gradually recognised as agents of disease. Many factors combined to bring about a gradual improvement in the conditions described in the writings of Bürkli in Zurich, Ramazzini in Padua and the many French authors cited above. Chief among these were technological progress and an increasing acceptance of the need for hygiene. Market forces were also at work, sometimes preventing but also encouraging improvements.

The incomplete review presented here is a reminder of the level of safety, in terms of public hygiene, enjoyed by present-day urban populations in industrialised countries and of the fact that the occupational groups responsible for maintaining the complex waste-removal systems on which this safety depends are no longer subject to the extreme hazards endured by their historical counterparts. Our review also shows that the problems that have been identified in relation to the increasing use of liquid manure in agriculture are not new – indeed, they must have existed for as long as people have lived in sizable towns and cities – but awareness of them has largely faded into history. Once important issues for public health and occupational medicine in an urban context, they have now to be satisfactorily resolved on the farm.

### **Note**

English translations of quoted material (except Corbin) are by Peter Boyle. Material from Corbin is quoted from the English edition of 1986 (cf. footnote 11).

### **Acknowledgement**

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