The Biological Targets of Chemical Weapons: A Short Approach

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Biography
Jean-Michel Panoff is a biologist and professor in the *Institut de Biologie Fondamentale et Appliquée* at *Université de Caen Basse-Normandie*. His research is connected to risks, quality and sustainable environment, concerning the way microorganisms respond to stress, and adopting an interdisciplinary approach to biological risks both natural and human anthropogenic.

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This article explores the use of chemical weapons, from their origin and up to the present day. World War I can be situated as a turning point in the increasing use of chemical substances in warfare.

Weapons have been developed since the origin of the human species, and can be classified in three categories: physical, biological and chemical. Physical weapons appeared naturally at first and did not cease "progressing" technically, from the simple javelin to the nuclear bomb. Only within the last three thousand years have biological and chemical weapons begun to be used. It will be noted that the distinction between biological weapons and chemical weapons is not always very clear: ricin, for example, is a substance of plant origin which can, rightly, be regarded as a (bio)chemical weapon. In order to avoid any ambiguity in this brief overview, and within the somewhat subjective possibilities of classification, biological arms will here be defined as not only militarizable pathogenic agents but also toxic chemicals originating from living organisms. In this context, we will thus limit the term "chemical weapons," the subject of this short article, to synthetic chemicals.

Currently, militarizable chemicals belong mainly to four different groups: The neurotoxic, the hemotoxic, the vesicant and the suffocating ones. Contact with neurotoxic chemicals leads to a blocking or an inhibition of the nervous system. Some vital functions of the organism can be affected, and physiological malfunctioning can be observed such as vomiting, abundant sweats, respiratory difficulties, or eye trouble. Exposure to neurotoxic chemicals can also result in death. Among the examples of this group of chemicals are:

Tabun (ethyl dimethylamidocyanophosphate - 1937),
Sarin (isopropyl methanefluorophosphonate - 1939),
Soman (pinacolyle methanefluorophosphonate - 1944), or the
VX (O-ethyl S-diisopropylaminoethyle methanethiolophosphonate - 1956).

The first three agents are known as "respiratory" whereas the VX belongs to the "percutaneous" neurotoxic agents.

Hemotoxic chemicals lead to blood poisoning by respiration. *Hydrocyanic acid*,[1] cyanogen chloride and *arsines* belong to this category. Vesicants may cause cancer and they produce burns on the skin, eyes and lungs. Some of these effects can last up to 15 years after the intoxication. *Yperite* (1859) or mustard gas (Bis(2-chloroethyl) sulphide) and lewisite are two important examples of vesicants. Suffocating agents attack the lungs. *Phosgene* (carbon oxychloride), *chlorine* and chloropicrin are three examples of suffocating chemicals whose major characteristic is to overwhelm the respiratory system.

Historically speaking, the beginning of the current military use of chemicals derives from the macabre trilogy that started on April 22, 1915. But even before then, numerous examples over the course of twenty-five centuries shows human ingenuity at developing mortal chemical weapons. In Greek and Roman times, sulphur based gases were used by the Greeks during the Peloponnesian war (5th century BC). Caustic ashes were employed by the Romans at the Siege of Ambracia (187 BC). Byzantium's secret weapon was "Greek fire" (7th-14th C).

During the Medieval Period and the Renaissance, barrels of blinding quicklime were catapulted by the English fleet onto French vessels in the middle of the 13th Century. Bombs, grenades or rags were fired with arsenic by the defenders of Belgrade against the Turks in 1456. Arrows poisoned with curare were used by the Amazon Indians, even as late as the 20th Century. In the 18th and 19th Centuries weapons based on chemicals such as arsenic, lead or antimony, with the addition of biochemical substances such as belladonna, euphorbia, hellebore or nux vomica (cited in 1726 by Fleming, a German military author). It is not clear if they were actually used. There was also an unexecuted British project to smoke out the Russian garrison at Sebastopol with a lethal mixture including 500 tonnes of sulphur and 200 tonnes of coke (Crimean War, 1854-1855).

The "Chemical Great War" began in 1915, with the events of April, May, and July, 1915 and continued to increase in intensity. On April 22, 1915, near Ypres, 5830 cylinders, containing 150 tons of chlorine, were spread by two battalions along six kilometers of the front. Pushed by the wind, the gas cloud caused the death of approximately 800/1400 soldiers and would put 2000/3000 of them out of combat, leading to an intense panic. On May 31, 1915, new and more lethal attacks occurred, using a mixture of chlorine and phosgene along 12 kilometers on the Russian front, at Bsura-Rumka. 12000 bottles of gas were used, resulting in 9000 victims, including 6000 deaths. During July 1915, 100,000 "T" shells (benzyl bromide) of 155mm were fired in the Argonne.

There were two major chemical offensives in 1916. At Verdun during the month of March, shells of 75mm containing phosgene were used, with many resulting deaths. During the month of July, shells filled with hydrogen cyanide were used during the Battle of the Somme.

In 1917, in July, the chemical war reached its paroxysm with yperite or "mustard gas" in the area of Ypres - hence its name. 9,500 tons of mustard gas were manufactured. Its toxic action affects not only the respiratory system; it is also a persistent and insidious vesicant agent, causing intolerable burns. The psychological

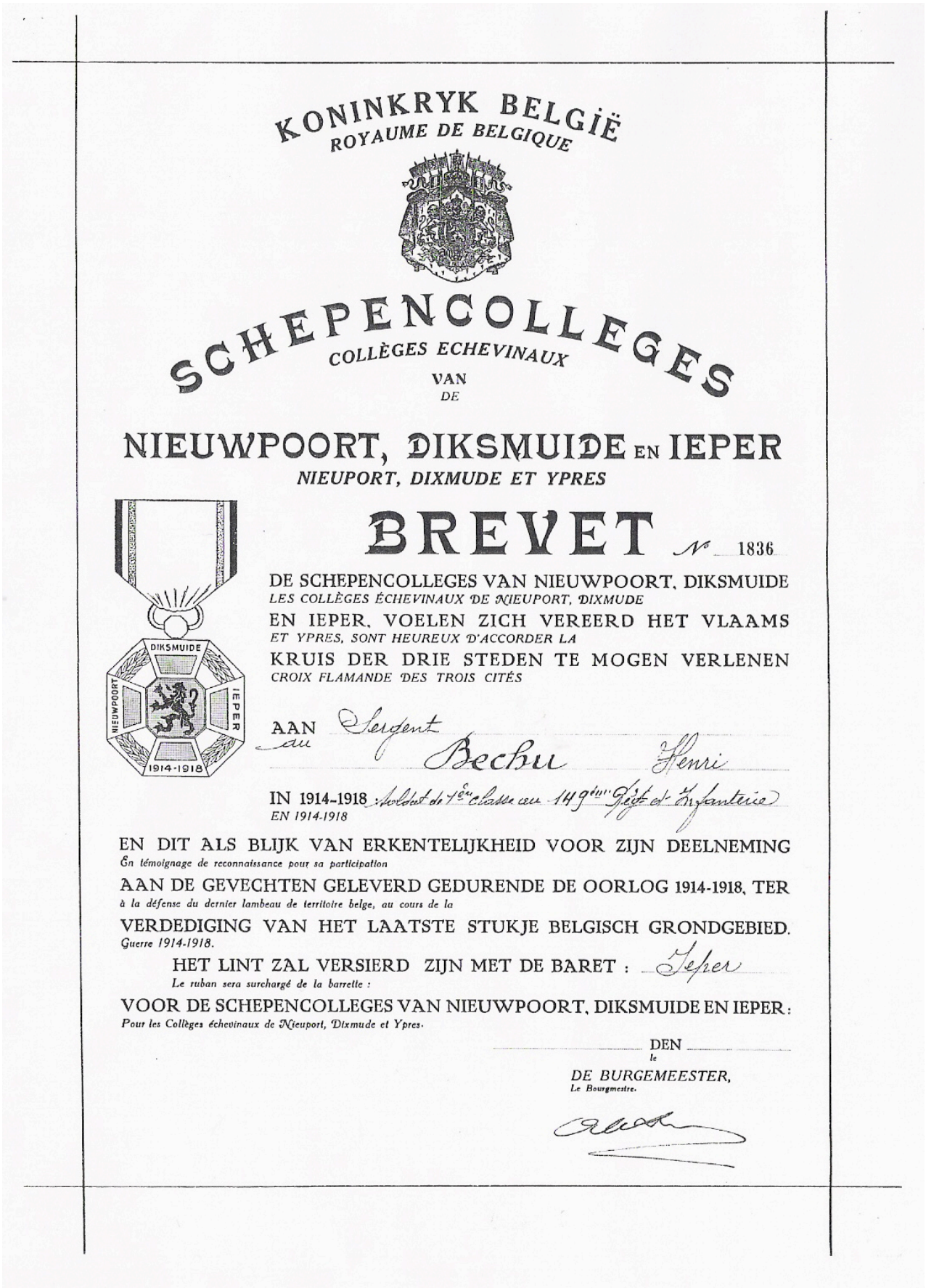
effect was disastrous. September 1917 saw the first use of arsine-based "Clarks". They were substances causing nausea and vomiting, which gas mask filters could not stop.

During the final year of the First World War, shells with aggressive gases were extensively used. In the attacks of 1918, approximately 25% of projectiles used on both sides were chemical weapons. It is estimated that if the conflict had been prolonged one more year, it would have lead to a real chemical war.

The number of military victims due to chemical arms, mainly yperite, during World War I is estimated at 1,360,000 including 94,000 deaths out of an approximate total of 8,500,000. Survivors who were injured consecutively to contact with chemicals, very often died later of infectious diseases.

After World War I, other historical events related to the use of lethal chemicals should be remembered: In 1935, The Italian army used mustard gas against Ethiopians. During the Second World War, the Japanese used various chemical weapons in China. In Vietnam, the United States used defoliants from 1961 to 1971.

This article ends with a few perspectives for the future, with the hope of limiting the use of chemical weapons on earth. Initially, chemical weapons might be characterized by scientific evaluations and evolutions, suggesting the persistent advance of technology over humanity. However, political negotiations have already led numerous countries to make successive international agreements. The Geneva Protocol was signed on June 17, 1925. The Chemical Weapons Convention (Paris, Jan 13, 1993) legislates “on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons, and on their Destruction.” But finally, neither Cartesian scientists, nor reasonable diplomats will be able to enact a total ban of chemical weapons on earth, if they are not sustained by the wind of a spirit of humanity.



KONINKRYK BELGIË
ROYAUME DE BELGIQUE

SCHEPENCOLLEGES
COLLÈGES ECHEVINAUX
VAN
DE

NIEUWPOORT, DIKSMUIDE EN IEPER
NIEUPORT, DIXMUDE ET YPRES

DIKSMUIDE
NIEUWPOORT
IEPER
1914-1918

BREVET N° 1836

DE SCHEPENCOLLEGES VAN NIEUWPOORT, DIKSMUIDE
LES COLLÈGES ÉCHEVINAUX DE NIEUPORT, DIXMUDE
EN IEPER, VOELEN ZICH VEREERD HET VLAAMS
ET YPRES, SONT HEUREUX D'ACCORDER LA
KRUIS DER DRIE STEDEN TE MOGEN VERLENEN
CROIX FLAMANDE DES TROIS CITÉS

AAN Sergent Bechu Henri
au

IN 1914-1918 : Soldat de 1ère classe au 14 9de Régt d'Infanterie
EN 1914-1918

EN DIT ALS BLIJK VAN ERKENTELIJKHEID VOOR ZIJN DEELNEMING
En témoignage de reconnaissance pour sa participation
AAN DE GEVECHTEN GELEVERD GEDURENDE DE OORLOG 1914-1918, TER
à la défense du dernier lambeau de territoire belge, au cours de la
VERDEDIGING VAN HET LAATSTE STUKJE BELGISCH GRONDGEBIED.
Guerre 1914-1918.

HET LINT ZAL VERSIERD ZIJN MET DE BARET : Ieper
Le ruban sera surchargé de la barrette :

VOOR DE SCHEPENCOLLEGES VAN NIEUWPOORT, DIKSMUIDE EN IEPER :
Pour les Collèges échevinaux de Nieuport, Dixmude et Ypres.

DEN
le

DE BURGEMEESTER,
Le Bourgmestre.

Figure. Certificate awarding "The Flemish cross of the three cities" Nieuport, Dixmude and Ypres. The latter is at the origin of the name "Yperite" or Mustard gas.

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[1] Chemicals used during the First World War, to my knowledge, are in italics in this paragraph.