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Pesticides and war: the case of Fritz Haber

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The interconversion of military and civilian scientific research has been discussed in various contexts. Fritz Haber was concerned with the military application of poison gas research in the First World War. It is less well known that, simultaneously, he also initiated modern pest control by toxic substances, thus taking advantage of the military development for civilian purposes. However, the case of Haber shows that, in the Age of Mass Extermination, such conversion cannot be easily kept under control.

As a starting point for my paper, I will present two photographs of the renowned German physical chemist, Fritz Haber (1868–1934). Both pictures (Figures 1(a) and (b)) were taken at nearly the same time in 1915. It will be relevant to keep in mind the implicit suggestive force that these pictures have for today's historians. The first photo 1(a) shows Haber, together with Albert Einstein in his institute, the Kaiser-Wilhelm-Institute of Physical Chemistry and Electrochemistry in Berlin. It is the embodiment of the 'good Haber', the ingenious scientist and Nobel Prize winner of 1918, the benefactor of mankind whose ammonia synthesis process helped to save the world's population from starvation. We see the great scientist as he talks on equal terms with another genius. This photo is usually published in studies that judge Haber's personality and achievements positively.

Just the opposite is true for the second picture 1(b), a portrait of Haber in uniform. Here you can see the personification of the 'wicked Haber'. This is the convinced German nationalist, the militarist and unscrupulous inventor of poison gas warfare in the First World War. This is the war criminal whose extradition is said to have been demanded by the Allies after the German defeat. This is also the dominant, unfeeling husband who drove his sensitive first wife, the physical chemist Clara Immerwahr, to suicide in 1915. No wonder that you find this photo mostly in books expressing a very negative opinion of the scientist.

The aim of this paper is to argue that Haber's case is an example of the difficulty in modern science of separating the 'good' from the 'evil'. In fact, the good and the evil often are two sides of the same coin. To express it in an imaginary third photograph, Einstein would have to be placed just behind the 'wicked' Haber in uniform. I will develop my thesis by using the relatively unknown – and at first sight marginal – example of chemical pest control where 'good' and 'evil' are closely interwoven. In addition, I want to show some of the changes in

Figure 1(a). Fritz Haber and Albert Einstein in the Kaiser-Wilhelm-Institute of Physical Chemistry, Berlin, ca 1915.

structure as in function of the relationship between the sciences, the military and the chemical industry during the First World War. I shall trace this development through the Weimar Republic and with a glance at the Third Reich.

I.

There were two groups of insect pests that attracted attention under the conditions of war. First the insects that ruin provisions, and then bloodsucking insects that attacked persons.

A little moth first discovered in Germany in 1877 caused major damage in mills and storehouses. The net of the meal moth spoiled the corn provisions so that they had to be thrown away and also damaged the grinding engines in the mills. The repair of the mills took a long

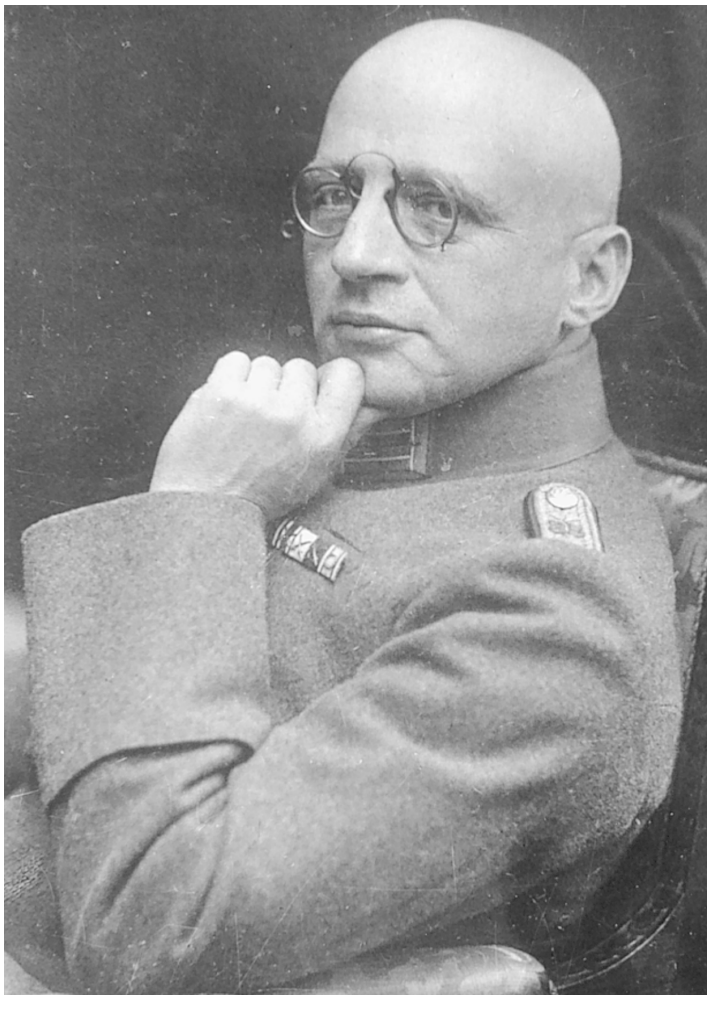

Figure 1(b). Fritz Haber in uniform, ca 1915.

time and interrupted the badly needed production of flour. A rough estimate of the costs due to those damages in peacetime was about a million marks per year. It was much worse in wartime after 1914, when the war economy led to large-scale centralization. Mills were replaced by huge flour factories and giant warehouses. Big industry was very vulnerable and suffered from big losses, even though the problem was caused by a very small insect which found ideal conditions for its reproduction in exactly those huge mills and stores. There seemed to be no means to fight the delicate moth, which turned out to be astonishingly resistant to all known methods of extermination, whether they were mechanical or biological, physical or chemical.

Meanwhile, soldiers in the army, prisoners of war and the civilian population in the occupied territories of the East were suffering badly, mostly from head lice but also from bugs, fleas,

mosquitoes and mites. The lice were spread easily by the constant movement of troops and their accommodation in vast camps. People suffered not only from the unbearable itching. Lice were dangerous because they could transmit diseases such as typhus fever, which could easily become epidemic in wartime conditions. The German military medical service was effective in taking sufficient preventive measures so that typhus fever claimed relatively few victims in the German army and its allies. The same cannot be said regarding prisoners of war, foreign workers, and the civilian population of Eastern Europe, among whom typhus fever developed into a serious epidemic.

As the main reason for the plague of lice, contemporary scientists blamed the 'too intimate relations', as they expressed it, of German soldiers and civil servants with the generally lice-ridden population of the East. That is to say, they blamed prostitution, the billeting of soldiers in private houses, or similar social contacts. Reading the numerous reports of the medical services, you can detect in some of them a racist undertone as they related the Eastern, often Jewish, population to the plague of lice.

The health and economic problems were therefore very serious. So what options were currently available for the government and military to deal with the lice effectively? There were about 250 tinctures and powders on the market, but they benefited only their manufacturers! Heat or gassing with sulphur dioxide turned out to be the only effective means. Therefore, as early as in the winter of 1914/15, huge complexes of euphemistically called *Sanierungsanstalten* (rehabilitation centres), were erected at all major railway junctions, first along the Eastern borders of the Reich, later also in the West. All persons passing through these delousing institutions had to take a warm bath or shower, they were completely shaved, and their clothing and equipment were deloused by heat or sulphur dioxide. There were also mobile delousing trucks in service just behind the frontlines. However, the military medical services running these facilities were confronted with three difficulties in applying these measures – during the course of the war, they suffered shortages of coal and sulphur, transport conditions to the remote delousing centres deteriorated and, furthermore, cloth and leather were considerably damaged.

Given the urgent wartime need for new remedies, there were three groups who participated in the ensuing campaign of pest control: science, industry and the military.

The science dealing with the biology of pest insects is applied entomology, but this discipline was still in its infancy in pre-war Germany and had difficulty in establishing itself as a scientific field. The self-image of German zoologists at that time was mainly theoretical, they understood their discipline as a pure science, so that they could not accept applied entomologists as equals. Even worse, they labelled them as ordinary pest controllers, who did not have a very high intellectual status and social prestige in those times. One looked in vain for a chair for applied entomology in the universities or even in the agricultural colleges.

The pioneer of applied entomology in Germany was Karl Escherich (1871–1951), a zoologist with a very interesting academic career, but a dubious political background as he was one of the early members of the National Socialist Party (NSDAP) in Munich, from 1921 to 1923. Before the First World War he had visited the United States – the El Dorado of modern pest control at that time – at the invitation of L. O. Howard, the director of the Bureau of Entomology. In 1913, Escherich published a book which extolled the efficient organizations and networks of the competent American authorities and which made proposals for reform

in Germany. He founded a new scientific association in the same year, the German Association for Applied Entomology (*Deutsche Gesellschaft für Angewandte Entomologie*). Its declared aim was to overcome Germany's backwardness in this field and to promote scientific research on parasites. This proved to be the decisive step towards the successful institutionalization of applied entomology in German academic life. The Association's reviews, publications, and annual meetings were the means by which its members learned about the method of pest control that Escherich favoured: the gassing of mills and storehouses with the highly toxic poison gas of hydrocyanic acid(HCN).

At the same time, that is at the beginning of the First World War, the entomologists found their industrial partner, the *Deutsche Gold- und Silberscheideanstalt* in Frankfurt. Since hydrocyanic acid was an essential component of gold refining, Degussa, as the company was called from 1928 on, was the German market leader in hydrocyanic acid chemistry. For obvious reasons, that company was very much interested in the nationwide introduction of HCN-gassing. Degussa's subsidiary company in the United States added their experience, as the firm built up its own chemical laboratories in Germany.

As has often been observed, in a new field, the results of the industrial laboratories are often not sufficient to establish the technical application of a new process. This was just such a case. Degussa hurried to become a member of the newly founded German Association for Applied Entomology in order to promote cooperation between industry and science, but also between industry and the state by exploiting the close relationship of German professors to the state. It turned out that Degussa made a profitable investment in the future by providing chemicals, instruments, equipment and competent staff, free of charge, to academic researchers who were interested in pest control by gas. So when Escherich carried out the first large-scale gassing of a mill near Würzburg in April 1917, it was the state authorities themselves that propagated the new method among German mill companies and storehouses.

The third participant in the project of pest control by poison gas was, of course, the military. They joined in 1916 and it was again the German Association for Applied Entomology that helped to create the partnership. The Association requested its members in military service to carry out experiments with lice or bugs, and it offered them the money and equipment required. Albrecht Hase, an enthusiastic entomologist from the University of Jena, offered his services to the Prussian ministry of war. He was promptly engaged to research into the biology of lice and the development of efficient means of fighting them. Hase opened the first German 'field-laboratory for lice' in a camp for Russian prisoners of war in March 1915. In the following years, he published a series of basic studies on lice and bugs. He had first-class working conditions in which he started experiments with hydrocyanic acid in the summer of 1916. These were not successful as he did not provide the necessary gas concentration.

By now, you might be wondering what this has to do with Fritz Haber. Haber was, to coin a phrase, the right man at the right time at the right place. As the scientific director of the Kaiser-Wilhelm-Institute of Physical Chemistry, and as the head of the chemical department of the Prussian ministry of war, his position was exactly at the intersection of science, the military and the state and, of course, he had very close relations with the chemical industry. It was only by Haber's decisive intervention that both the civilian and the military measures against all kind of parasites turned into systematic, well-organized, large-scale action. Nobody in Germany was more competent in research work in poison gas than Haber: by February 1916

his well-equipped scientific institute had been completely changed into a highly specialized laboratory for gas warfare, with a staff which numbered nearly 2000 by the end of the war.

As early as 1917, the question arose what to do with the war scientists in Haber's institute once the war was over. Clearly, the institute itself would have to become a purely civilian organization, but the army was interested in continuing poison gas research in peacetime. Haber himself thought about the problem and proposed, as early as February 1917, to found a separate Kaiser-Wilhelm-Institute for poison gas research. This institute, commonly called the 'gas institute' by insiders, should carry out both military and civilian experiments, the latter to promote chemical pest control in agriculture and forestry. The civilian part of the programme has often been misunderstood as a mere disguise for the fundamentally military use of poison gas, in order to convince the reluctant Kaiser-Wilhelm-Society of the necessity of the new institute. However, we know from many sources, that Haber did honestly believe in the importance of the civilian use of poison gas for pest control. He was, in general, convinced of the technocratic vision shared by many scientists and engineers of that time that most, if not all, political, economical and social problems could be solved by scientific means. Concerning the war technologies, he urged to make use of them in times of peace, after conversion to civilian purposes, in order to get some scientific and economic profit back from all those enormous investments for war. Consequently, in his memorandum proposing the foundation of the new Kaiser-Wilhelm-Institute of Applied Physical and Biological Chemistry – as the 'gas institute' was officially called – Haber pointed out that the civilian use of poison gas research would probably lead to the most promising future for the technologies developed in war. The important issue was to continue the systematic cooperation of chemists, physicists, biologists and medical scientists, 'to turn the means of extermination into sources of new prosperity'.

For various reasons, the 'gas institute' could not be created. Instead, Haber's initiative led to a conference in February 1917 where senior representatives of the military, civilian authorities, and of the chemical industry, met scientists from various institutes. Haber pointed out the general importance of pest control and thus introduced the keyword to the director of Degussa who welcomed this chance to present his company's success in exterminating lice and bugs by hydrocyanic acid gas. Several research institutes gave similar reports so that finally the authorities accepted the initiatives proposed by this concerted approach of science and industry. They promised not only financial help, but immediate action. Wichard von Moellendorff, a former engineer at AEG and one of the leading organizers of the German war economy, proposed not to wait for some improbable gas institute to be organized, but to act immediately by setting up a committee with Haber as its chairman. This Technical Committee for Pest Control (*Technischer Ausschuss für Schädlingsbekämpfung*) would provide the liaison and systematic coordination which the state and military authorities, the chemical industry and the scientists clearly needed if the large-scale introduction of pest control by poison gas was to become effective.

The Committee, which was obviously dominated by Haber, started its work in April 1917. It set up a range of research projects, because it had become evident that the results and experiences drawn from gas warfare on the battlefield could not simply be transferred to the struggle against parasites, which had proved to be strikingly resistant. Most of the research projects were carried out in Haber's Institute, with the result that he and his collaborators

entered into a tacit, but fierce competition with the entomologists who hitherto had considered themselves to be the only competent experts on lice and bugs. Escherich saw Haber as a poacher in his field and watched him jealously, but, under the conditions of war, he was forced to cooperate. Consequently, it was the section for gas defence at Haber's institute that developed a special gas mask to provide protection against hydrocyanic acid and also invented a most important apparatus to determine whether a room was really free of gas after airing. In particular, the institute's toxicological section, under the renowned pharmacologist Ferdinand Flury (1877–1947), was set up in a way showing all characteristics of modern research. A team of scientists of various disciplines cooperated closely and systematically: chemists, biologists, pharmacologists, veterinary and medical scientists carried out experiments and cooperated with technical employees in order to use poison gas for pest control.

Having focused so much expertise and actual laboratory work under Haber's direction, exactly what kind of institution was the Technical Committee for Pest Control? It seemed to be a rather bizarre hybrid, viable only in wartime, but it also embodied the new form of an institutionalized cooperation of state, military, chemical industry and science. Formally, although the Committee was no more than a team of volunteers, because of the way its chairman used his influence it became almost an official subdivision of the ministry of war, where Haber was head of the chemical department. On the other hand, the Committee had many features of a private enterprise. It employed, for example, a managing director who had previously worked at Degussa. In fact, Haber's vision was to formalize pest control as an enterprise under public law, an idea that was strongly influenced by his friend Moellendorff. To implement this, the Committee would transform itself as soon as possible into a non-profit-making limited company. In this company, the authorities performed the controlling functions whereas scientists were to act as an advisory board. Haber strictly opposed any kind of private enterprise in pest control, not only because the chemicals in question were so extraordinarily dangerous, but also because of the strong military interest in 'certain substances'.

Due to the dynamic personality of its chairman Haber, the work done by the Technical Committee was in fact quite efficient. It extended to both the military and the civilian fields. Under Haber's guidance, Albrecht Hase introduced to the army in April 1917 large-scale gassing as an effective new means of delousing. He first put his method into practice at the big delousing centre near Kattowitz in today's Poland. Its conversion into a centre using hydrocyanic acid gas was successfully carried out within three months. All other *Sanicrungsanstalten* followed one by one. Other experiments did not succeed; for example, the delousing of railway waggons packed with worn uniforms, which was carried out in a heated, gas-tight tunnel near Potsdam. As for the gassing of mills, the Technical Committee coordinated the applications and provided the necessary chemicals and equipment. Under war economy conditions, this was the only way for civilian institutions to get hold of the materials required. Using his close links to the army, Haber also solved the problems of staffing that soon emerged. Since there were many mills to be gassed, but only very few trained people to do that dangerous job, Haber raised a so-called 'Company for pest control' from former front-line gas pioneers. After their experience with poison gas on the battlefields, it was easy for these men to get used to handling hydrocyanic acid gas in mills and storehouses. In order to save time and money, Haber gave up the gassing of single mills in 1918, but combined several mills in the same region in so-called 'gassing-cycles'. A few figures will outline the

scale of these measures. By August 1918, nearly 150 mills with a volume of 1.2 million cubic metres had been gassed, and combined with military objects such as barracks, hospitals or delousing centres, this figure amounted to some 2 million cubic metres.

When we assess Haber's role in the institutionalization of chemical pest control, it is obvious that he had succeeded in bringing diverse military and civilian interests under one coordinating command. To use chemistry as a metaphor, this means that Haber played the role of a catalyst in forcing the existing, rather reluctant elements – state authorities, military, industry and science – to blend a fierce chemical reaction that unleashed its own dynamics. The result was that technical processes, organizational and institutional structures and even a market for pest control, all of which scarcely existed before 1914, gradually developed precisely because of the protective conditions of the war. Subsequently, in the Weimar Republic, the participants in the new technology had, in a sense, matured so that they could stand on their own feet and continue to develop their interests on their own. Pest control as a scientific discipline and as an industry had been established and institutionalized by war and, in this, one person, Fritz Haber, had played a decisive role.

II.

In the early Weimar years, as regards the industry, the most interesting development was created by a decree in January 1919 which prohibited the general use of hydrocyanic acid in any form. Exceptions were made for the army, for research institutes and for the still existing Technical Committee for Pest Control. As it seemed that this hybrid creature of war could not survive under the conditions of peace, Haber was busy implementing his old plan to create a non-profit-making company under public law. It was founded in April 1919 in Berlin under the name of *Deutsche Gesellschaft für Schädlingsbekämpfung*, i.e. the German Company for Pest Control, usually abbreviated as Degesch. Degesch owned the state monopoly for pest control using hydrocyanic acid. It was argued that the state monopoly was legally and politically justified because this was not only a highly dangerous process, but also the only way to enable the state to profit from a technical process that had been introduced by the state itself at high public costs.

Degesch was Haber's own invention, a facility where, in times of peace, he could exploit the achievements of war. It is interesting to look at the partners in this deal: the Reich, the German states and, for the chemical industry in particular, Degussa, which wanted to enlarge its share of the production of hydrocyanic acid. This close link between Degesch and Degussa became visible when, as early as May 1920, Degesch moved its headquarters from Berlin to Frankfurt. Shortly afterwards, it was transformed from a public corporation into a private company. Following Haber's advice, as early as 1921 it opened eight flourishing branches in the Balkan states and, in the following years, Degesch developed into a very successful firm operating all over Europe.

Concerning science as a participant in the deal, Haber proved his serious commitment to pest control in 1919 and 1920 when he played an active part in the radical restructuring of the Biological Institute for Agriculture and Forestry (*Biologische Reichsanstalt für Land -und Forstwirtschaft*), which had completely failed under war conditions. Haber was acquainted with its appointed director, Otto Appel, a renowned botanist, who had participated as a scientist

in several poison gas attacks in Russia. It was therefore easy for Haber to intervene in the restructuring by issuing two detailed memoranda in which he pointed out the scientific and economic relevance of pest control. In consequence, for the first time in its existence, the Reichsanstalt employed several entomologists. Its new department structure was reshaped to accommodate the requirements for a successful transfer of scientific applications to agricultural practice. For example, in the first department, with its 13 laboratories for applied research, there was now a separate laboratory for parasites in mills and storehouses. In the second department, which was dedicated to projects without immediate application, Haber insisted on a laboratory for what was called 'physiological zoology'. This very general term was misleading because in fact it was intended to be a facility for basic research into scientific pest control. It dealt with problems such as the biology of insects, the impact of high or low temperatures on their reproduction, and the reasons for plagues of parasites.

Meanwhile, the German Association for Applied Entomology had developed from its modest pre-war beginnings into an academically accepted, prestigious scientific society whose publications had a wide influence beyond its own membership. And just like any scientific society, it soon became the forum for the most violent struggles among scientists. For example, at the Association's annual meeting in September 1918, Karl Escherich, as chairman, proudly presented his own achievements and plans without even mentioning Haber and the Technical Committee. The same annual meeting became much more colourful than usual when suddenly Haber showed up in uniform, accompanied by the impressive entourage of his assistants, and asserted publicly that his institute was, of course, going to continue its most successful research in pest control in peacetime.

Having seen how Haber managed industrial and scientific continuity through Degesch and the Reichsanstalt, let us see how he continued his interests in poison gas. Since his old plan to establish a separate gas institute within the frame of the Kaiser-Wilhelm-Society had failed, he claimed poison gas research to be an official part of his own institute's purpose. The German defeat obviously did not allow open research into any warfare agents, but Haber established a pharmacological department in his institute, which then continued the work of the toxicological section that had been built up in wartime. The official purpose of the new department was to evaluate systematically the experience with gas warfare in regard to chemical pest control. The department's conception was as modern as that of the previous section. It was based on interdisciplinary teamwork, which became evident in the joint headship of the department by the pharmacologist Ferdinand Flury and the entomologist Albrecht Hase, who had joined the institute just after the armistice. The miserable conditions of postwar Germany notwithstanding, Haber urged the team to begin its research projects right away. So Flury made crucial experiments with a former chemical warfare agent, abbreviated as T-gas, but because of the allied controls, the results of these experiments could only be published in 1930. Haber personally checked the impact of mustard gas on cockroaches, which to his surprise turned out to be absolutely resistant to this chemical weapon. They could only be killed by hydrocyanic acid which, on the other hand, proved to be useless against the corn weevil, a parasite that could be exterminated only by a warfare agent known in Britain as 'white star' or 'yellow star'. At that time, 1919 to 1920, Haber also tried to free a whole forest near Guben from a plague of pine lappet moths by using, for the first time, bombs filled with arsenic powder. He even had the vision of spraying poisonous powders by aircraft, but he was realistic enough to foresee the allies' resistance to this plan.

III.

Nevertheless, at first glance, the history of pest control by poison gas seems to be a first-rate example of how a technology of war can be converted into a useful, beneficial technology in peace. I leave aside the possible long-term damage by toxic chemicals to health or to the environment, aspects that are considered so important nowadays. Instead, we can go much further to understand Haber the scientist, and his motivation, which was 'to turn the means of extermination into sources of new prosperity'.

To secure the existence of his Institute, Haber in the immediate postwar years had to avoid the slightest suspicion of continuing any kind of military research. So the reason why Flury's and Hase's department was hastily dissolved in May 1920 is not to be found in the financial miseries of inflation, as has often been presumed, nor as a result of Flury being called to a chair at the university of Würzburg in the same year. As Hase admitted later in an autobiographical account written in 1961, the true reason was the Interallied Military Control Commission, which started demilitarizing Germany in January 1920. Haber wanted to avoid anything that could be used as a pretext to liquidate the Institute as a whole. In fact, he and his colleagues made experiments with former war gases and their impact on various kinds of animals and insects which, without any doubt, was against the Treaty of Versailles. However, there was hardly any difference, in the type of research done, whether these gases are used for pest control or for warfare. Therefore, much to the delight of the entomologists around Escherich, Haber again had to withdraw from the scientific hunting ground. He could not even mention the decisive role his institute had played in pest control, nor could this work be continued. On the other hand, Haber was not the man to give in easily, so his scientific competitors never really got rid of him. He pulled off an ingenious coup when he succeeded in transferring his institute's pharmacological department to the restructured Biological Reichsanstalt, where it could hide under the cover of the previously mentioned laboratory for physiological zoology.

The way this laboratory was financed and how it developed in the following years does, in fact, reveal a lot about the true character of the research projects carried out under the cover of the unsuspected Reichsanstalt. The official budgets and files only give a limited and misleading idea of these faculties. It is again Hase's autobiographical account of 1961 that permits a deeper insight. According to Hase, the pharmacological laboratory suffered heavily from shortage of money, staff, and room. In 1920, Haber was able to raise some funds from Degesch to pay the staff. In 1921, it was left to the Reichsanstalt to bear the costs. The following years brought remarkable improvements: Haber was suddenly able to raise funds to employ two new technical assistants, but the otherwise talkative Hase does not reveal where the money came from. We find even more mysterious remarks for the year 1924 when some samples of newly invented highly toxic poison gases were sent to the laboratory. They should, as was stipulated, be tested regarding their utility for industrial pest control. Haber again found anonymous funds, in this case in order to employ two additional academically trained physical chemists, as, according to Hase, the testing of those gases required competent scientists. So in 1926, the pharmacological laboratory employed four scientists and four technical assistants. As it kept lots of laboratory animals and insects for breeding, it suffered again from a considerable shortage of space. Again it was Haber who solved the

problem. He succeeded in persuading an 'anonymous foreigner' to give the Reichsanstalt a generous donation for the erection of a new building for animal breeding and animal experiments: a total of 22,000 Reichsmarks in three instalments. In 1927, the laboratory moved into its new building so that, according to Hase's account, Haber's ambitious postwar plans could finally be realized.

So who gave all those mysterious funds? In Hase's autobiographical account, there are some striking inconsistencies and most peculiar phrases. We are left wondering where exactly did those newly developed poison gases come from, which were to be tested in 1924, and why on earth did the laboratory need two additional experienced physical chemists to do this job? Why did they test the impact of these gases on warm-blooded animals, such as rabbits, rats and guinea-pigs, if they were meant for pest control? Why did that mysterious anonymous foreigner insist on a new building for animal breeding and animal experiments? And finally, why was it strictly forbidden even to mention Haber's name in any official meeting or document?

As historians are more than passionate readers of detective stories, we must look deeper into the sources. In a separate supplement to his autobiographical account, Hase confirms our suspicion. Haber had effected a top-secret transfer of considerable funds from the German army, the Reichswehr, to the Biological Reichsanstalt. Until 1933 the Reichswehr funded the running costs of the pharmacological laboratory and the monthly pay of two physical chemists and three technical assistants. Further, the Reichswehr also funded the erection and equipment of a new building for animal breeding and animal experiments. So what motivated the army to this considerable funding from 1922 to 1933? Hase talks very vaguely about Haber's good contacts with the military and his merits for 'gassing of all kind'. I think we can be rather sure that during the Weimar Republic, the Biological Reichsanstalt in Berlin developed and tested poison gases not only to exterminate pest insects, but also for military purposes, that is to say to kill human beings. It seems very unlikely that the Reichswehr, running a severe political risk of international discovery, would continue to spend considerable amounts of money only in order to fight lice and cockroaches.

The long-term deal was initiated and arranged by Fritz Haber whose role as a mediator between military, industry and science can hardly be over-estimated. He was in no way reluctant to have his research work applied for military purposes, and clearly he pursued that application deliberately and in total awareness of the consequences. The other, and even more horrific, possible application of the research on poison gases, however, was absolutely beyond his imagination.

In close contact with Haber's institute, the Technica1 Committee for Pest Control, and later Degesch, improved the technical means and processes for gassing mills and storehouses. First, they used a huge generator – called *Cyanator* or *Cyanofumer* – to produce the gas outside the building, but it took a lot of time to have such a big machine transported and installed. So they invented a procedure using large tubs with liquid cyanide. The tubs were put inside the building where the liquid poison gas vaporized. However, this procedure was still highly dangerous for the staff because the liquid substances in the tubs could splash over and it also endangered people who happened to enter the mill after it had been gassed. There are statistics for 1920 that show that several tramps looking for shelter at night were accidentally killed because there were residual traces of hydrocyanic gas just above the floor. One of the main problems was

that hydrocyanic gas had a very weak smell. So in 1919, still in Haber's institute, Hase and Flury started to develop extremely poisonous cyanides and combined with them irritant substances that would alert people. As early as 1920, they discovered a very effective cyanide derivative, and published their result in an inconspicuous medical review. They called this new liquid substance Cyclon A.

In close contact with Haber, and protected by the monopoly he had secured, Degesch continued to develop and apply Cyclon, which seemed to be most suitable for gassing very large buildings. Degesch funded Hase so that he was able to continue his research work on cyanides in the Biological Reichsanstalt. By 1924, the firm could proudly present the results of this project, a new substance called Cyclon B. Cyclon B proved to be absolutely safe for the staff. It was a crystallized substance, packed safely into tins, which could be handled easily. Cyclon B only released the deadly gas upon contact with the air after the tin was opened. It was also combined with a very irritating substance in order to warn people.

We all know about Cyclon B in the Third Reich, when from 1941 onwards it was used as a horribly efficient means of mass extermination in concentration camps. In fact, 95% of Cyclon B was used for pest control, 5% for gassing human beings. In the latter case, the SS ordered the irritating substance to be removed. Cyclon B can therefore be seen as a result of the conversion of military into civilian poison gas research or, taking up the idea from the beginning of this paper, as the result of the conversion from 'evil' into 'good' science. Without doubt, Haber saw the technical development of Cyclon B as one of the 'sources of new prosperity' he had praised in 1917. But then, only some 20 years later and absolutely unforeseen by him despite his military experience, it turned into a means of extermination, annihilating the Jews in Europe and tragically also killing some members of Haber's own family. Haber had been convinced that he could keep the mutual military and civilian conversion of poison gas research under control, but it turned out, that in the Age of Mass Extermination, this was not possible.

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