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Art and Representation: From the “Mad Scientist” to Poison Gas and Chemical Pollution

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Introduction

The task of providing a comprehensive survey of how chemistry was portrayed in twentieth-century media faces three main challenges: the tremendous multiplication of mass media, the immense growth and diversification of chemistry, and the lack of historical studies thus far.

No century before had created so many new media for a mass audience. Nineteenth-century writers and artists had still produced their works for an educated elite of frequently much less than 10 percent of the population. The new mass media of the twentieth century reached out to everyone, including illiterates and children, which made them economically extremely successful. Beginning with short motion pictures, screened in booths for a small price, the movie industry rapidly grew to national and international networks which performed full-length films in big theaters. Radio and television networks transmitted audible and visible entertainment, including films and series produced by television companies, into the most remote homes. Computer and video games, which frequently adopted movie themes, provided interactive tools to the story line, which at the end of the century became the economically most successful approach. At the same time, the Internet developed into a mass media that began to exceed anything else seen before in terms of content, omnipresence, and influence.

Despite all this competition, the print media continued to grow for most of the century. It did so mostly by targeting the same mass audience, not only in newspapers but also in fiction writing. For instance, novels were broken down into genres, such as romance, crime thriller, and fantasy, each with a general plot frame to be filled out with little variation. An army of writers produced simplistic short stories published in weekly or monthly magazines, out of which the US genre of science fiction emerged. Originally tailored to children, but soon equally popular with adults, comics became one of the most successful print media in many countries. Nonfiction writing also reached out far beyond its original audiences of students and specialists. Written in journalistic style, book-long reports on political scandals or environmental issues competed with novels on bestseller lists.

While the media moved toward content simplification, chemistry experienced an extraordinary sophistication, diversification, and growth during the twentieth century. The late-nineteenth-century triad of inorganic, organic, and physical chemistry, while still taught at universities, gave way to a multitude of specialties that resulted from interdisciplinary research, such as bio-, geo-, atmospheric, mineral, environmental, medical, quantum, mathematical, instrumental, bioinorganic, and physical organic chemistry; or from a specific interest in particular materials or processes, such as colloid, radio-, organometallic, polymer, petro-, surface, catalytic, supramolecular chemistry; or from a historical angle, such as cosmological chemistry, chemical evolution, and archeometry. Furthermore, the chemical industry which before World War I had been the domain of a few countries soon grew in all industrialized countries to one of the main manufacturing sectors, which, because of its unique demand for academically educated scientists, allowed chemistry to grow more than any other discipline. Following new material needs the chemical industry split up into many specialized branches,

such as the dye, photographic film, pharmaceutical, petrochemical, polymer, biotechnology, and electronics materials industries.

Against the background of the tremendous growth and diversification of both the media and chemistry during the twentieth century, any attempt to cover chemistry's media representation seems futile. That may be one reason for the almost complete absence of previous studies on this subject, although chemists themselves have long complained about their bad public image.[1]

However, despite their diversification in form, the mass media frequently simplified and recycled themes developed already in nineteenth-century literature where the "mad scientist" had become the overarching theme with many variations (Schummer 2021). Thus, rather than providing a chronological overview of the media representation of chemistry, this chapter first explores how the nineteenth-century "mad scientist" was further developed in both Western mass media and original novels. Against the background of the diversity of the nineteenth century, the twentieth century favored extreme figures, particularly the "benevolent absent-minded scientist" and the "evil-minded supervillain" threatening the entire world in a drama reminiscent of the biblical battle of Armageddon.

The subsequent sections of this chapter will investigate the two topics that have probably more than anything else in that century shaped the public's view and debates about chemistry: poison gas in World War I, and environmental pollution. However, in both cases the impact on the representation of chemistry is complex, because writers and artists struggled long and hard in their own traditions. Chemical warfare challenged first of all heroic war poetry and became emblematic of the modern war probably only in the second half of the century, but it provoked themes of chemical apocalypse already in the interwar period. The creeping chemical pollution, about which the general public was most concerned, could neither be painted nor would it easily fit into the disaster framework that had emerged out of radicalizing the "mad scientist." Moreover, among environmental activists who pointed out the issues were many scientists, including chemists, which for a while confounded the received black-and-white scheme.

The "Mad Scientist"

Adaption of Nineteenth-Century Themes

During the entire twentieth century the "mad scientist" theme, created by nineteenth-century writers (Schummer 2006), continued to play a dominant role in the public representation of chemistry. Originally that trope resulted from a transformation of the "mad alchemist," a popular theme in late medieval and early modern fiction and painting in order to satirically denounce human folly and greediness. Seduced by a fiendish tempter, the "mad alchemist" ruins his health, wealth, and reputation through his unsuccessful obsession with gold-making. In its original form, the nineteenth-century "mad scientist" still resembles that character, but he (and he was invariably male) now has a variety of ambitious goals, including the making of diamonds, elixirs of longevity, or the creation of human-like beings, and he is typically a chemist or physician conducting chemical experiments. While he now works mostly for altruistic reasons or "in the name of science," he still does so in social seclusion with the madness of obsession. However, unlike his alchemical forerunner, he is successful in his deeds but disastrous in its effects because he produces unforeseen run-away developments. That served writers to point to the combination of scientific power, hubris, and moral naivety by using the religious template of "playing God." Many associated chemistry even with materialism, nihilism, and atheism.

Almost from the start of the twentieth century, movies recycled nineteenth-century "mad scientist" classics and then developed the theme further. Particularly popular were *Dr*

Jekyll and Mr Hyde and *Frankenstein*, of which each several hundred productions have appeared since 1908 and 1910, respectively. Whereas the literary characters usually had philanthropic motives but failed out of moral naivety and hubris, their movie counterparts increasingly appeared as evil madmen who only pretend to act in the name of science (Toumey 1992). For instance, Mary Shelley’s original composition of alternating monologues by Victor Frankenstein and his alter-ego-like creature, which are both full of sophisticated moral deliberation, increasingly turned into simplistic plots of an evil-minded scientist who creates a mass-murdering monster, from the Universal Picture film *Frankenstein* (1931) to its numerous sequels.

Already in the nineteenth century, writers had transformed the standard “scientific madness” of chemists into a variety of forms (Schummer 2021), one of which was the “morally perverted scientist” that now became particularly popular in novel-adapting Hollywood movies. Another form of madness had been “criminal intent,” which through film adaption of *The Invisible Man* and original plots, including *The Cabinet of Dr. Caligari* (1920), *Dr. Mabuse* (1922), *Maniac* (1934), and *The Mad Ghoul* (1943), enjoyed similar popularity for most of the twentieth century and thereafter. For instance, in the enormously successful US TV series *Breaking Bad* (2008–2013), a chemistry teacher engages himself and his student in the illegal production of synthetic drugs. However, the most important further development of the “criminal intent” theme was the invention of the supervillain, which will be dealt with in the next section.

A third, and much more radical, transformation in the opposite direction was the detective-turned-scientist, whom Arthur Conan Doyle had invented in 1887 with the character of Sherlock Holmes. This smart and benevolent hero might appear as the opposite of the “mad scientist,” but he still bears some traits in common, particularly his eccentric character and his occasional obsession with chemical experimentation, which only Arthur Benjamin Reeve in 1910 stripped off in his chemist-detective Craig Kennedy. Both figures enjoyed great popularity in numerous movie and TV series adaptations, but later crime serials replaced the scientist-detective by the policeman as hero. In this genre science returned to the fore only with the US TV series *CSI: Crime Scene Investigation* (2000–2015).

The “benevolent but absent-minded scientist,” while rare in the nineteenth century, became fully developed at first in two genres of comic strips that soon were adapted in animated cartoons, movies, and TV series. One is the adventure travel genre, from which it originated and in which a sometimes eerie scientist helps the hero overcome obstacles by his profound knowledge, as for instance in *Flash Gordon* (since 1934). The second one is the fable-like comic strips for children after World War II, most of which remarkably included a scientist-engineer (see below). In the 1960s the “absent-minded scientist” also turned into a source of public amusement in comedy science fiction movies such as *The Absent-Minded Professor* (1961) and *The Nutty Professor* (1963).

Whereas the nineteenth-century “mad scientist” was mostly a chemist or a physician carrying out chemical experiments, his twentieth-century counterparts represented various disciplines, including psychology, biology, physics, engineering, and eventually computer science, or increasingly science and engineering together. Nonetheless, chemistry featured prominently in “mad scientist” stories but went far beyond the earlier focus on the making of gold, diamonds, or elixirs of life. On one hand, writers employed a more diverse and fanciful repertoire of chemistry, thereby establishing “science-fiction.” On the other hand, and more important here, they envisioned global chemical hazards. While the medieval “mad alchemist” first of all harms himself and his family, and the nineteenth-century “mad scientist” causes damage to his local surroundings, the twentieth-century chemist is frequently a threat to the entire world. Before the advent of nuclear physics, chemistry played an exceptional role in global disaster stories because it was more than any other science suspected to have control over all environmental media that sustain life (air, water, soil, and nutrition) and over destruc-

tion by poisons and weapons (see below). Global chemical threats occurred in such diverse genres as apocalyptic and post-apocalyptic science fiction, disaster, espionage, war, and environmental thrillers. Under the impact of the two world wars and the Cold War, which posed the new threat of a nuclear war, Western popular culture showed a hitherto unseen fascination with doomsday scenarios.

I will first have a look at the two extreme, and most important, stereotypes into which the “mad scientist” was transformed in the twentieth century: the supervillain and the benevolent scientists, both originating from comics strips. Then I will investigate the origin of the disaster theme in writings about poison gas in World War I, and finally ask how writers dealt with the actual issues of environmental pollution.

Superheroes and Supervillains

Several factors contributed to the invention of the supervillain in the US. First, the rise of new media for mass entertainment, comics strips and movies, required the plots to be adapted to the target audience that was assumed to want simple moral messages. Second, the moral simplification of plots, which for instance tended to exclude cases of good intentions with bad outcomes, followed a quasi-religious (Manichean) scheme of dividing up the world into intrinsically good and evil parts. Rather than fights over local issues, the world as a whole was now at stake. Mass entertainment thus was now modeled after the battle of Armageddon between angelic and diabolical forces, between God and Satan, to be represented by a superhero and a supervillain. Third, because the superhero/supervillain genre started at the beginning of World War II and temporarily faded afterwards, it probably resonated well with the black/white schemes of wartime articulated in public and political debates at the time. Indeed, American and British writers frequently related their “mad scientists” to the Nazi regime up to the 1980s, either by direct reference or by choosing an obviously German name. Because Germany also had a reputation in chemistry, the old link between the “mad scientist” and chemistry could thereby be reinforced. Indeed, many of the supervillains are associated with chemistry.

In 1938 Detective Comics Inc. (later renamed DC Comics; Gabilliet 2010: 16) introduced in their debut issue of *Action Comics* the first superhero, Superman, as an extraterrestrial angelic being in the disguise of an ordinary man. His counterpart and archenemy, the supervillain Lex Luthor, appeared only two years later as a diabolical maverick with extraordinary scientific and engineering skills, who was later developed into a powerful industrialist. Based on the success of the comic books, Fleischer studios soon produced a series of Superman cartoon films, starting with *The Mad Scientist* (1941), in which the angelic world-saver prevents the evil-minded scientist from destroying the fictional “universe” Metropolis with a ray gun.

In 1939, Detective Comics increased their output by introducing the superhero Batman, who first fought Doctor Death’s world-poisoning ambitions, before in 1940 The Joker became his regular archenemy. The Joker owes both his criminal activity and character to chemistry. He poisons his victims with his chemical invention “Joker venom” or Smilex, which leaves the dead with a grim smile on their face, and is said to have turned evil-minded after he fell into a tank of chemical waste. Two years later the same publisher introduced the superheroine Wonder Woman who fights, among other supervillains, Doctor Poison, alias Princess Maru, head of a Nazi team that tries to poison the US.

Public interest in the superhero genre faded immediately after World War II and revived only after Marvel Comics launched *Spider-Man* in 1962 (Gabilliet 2010: 34, 54). Two years later its main supervillain became Norman Osborn, head of Oscorp (later called Alchemax), a chemical company that he has cofounded with his former chemistry professor Dr. Mendel Stromm. Rather than poisoning or pollution, their main business is working on chemical formulas for the enhancement of human strength and power and for controlling people’s

daily life. Political and economic issues clearly dominate over health and environmental issues, but the focus is on chemistry.

All these superhero/supervillain comics stories later became very popular worldwide, and increasingly so through numerous Hollywood movie adaptations and countless imitations in cinema and TV productions well into the twenty-first century. The original enemy, Nazi Germany, was during the Cold War increasingly replaced by the Soviet Union, and then by extraterrestrial diabolical forces, but the supervillains’ associations with chemistry remained for several decades. With the science – or better, weapons technology – turning more fanciful, the superhero also makes use of it and increasingly wins through his technological advancement rather than by his inherent angelic capacities, which is reminiscent of the Manhattan Project and in accordance with the official arms race policy. Thereby the originally science-critical attitude of the genre turned into the reverse.

The Absent-Minded, Benevolent Scientist in Comics for Children

The fascination of US publishers and producers with the “mad scientist” theme, of which only a small fraction is sketched above, also infected Walt Disney who, together with his brother, had founded a firm in Hollywood in 1923 that soon specialized in animated films for children featuring animal characters, as in traditional fables. Their first successful series was *Mickey Mouse*, starting in 1928, for which they produced the short film *The Mad Doctor* (1933), in which Dr. XXX kidnaps Mickey’s dog Pluto in order to conduct a hybrid experiment that should connect the dog’s head with the body of a chicken. However, the story shocked children, many US theaters refused to show the film, and other countries even banned it, so that the character and the theme disappeared from entertainment for children.

The figure was replaced by the “absent-minded, benevolent scientist”, who probably first appeared in the illustrated short stories for children about Professor Branestawm (1933–1937, 1970–1983) by British author Norman Hunter, and then as Dr. Hans Zarkov in *Flash Gordon*, a US space opera adventure comic strip published since 1934. Both the figure and the storyline of *Flash Gordon* borrowed from Jule Verne’s classic *Off on a Comet* (1877), featuring Professor Rosette. In 1944 the Belgian comic strip *The Adventures of Tintin* (published since 1929) introduced Professor Calculus, a largely benevolent inventor and genius in all scientific and engineering matters but clumsy at best in social affairs, frequently absent-minded and secluded, and at times revealing an eccentric or irascible character.

With little variation that figure was soon incorporated as a secondary character in many famous Western comics for children. In the first competing Belgian comics *Suske en Wiske* (French: *Bob et Bobette*, British: *Spike and Suzy*, American: *Willy and Wanda*) he appeared as Professor Barabas or Barnabas since 1945; in the second one, *Jommeke*, as Professor Gobelijn since 1955. Walt Disney’s *Donald Duck* adapted him in 1952 as Gyro Gearloose. The German imitation *Fix & Foxi* called him Professor Knox (since 1953). The most famous French comics, *Astérix*, even made him in 1961 its founding figure in the form of the Druid Panoramix (English: Getafix). This pre-modern chemist, whose white coat resembles the modern lab coat, concocts, besides numerous elixirs, the magic potion that makes the people of a small Celtic village invincible against the troops of Julius Caesar.

The “absent-minded, benevolent scientist,” rather than having a disciplinary specialty, is a universal scientist, engineer, and inventor, and chemistry is one of his main areas (Carter 1988). For instance, Gyro Gearloose creates a large variety of chemical preparations, from more realistic inventions, such as a super strong sealant (1954), a tranquilizer for animals (1955), high-speed gasoline (1956), and a bear repellent (1959), to more fanciful things, such as a liquid that turns inanimate objects into living beings (1959) and a drug that shrinks people (1960). However, not all these products work as the helpful inventor expects, and some run out of control as in the classic “mad scientist” stories.

Only a few comics went further and stripped off all the remaining traits of the “mad scientist.” One example is the Croatian animated television series *Professor Balthazar* (1967–1978). This thoroughly benevolent, social, and open-minded chemist develops a solution to any problem of people who consult him, by the help of his magical machine for chemical concoctions.

Thus, while scientists play a marginal role in the overall literature for adults with the exception of science fiction, they remarkably became a regular figure of the set of characters in comics for children, unlike for instance criminals, policemen, lawyers, or politicians, who are regularly employed for the entertainment of adults. Real scientists might also appreciate that most of the traits of the mad scientist have been removed from the comic characters to the point that the origin is hardly recognizable any more. Chemistry is largely portrayed as the art of producing wondrous concoctions, mostly for useful purposes.

The extraordinary importance of the “benevolent scientist” in comics for children, compared to literature for adults, calls for explanation. If one compares comics for children with traditional fairy tales, the scientist, by his wondrous inventions that seem to make anything possible, corresponds to the fairy. And because, unlike fairy tales, comics were produced as serials with the same characters, there was a particular need for variations that a character with surprising capacities could supply. In addition, the general attitude toward science and technology was quite favorable in the 1950s (Miller et al. 1997), in stark contrast to the period following World War I.

From Poison Gas in World War I to Chemical Apocalypse

It would seem that chemical warfare in World War I was the first real-life confirmation of the large number of “mad scientist” stories written since the early nineteenth century without any reference to actual science. Hundreds of chemists, such as Fritz Haber in Germany, Charles Moureu in France, William Jackson Pope in the UK, James B. Conant in the US, and Fritz Pregl in Austria, put all their “scientific” efforts on developing and improving or even overseeing the production and deployment of a new kind of devastating weapon that could kill up to 100,000 people (Freemantle 2014; Schummer 2018). Poison gases, which were actually mostly liquids, were not the only new weaponry invented. Tanks, machine guns, aircraft, submarines, and shells filled with high explosives, developed by various engineers and scientists including chemists, also had their first big stage entrance on the battlefields of World War I. They all posed new and difficult to foresee threats to soldiers, and confounded the received military routines. However, the use of “asphyxiating gases” and poisons was prohibited by the Hague Conventions of 1899 and 1907, signed by all major belligerent parties, of which all chemists of course were aware, at the latest from the worldwide (including German) newspapers reports of Haber’s first deployment of chlorine gas on April 22, 1915. How did fiction writers and artists respond to that new kind of “scientific madness”?

Poetic Self-Reflection

Chemical warfare plays only a very small quantitative role in the myriad poems and numerous novels of World War I written both during and after the war, and similarly in the later movies, such that most literary scholars have ignored it.[2] For instance, one of the most famous English war poems, *In Flanders Fields*, written by John McCrae on the battlefield of Ypres where Haber had directed the first poison gas attack just ten days earlier, does not even allude to chemical warfare. Poets and writers probably encountered difficulties in capturing the invisible and silent threat of poison gases by traditional metaphorical resources (Löschnigg 1994: 152). Chemical warfare’s first impact on poetry was, strangely enough, an urge for poets to reflect on their own profession.

Almost from the beginning of the war, poetry became a powerful tool for psychological war mobilization on all belligerent sides. In England, France, and particularly in Germany,

people submitted hundreds of thousands of poems to newspapers that called for patriotic engagement in a heroic and glorious war; according to one probably overrated estimate, Germans alone submitted as many as 50,000 war poems per day (!) to their newspapers during the first month (Marsland 1991: 1–2). Encouraged by nearly all the well-known poets, the "poetical mobilization" turned into a mass movement – a "poetry slam" – about who could best express hatred for the enemy and pathos for the unconditional willingness to sacrifice one's life. For instance, Gerhart Hauptmann, who had received the Nobel Prize for Literature in 1912, published his influential poem *Reiterlied (Cavalry Song)* on August 12, 1914, which offered a call to arms against France, Russia, and England, and employed the outdated but romantic theme of the sword-fighting chivalrous cavalry.

Chemical warfare became a remedy to romantic war poetry for poets who regretted their earlier war enthusiasm and later wrote antiwar poems, usually published only after the war because of censorship. For instance, Wilfred Owen, who in 1914 had written "But sweeter still and far more meet / To die in war for brothers" (*Fragment* 126), radically changed his mind in the battlefield and wrote his famous *Dulce et Decorum est* (1917). By contrasting the "old lie" of how sweet it is to die for the fatherland – the poem title refers to a quote from an ode by the Roman poet Horace – with the cruel death of a gas-poisoned soldier, Owen denounced the abuse of poetry for war propaganda altogether:

"If you could hear, at every jolt, the blood / Come gargling from the froth-corrupted lungs / ... My friend, you would not tell with such high zest / To children ardent for some desperate glory, / The old Lie: Dulce et decorum est / Pro patria mori."

Many other poets, however, contrasted the glory of the traditional war, which they still seemed to uphold, with the poison gas of the modern war. For instance, British writer Gilbert Frankau set "fighting cleanly" with traditional weapons versus "murdering" with gas in his poem *Poison* (1919). Austrian writer Karl Kraus invented the term "chlorreich" in opposition to "glorreich" (chlorine-rich versus glory-rich), which he frequently used after 1918. The German poet Klabend, who once had been a prolific writer of propaganda poetry but spent the war in neutral Switzerland working for the German intelligence service, wrote afterwards in his *Die Ballade des Vergessens* (1926, *The Ballad of Forgetting*):

"Once in the battle, head against head counted / And man against man – however / Today the chemist pushes the button / And the hero is forgotten, forgotten. ... The new war ... comes with charges of poison and gases, / Brewed in the devil's hearths."

Chemical warfare killed not only hundreds of thousands of soldiers, it also killed the dreams of heroic war, the martial myth, that was so dear to the tens of thousands of professional and would-be poets during the first years. That made the few poison gas poems famous in the first place. Later, in the interwar period and after World War II, when people were tired of war, they became models of pacifist poetry, even though many people still upheld the received ideas of glorious warfare in contrast to chemical warfare.

The Gas Mask Becomes a Deferred Emblem of the War

Strange to say, the gas mask became a worldwide visual symbol of World War I in general (Spear & Summersgill 1991: 321; Smith et al. 2003: 88f.; Münkler 2013, chap. 4.10; Skrebels 2014). In poems they hardly appear; a very rare exception is the one by Owen mentioned above. However, most World War I novels that mention chemical warfare – no matter at what time and from what country they originated, but particularly so those from the late 1920s – include short passages about the fear of soldiers in the trenches of putting on their gas masks at the right time and properly, to be protected in cases of gas alarm.[3] They describe the difficulties of wearing a gas mask more often than they mention casualties: the uncomfortable feeling and constricted breathing, the hampered communication and limited vision as well as the alienated, animal-like faces of their comrades. However, that alone would hardly justify making the gas mask an emblem of the war. Instead, the issue of what image best

symbolizes the war – and by that, the role of chemical warfare in general – has been negotiated over many decades, as the following example illustrates.

Probably the most famous World War I novel is Erich Maria Remarque's *Im Westen nichts Neues* (1928, *All Quiet on the Western Front*) that soon after its publication outnumbered by far the sales of any other World War I novel in Germany, the UK, and many other countries (Owen 1989). It was translated into fifty languages, sold in total at least 20 million copies by 2007, and was twice adapted into award-winning movies of US (1930) and US/UK productions (1979). This novel by Remarque, who himself served only for less than two months on the Western Front before he was injured, is famous for describing first-hand experience of the atrocities of the war. However, poison gas attacks are only briefly mentioned three times (in chapters 4 and 6). Another mention of gas occurs in chapter 7, where the main figure, Paul, on a short leave, meets total misunderstanding and incomprehension about the war by people in his hometown. Among them is his mother, who worries that it is "terrible out there now, with the gas and all the rest of it," upon which Paul indeed remembers cruel gas casualties. In the final chapter Paul is said to have "swallowed some gas," which allows him to take a break from the war and, lying in the sun, reflect on the miserable condition of his generation.

As if by tacit censorship, the US 1930 movie adaptation removed all mention of gas, at a time when the implications of the Geneva Protocol of 1925 were still heavily debated in the USA (Ede 2002), and instead focused on shells and trench fighting. By contrast, the 1979 movie adaption put more emphasis on gas than the novel. For instance, it has Paul saying: "Gas – the most feared, the most obscene weapon of all!" (Skrebels 2014: 85), whereas in the novel Paul argues that "tanks ... more than anything else embody for us the horror of war" (chapter 11). Note that Robert Graves, in his autobiographical novel *Goodbye to All That* (1929), reckoned that British soldiers regarded the use of German bowie knives particularly atrocious, while the Germans most feared the British Mark VII rifle bullet.

Early pictorial representations (paintings and drawings) of gas warfare are similarly rare and diverse. For instance, of the 316 drawings by famous Dutch artist Louis Raemaekers (1869–1956) in *Raemaeker's Cartoon History of the War* (1919) only four refer to chemical warfare – a soldier carrying poison, a gas attack symbolized by a dragon and gas-wounded soldiers, and a German chemist producing weapons in his laboratory – but not a single one shows a gas mask. The international online exhibition "Art of the First World War" (1998), with 110 works from the major six European museums of war history, included six images on chemical warfare.[4] The three British and American contributions represent the effect of poison gas in the form of blinded soldiers, indicated by blindfolds or hands covering their eyes (William Roberts, *The First German Gas Attack at Ypres*, 1918; Eric Kennington, *Gassed and Wounded*, 1918; John Singer Sargent, *Gassed*, 1918–1919). The French painting places a hardly recognizable poison gas cloud in a burning landscape full of colorful beams (Félix Vallotton, *Verdun, tableau de guerre interprété ...* 1917). In both the Belgian and German contribution, poison gas is only alluded to by soldiers wearing gas masks (Henri de Groux, *Masques à gaz [Gas masks]* 1915; Otto Dix, *Sturmtruppe geht unter Gas vor [Assault under Gas]* 1924). It seems that this kind of image would eventually dominate the visual culture of chemical warfare because neither the blindfold nor a colored fog conveyed a simple and strong message.

It might appear cynical that neither the weapon nor its disastrous effects, but its protective device, the gas mask, eventually became the strongest emblem of chemical warfare, and, along with the helmet, an emblem of World War I as a whole. However, the gas mask came to epitomize the technological sophistication, the anonymity, and the horror of the war, because it covers and distorts the human face with a technological apparatus, and because its wide eye windows convey the impression of fear. Probably much more than poetry, novels, and even paintings, photographs of soldiers wearing gas masks, which in the course of the

twentieth century were increasingly used as illustrations in magazines and books, shaped the visual image of the war.

Chemical Apocalypse

An irony of history, the first apocalyptic chemical warfare novel was published in early 1914 “written under the immediate shadow of the Great War,” as the author later remarked in the preface to the 1921 edition. Already in 1913, when he wrote *The World Set Free*, H.G. Wells saw Europe willing to engage in an all-devastating war, and chemistry ready to provide the appropriate weapon: not poison gas but nuclear fission, discovered by the fictional chemist Holston in 1933, rather than by chemists Otto Hahn and Fritz Strassmann in 1938. The novel at first narrates the history of alchemy and chemistry (“Prelude”) and then the discovery that makes true the dreams of the alchemists, elemental transmutation to gold, as well as that of the military, eternal fire (chapter 1), which is then used in the “great war” to clean the world from all evil (chapters 2–3). After the war a “World Society” emerges that is based on a new integrated science to provide health and love to everyone (chapters 4–5). In stark contrast to his many “mad scientist” stories, on the eve of World War I Wells envisioned chemistry as a purgatory tool to reach a Golden Age.

Such millennialist war utopias – which later came to be known as post-apocalyptic science fiction – faded during the first years of the actual war. However, apocalyptic themes soon arose anew, among others from devastated battlefields to which the effects of poison gases added further bizarre impressions. An early example is Arnold Ulitz’s poem *Gasangriff* (1916, *Gas Assault*), written from the point of view of the aggressor who unleashes the “gas predator” that, to his own horror, kills not only the enemy but all living nature around, turning spring into eternal winter. One of his next poems, *Frühling in Litauen* (1917, *Spring in Lithuania*), describes the hoped-for end of the war in metaphors of the biblical flood, while his futuristic war novel *Ararat* (1920) is completely framed around the Noah myth. As late as 1932, the German painter Otto Dix depicted an apocalyptic war landscape featuring a gas mask in his famous tryptichon *Der Krieg (The War)*, reminiscent of sixteenth-century paintings by Hieronymus Bosch.

The first genuine work of End Times literature on World War I is probably *Die letzten Tage der Menschheit (The Last Days of Humanity)*, which the famous Austrian writer Karl Kraus wrote and published in pieces between 1915 and 1922, satirically commenting on various episodes of the war in verse. In the epilogue (written in 1917) the Berlin (chemical) engineer Abendrot (meaning “evening glow”) proudly presents the latest art of chemical warfare to be used by “pushing the button” from the distance, shortly after which the Martians execute the “Last Judgment” by destroying humanity. That may have provoked the German writer Erich Kästner to write his sarcastic poem *Das letzte Kapitel (The Last Chapter)*, 1930) in which neither the Martians nor God but the human world government, in a last effort to bring peace to earth, decides in 2003 to destroy all human beings by pouring poison gas from airplanes around the globe. Poison gas (chlorine) became the first weapon of mass destruction in fiction because, due to its high density, it flows and spreads like a fluid over the entire surface and into every corner, reminiscent of the biblical flood.

Once established as a literary trope, “chemical apocalypse” was soon employed for various purposes in different genres. It featured prominently in warnings of the next world war, for instance in the mentioned poem by Kästner, Stephen Southwold’s *The Gas War* of 1940 (1931), and H.G. Wells’ *The Shape of Things to Come* (1933). When combined with socialist critiques of capitalism, the apocalyptic threat comes from chemical companies, as in Georg Kaiser’s play *Gas II* (1920), Johannes R. Becher’s *Levisite oder der einzig gerechte Krieg* (1926, *Lewisite or the Only Just War*), or Michail Dubson’s silent movie *Giftgas (1929, Poison Gas)*. Equip the chemical company, or its leader, with some traits of the “mad scientist,” willing to destroy the whole earth with some poison for some weird reason, and you

have the basic ingredients for popular thriller movies that were produced in the late twentieth century, perhaps the most famous one being the James Bond movie *Moonraker* (1979).

After the US deployment of atomic bombs on Japan in 1945, nuclear apocalypses dominated the genre for decades, to be followed by global threats of runaway bacteria or viruses and climate change. However, all those topics were originally inspired by fictional ideas about chemistry, which quite recently moved from the apocalyptic theme to the eco-thriller genre (see below).

Chemical Pollution

Before we deal with the representation of chemical pollution in fiction, it is useful to first have a look at its history and representation in nonfiction. As was pointed out in the Introduction, nonfiction writing also changed drastically during the twentieth century and produced new genres such as environmental reports written by journalists, science writers, and non-governmental organizations, which were increasingly targeted at a mass audience and out of which the environmental movement developed. That required the development of new styles of writing, and it shaped new narratives that fiction writers later adapted. In the last third of the century, chemistry when mentioned in public media was probably most often associated with environmental pollution.

Three Kinds of Chemical Threats

During the twentieth century the public increasingly perceived the chemical industry as a threefold threat: production accidents, pollution, and the adverse side effects of its products (Koch and Vahrenholt 1978).

There were several industrial production disasters. In terms of immediate casualties, the three worst accidents, or disasters in the narrow sense, were the plant explosions at the Union Carbide subsidiary in Bhopal, India, in 1984 with several thousand casualties, and at the BASF factory at Oppau near Ludwigshafen, Germany in 1921 and 1948, which caused 561 and 207 casualties, respectively. Because the last two cases are not well known, it is unlikely that industrial accidents were perceived as the main threat. Moreover, disasters in other industries greatly outnumbered those of the chemical industry both in terms of frequency and casualties, such as dam failures, mining tragedies, and aircraft accidents.

However, in addition to the immediate deaths, the damage to health is important in terms of judging hazards, which in the case of Bhopal alone affected hundreds of thousands of people (Eckerman and Børsen 2018). The main threat of most chemicals, as perceived by the public, is the slowly creeping pollution that develops its poisonous effect from either one-time or long-term exposure, and which affects not only humans but all living beings by polluting the entire environment. Public concerns about air, water, and soil pollution from the chemical industries are almost as old as these industries themselves (Tarr 1996; Homburg et al. 1998: 121–201; Tarr 2002; Bernhardt 2004). In the second half of the twentieth century, widely noticed chemical disasters without immediate human casualties included the release of methylmercury in waste water over several decades into Minamata Bay in Japan since 1932, causing mercury poisoning of humans and wildlife discovered only as late as 1956; the release of the extremely toxic dioxin in Seveso, Italy in 1976; and the Sandoz chemical spill in Switzerland in 1986, releasing various toxic agrochemicals into the air and the Rhine River and killing aquatic wildlife.

A third chemical threat increasingly raised public concerns during the second half of the twentieth century: the toxic and eco-toxic effects of the chemical products themselves. The worst case happened in late 1961, when thalidomide, after having been on the European market without clinical tests for more than four years, was found to be severely teratogenic. Recommended as a side effect-free sleeping pill and widely used against nausea by pregnant women, the drug had caused more than 10,000 stillborn children and between 5,000 and

10,000 surviving babies with malformations before the German company Grünenthal and its international licensees could no longer dismiss warnings and were eventually forced to withdraw it (Ruthenberg 2016).

Since the 1960s, hundreds of chemical products have been shown to have adverse effects on human health and other living beings by their regular use and release to the environment, from the insecticide DDT, to chlorofluorocarbons (CFCs), to polymer additives which may cause endocrine disruption. Over time, many people suspected all chemical products are more harmful than useful and began to prefer “natural” products instead.

In summary, it was not industrial accidents but pollution through plant leakages and waste disposal, and the use of chemical products that were perceived as the main threat to humans and the natural environment, and heavily debated in public media.

Industrial Pollution Narratives in Non-Fiction

Less than seven months after the shock of the thalidomide scandal broke, the American marine biologist and by then already famous nature writer Rachel Carson serialized her fourth book, *Silent Spring* (1962), in three parts in *The New Yorker* magazine. Unlike her previous books, which described the history, diversity, and beauty of marine wildlife, *Silent Spring* accused the chemical industry of indiscriminately and severely threatening life on earth, from insects to fish, birds, and mammals, including humans. Based on previous research and her own field investigations, she argued that insecticides such as DDT (called “Elixirs of Death” by Carson), which since the 1940s had widely been used to fight insect pests and insect-borne diseases like malaria, accumulate in the food chain and damage organisms even in remote areas. The American chemical industry started a counter-campaign, denying the threat, denigrating Carson, and suing the magazine. However, Carson had made her case carefully and convincingly for many, before she died in 1964. Although various other political factors favored the US ban of DDT as late as 1973 (Morris 2019), she is widely considered the person who started the environmentalist fight against insecticides.

During the second half of the twentieth century, there was a recurrent pattern in the chemical industry’s responses to environmental and health issues. Even if the historical details did not always accurately match this pattern, journalistic narratives highlighted those aspects that corresponded to the pattern, as if the same story had to be reenacted and/or narrated over and over again, like a classical myth. In this narrative, a chemical company faced with the accusation of causing a health or environmental hazard first ignores and downplays the hazard, then counteracts with campaigns that highlights their merits, denigrates and sues the accusers, pays for “scientific” counter-reports, lobbies policymakers, and changes its behavior only when a better alternative is in its pipeline or when required to address the issue by legal regulation or a court judgement. In full or in part, we have this narrative, besides in numerous journalistic descriptions of local cases, also in scholarly accounts: Minamata, thalidomide, DDT, Seveso, Bhopal, CFCs, and endocrine disruptors, as well as other industries, such as nuclear energy production, waste disposal, and for global climate change and tobacco smoke (Oreskes and Conway 2010). In several cases, like that of DDT and that of Love Canal – a suburb in New York state built on a chemical dumping site that caused health impairments in the 1970s (Fjelland 2016) – the narrative includes a heroine who fights the powerful industrial–governmental complex, reminiscent of the Joan of Arc theme.

In the present context, it does not matter if the narrative was always correct or not; it became an essential part of the public view of the chemical industry, and frequently that of chemistry altogether. Unlike the “mad scientist” of the nineteenth century, the “chemical-industry-as-villain” stereotype was not developed and shaped by fiction writers. Rather, it was created in real life interactions between the chemical industry and its critics, including victims, environmental activists, scientists, and journalists.

Environmental Doomsday Narratives in Fiction

While activists, including scientists and journalists, fought for a safer environment, artists and fiction writers long faced difficulties to include the topic in their works. In the late nineteenth century, when industrial pollution was already publicly debated, the smokestack was still employed as a symbol of economic progress in landscape paintings. Wilhelm Raabe's pioneering environmental novel *Pfisters Mühle* (1884, *Pfister's Mill*), in which industrial pollution destroys a holiday resort near Berlin, remained for many decades the only one of its kind worth mentioning (Schummer 2021). When the environmental movement began in the 1970s, the formative arts hardly engaged with it, with few notable exceptions. For instance, in his art performance of planting "1,000 oaks" (1982) the German artist Joseph Beuys referred to a popular phrase attributed to Martin Luther, who would have planted a new tree even on the day before Doomsday.

Writers probably lacked interest in pollution because many had long since also embarked on the doomsday theme, which dwarfed any local, creeping, and unspectacular pollution. Moreover, it was difficult to feature an environmental activist-scientist in plots that still recycled the nineteenth-century "mad scientist." However, writers were extremely inventive in attributing diverse kinds of global disasters first of all to chemistry, including famine, nuclear energy, run-away bugs, global warming, and the removal (not pollution!) of the Earth's drinkable water and breathable oxygen. And they remained steady in their reference to biblical themes.

Probably the first twentieth-century chemical disaster novel was written in 1904 by H.G. Wells. In *The Food of the Gods and How It Came to Earth*, chemists invent a substance that let children grow endlessly, resulting in a bitter war between the normal and the giant people about food. This was not just an interesting story about biochemistry, but a variation of the biblical myth of the fallen angels or devils: under the leadership of Satan they build a godless kingdom on earth and mate with human females to beget giants who eat all food causing a human famine and insurgency. Wells thus put chemists and devils in parallel. Ten years later, on the eve of World War I, he published the already mentioned post-apocalyptic novel *The World Set Free* (1914), in which a chemist manages to achieve chain reactions of nuclear fission that is soon employed as a weapon in a devastating world war. That set the stage for both chemical End Times stories after World War I and for the nuclear disaster theme that became popular after World War II.

British authors continued to dominate the genre with original ideas, which American directors would much later turn into movies. Scottish chemistry professor Alfred Walter Stewart, who wrote novels under the pen name J.J. Connington, published the first runaway bacteria drama, which became the favorite disaster theme towards the end of the twentieth century. In *Nordenholt's Million* (1923) the amateur scientist Wotherspoon has recently extended his chemical research to include "denitrifying bacteria" when ball lightning happens to enter his laboratory still full of "flasks, retorts, test-tube racks." The electric discharge modifies his bacteria such that they proliferate at a tremendous speed. Spread within weeks by airplanes to all continents, they stop the growths of plants worldwide and ruin agriculture by turning fertile soils into denitrified sandy soil, causing a global famine. Replace bacteria with locusts, and you have a disaster similar to the eighth Plague of Egypt from the Book of Exodus.

Global warming, which would become a popular literary and movie theme only in the twenty-first century, was attributed to chemistry as early as in 1964. In *The Burning World* British novelist J.G. Ballard envisioned polymer waste from the chemical industry flushed into the oceans where it forms a semipermeable layer on the surface that hinders the vaporization of seawater, resulting in a global drought and heat wave. The novel is also one of the earliest examples that focuses on industrial waste and thus is rightly considered to be a classic of the eco-novel genre. But note that the point is not the harm to marine wildlife as in Carson's

book two years before, but a disaster reminiscent of the fourth End Times plague from the Book of Revelation, a burning heat wave.

In another science-fiction classic, *Cat’s Cradle* (1963) by American author Kurt Vonnegut, the chemist/physicist Felix Hoenikker (supposedly modeled after Irving Langmuir) invents ice-nine, a modification of water that is solid at room temperature. A seed crystal can turn ordinary water into ice. Originally created for the military purpose of crossing swamps, a piece falls by accident into the sea, solidifies the water of the oceans, and kills almost all life. Ice-nine is, so to speak, the doomsday equivalent for contemporary water pollution.[5]

In the aforementioned disaster stories, “mad chemists” destroy the life-sustaining media of nutrition, soil, water, and climate, or threaten life with weapons and poisons. Pollution of the air other than by poison gas was even harder to adjust to the disaster theme. Rather than by pollution, the spoiling of air was imagined by de-oxygenation, as for instance in *Dalkey Archive* (1964) by Irish novelist Flann O’Brien, which features the evil-minded “mad scientist” De Selby who tries to destroy all life on earth through his invention of an oxygen-absorbing substance called DMP.

The chemical industry in the form of an evil-minded company, with malicious intent to pollute the environment, appeared – apart from post-World War I poison gas-producing companies – very late in novels. In post-World War II America, like in post-World War I Germany, this trope was the product of an anti-capitalist movement. Left-wing US science fiction authors developed dystopian views of transnational corporations taking over governmental power and abusing society for their corporate interest, such as in Frederik Pohl and Cyril M. Kornbluth’s *The Space Merchants* (1953), as well as in the *Superman* and *Spider-Man* series. However, the first environmental activist-hero in a novel who fights pollution (and a corrupt US government in the far future) is probably the Savior-like character Austin Train in the dystopian novel *The Sheep Look Up* (1972), written by British science fiction author John Brunner. Note that in the same year the Club of Rome had already identified pollution as one of five limiting factors of human civilization in their *Limits to Growth*.

It would be several more years before the standard narrative from non-fiction – a scientist-hero fighting the chemical industry as villain – was adopted by fiction writers. One of the earliest novels of that kind was written by German author Michail Krausnick, who published a series of books with chemical companies featuring as villains. In *Die Paracana-Affäre* (1975, *The Paracana Affair*) they intentionally poison part of humanity; in *Lautlos kommt der Tod* (1982, *Death Comes Silently*) they secretly develop biochemical weapons; and in *Im Schatten der Wolke* (1980, *In the Shadow of the Cloud*) they are responsible for a mysterious epidemic. Only in the last one does the scientist-hero enter the stage, in the form of Professor Kovacs, who traces the cause of the epidemic to a chemical plant leakage.

Neal Stephenson developed this trope further in his novel *Zodiac* (1988). Here, the chemist Sangamon Taylor works for an environmentalist group and fights against the fictional chemical company Basco. The firm has been illegally dumping toxic waste in Boston Harbor and releasing genetically modified bacteria; once confronted with evidence of its crimes, it tries to denigrate Taylor and accuses him of terrorism. Eventually also the female heroine combating industrial pollution received a vehicle in Steven Soderbergh’s movie *Erin Brockovich* (2000), based on actual events.

At the turn of the century, a temporary twist of the eco-thriller genre by two famous US authors briefly shocked environmental activists. In T.C. Boyle’s *A Friend of the Earth* (2000) they are portrayed as miserable figures. And Michael Crichton, who had in *Prey* (2002) still employed the classical “mad scientist” framework for the fictitious nanotechnology of software-controlled molecular machines running amok, now displayed environmentalists as terrorists and villains in his *State of Fear* (2004). They unscrupulously fabricate the deadly disasters they had previously warned about. However, the genre soon returned to its original scheme and has produced many more works ever since.

Conclusion

The mostly negative image of chemistry in public representations, as described in this chapter, is to some extent influenced by the selection of topics. A history of the many representations sponsored by chemical industries and societies, from advertisement campaigns to paid publications and donated museum exhibits, might tell a different story. However, it is difficult to dispute that the three topics highlighted here – the recycling and further development of the nineteenth-century “mad scientist” theme, the impact of poison gas in World War I, and environmental pollution – strongly influenced the public image of chemistry. There would be many other negative stories to tell, which, for instance, explain the public opposition between chemistry and nature, as in the aversion to chemical medicines, food additives, cosmetics, plastics, and fertilizers.

In addition to the benevolent scientist in comics for children, there are also some independent, more nuanced or favorable representations of chemistry, particularly at the end of the century (Ball 2007), by writers who did not feel obliged to cater to a mass audience and who objected to the business of standardized genre writing. However, the twentieth century is the first era in which the publication and entertainment industry reached out to a mass audience for both media-technological and economic reasons. The most successful way to do so was to reproduce and exaggerate simple stereotypes, mostly developed in the previous century. Most Western stories about chemistry are framed after biblical themes, including the classical “mad scientist” who commits the sin of “playing God”; the fallen angels who bring evil to the world; the biblical flood of the Noah myth by global poisoning; the fourth End Times plague of global warming; and the battle of Armageddon in the fight between the angelic superhero and the diabolical chemical supervillain. That suggests that for the targeted mass audience, or their most influential writers, the Bible provided the dominating framework for entertaining drama and for formulating moral positions about chemistry throughout the twentieth century and beyond.

The religious approach could draw on a much older tradition that associated the precursors of chemistry with diabolical work (Schummer 2017). It already began with the apocryphal *Book of Enoch* (ca. 200 BCE) that for the first time introduced the concept of devils or fallen angels who reveal chemical crafts to humans, including the secrets of Creation. From the late medieval “mad alchemist” through the literary trope of the Faust myth to the classical “mad scientist” of the nineteenth century, all of which employ a fiendish tempter, alchemy and chemistry were portrayed as the devil’s work. That religious trope seems to be so deeply rooted in Western culture that it can be, and somehow must be, narrated over and over again for both entertaining and moral purposes, like a classical myth.

Two topics in this chapter – poison gas in World War I and chemical pollution – both illustrate the process and the obstacles of incorporating important historical events into the religious framework of literary narratives. Although many writers were for a period after World War I busy with reflecting on their earlier enthusiasm for heroic war, some soon developed from the theme of chemical warfare the first-ever notion of apocalypse by technological means, a global poison gas cloud reminiscent of the biblical flood. Once the trope was established, chemistry, much more so than any other science or technology, became firmly associated with the total destruction of the world as we know it. Indeed, as was shown above, all the global disaster themes in fiction that evolved during the twentieth century – from poisoning or suffocating, nuclear energy, and run-away bugs, to famine, drought, and global warming – each began with a novel in which the cataclysm was attributed to fictional chemists.

Although environmental pollution was already a severe problem in the nineteenth century, fiction writers had difficulties dealing with the issue for most of the twentieth century because those mostly local and insidious problems did not fit well their preferred plot, apocalyptic disasters of global dimensions. Instead, many scientists, including chemists, worked on

these issues and tried to raise public awareness. They thereby became actors in a non-fiction narrative, the scientifically minded environmentalist fighting the polluting industry, told in numerous journalistic and scholarly accounts. The late adoption of the theme in fiction, including the temporary twist of “eco-terrorism,” suggests that the scientist-as-hero was difficult to reconcile with the received “mad scientist” theme and its religious connotations. The most successful way of re-adoption was by attributing elements of the “mad scientist” to the chemical industry.

Oddly, the chemical profession encountered similar difficulties to identify environmental issues as part of their own core field. Environmental chemistry did not easily match the dominant self-image of chemists that highlighted making things in the laboratory rather than understanding the natural environment and moral engagement. If chemists were asked to articulate the goals of their research, many just pointed to the chemical industry, which, in the public view, dealt with environmental issues largely by denying, downplaying, campaigning, suing, and lobbying. While the chemical industries underwent radical reforms since the late 1970s (for instance, in waste treatment, labor safety, risk management, public communication, and acquiring non-chemical expertise), chemical societies largely missed the opportunity to develop a modern profile of their science that corresponded to the diversity of research fields that had emerged over the century. They particularly neglected to emphasize their important contributions to environmental issues such as in environmental analysis, monitoring, and cleanup, “green chemistry” production, materials recycling, biodegradable materials, and renewable energy.

The literary and media representations of chemistry during the twentieth century, dominated by the “mad scientist” theme, apocalyptic threats, and environmental pollution, probably contributed to a social isolation of chemists, which is incidentally a feature of the “mad scientist.” Chemists did comparatively well with physicists, biologists, and engineers in interdisciplinary work. But there have been huge barriers to the humanities and social sciences, even to those that could help chemists locate their field within the broader cultural context, overcome their societal isolation, and correct the public image. For instance, physics, mathematics, astronomy, biology, medicine, and engineering all actively contributed to the academic establishment of the history, philosophy, and sometimes ethics of their respective field. In contrast, the history of chemistry has remained marginal within the history of science, and has met with disinterest by most working chemists, while the small field of philosophy of chemistry has largely remained beyond their horizon. Ironically, for a discipline that has, much more than any other, faced moral accusations in public debates and media representations, not least through the hubris motif of the “mad scientist,” the ethics of chemistry hardly exists (Schummer and Børsen 2021).

Notes

1 The most detailed treatment of science in literature is still Haynes (1994). Shorter and more specific works include Stocker (1998), Schummer (2006), Labinger (2011), Ziolkowski (2015), and various chapters in Schummer et al. (2007), particularly Haynes (2007), Weingart (2007), and Ball (2007).

2 The topic is missing from most of the many monolingual anthologies and monographs about literature on World War I, and hardly appears in comparative studies such as Riegel (1978) (which discusses some 200 French, English, American, and German novels) and Marsland (1991). The international bibliography of the journal *Krieg und Literatur/War and Literature 1989–1994* includes nothing related to chemical warfare among its about 700 index terms. Earlier studies include Haber (1986: 230–8), Spear and Summersgill (1991), Löschnigg (1994: 150–63), and Kaufmann (2017). On the poor representation of gas warfare in later movies, see Skrebels (2014).

3 For instance, Henri Barbusse's *Le Feu* (1916, chapter 19); Roland Dorgelès' *Les Croix de bois* (1919: 286–7, 303); John Dos Passos' *One Man's Initiation: 1917* (1920, chapter 6); Erich Maria Remarque's *Im Westen Nichts Neues* (1928, chapters 4 and 6); Robert Graves' *Goodbye to All That* (1929: 90–1, 164–5, 220).

4 Parts of the exhibition are still temporarily available at <http://www.memorial-caen.fr/10EVENT/EXPO1418/>.

5 Ironically, the story inspired the polywater media hype in the US in the late 1960s, based on the suspicion that the Russians could have invented something like ice-nine. That in turn inspired the post-apocalyptic science fiction novel *Year of the Cloud* (1970) by Kate Wilhelm and Theodore L. Thomas, where all water turns into a gel through the impact of a cosmic cloud. Scientists are eventually able to solve the problem, which illustrates that chemists can also play the hero in disaster stories.

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