EDITORIAL

Use of Chemical Warfare Agents in Ancient History: The case of Persians and Romans in Dura-Europos, Modern Syria in 256 C.E.

REZA AFSHARI[1, *]

[1]Medical Toxicology Research Centre, Mashhad University of Medical Sciences, Mashhad, Iran.

Abstract

Background: Chemical warfare agents (CWA) were most notably used during the First World War in Europe, against Iranians and Kurdish citizens of Iraq at the hands of Saddam Hossein's regime in 1980s and more recently in Syria. The use of CWA is banned under the international law.
Methods: Ancient uses of CWA are not well studied. Recently, their use during the Persian siege of the Roman-held Dura-Europos (Salihiyah) in modern Syria in 256 C.E. has been theorized by revisiting the archaeological findings from Dura-Europos from the 1930s.
Case study: The paper describes the history of Persia (Iran) and Rome in that era and particularly Shapur I, the second King (Shah) of the [Sasanian] Persian Empire (215 - 270 C.E.) and Valerian, Publius Licinius Valerianus Augustus, the Roman Emperor (193/200 - 264 C.E.). In addition, composition of the potentially applied CWA and clinical findings related to the exposure are postulated through a medical toxicology lens taking into account archeological evidence (carbonized top of the tunnels and bodies and yellow crystals found in the tunnel), recent research and contemporary historical notes.
Conclusion: It is plausible that a combination of fire accelerant or so called pitch (oil based substance, naphtha, bitumen or crude oil) and Sulphur dioxide (SO_2) were used in this occasion. SO_2 in combination with water on the body membranes creates highly toxic sulphurous acid (H_2SO_3) which is life threatening in a small enclosed space. As a result, a burning sensation in the nasopharynx and eyes, coughing, dyspnea, choking that led to pulmonary edema and death would have shortly followed. Severe clinical manifestations, panic and consequent mass hysteria of the toxic exposure should have prevented any organized retreat. In this incident, nineteen Roman and one Persian soldier were killed.

Keywords: Chemical Warfare Agents; Dura-Europos; Persian; Roman

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INTRODUCTION

Chemical warfare agents (CWA) include a wide range of agents that have been used in battlefields and against civilians. Chemical attacks have been carried out against Iranians, Kurdish citizens of Iraq at the hands of Saddam Hossein's regime in the 1980s and more recently in Syria (1-3). Recent CWA use has shifted toward terrorism, political assassinations such as Kim Jong-nam (the North Korean leader's half-brother) in 2017 and the Salisbury assassination of Sergei (ex-spy) and Yulia (his daughter) Skripal, and accidental exposure, such as Charlie Rowley and Dawn Sturgess exposure to Novichok in Wiltshire, England in 2018 (4).

Modern history of applying CWA is mainly focused on its use during the First World War (5). The research, development, and production of CWA is an integral part of international law. Their use is banned, with particular attention paid to the protection against these weapons (6).
Since ancient times, toxic agents have been consistently employed to kill and terrorize target populations (2). Figure 1 depicts shooting fire upon the defenders of a fort with a hand-operated "Strepta" and Figure 2 illustrates using "Greek fire" against a fleet of rebels from historic paintings.

Use of chemical warfare agents in ancient Persians

According to Greek and Roman accounts, Persians used basic chemical warfare agents in three occasions; (i) under Xerxes (480 - 479 B.C.E.), when they used petroleum against Greeks (incendiary projectiles appear as an arrow bearing a piece of tow with a burning composition)[f1] [in this occasion petroleum was not mentioned but Herodotus cited the Persian people's familiarity with petroleum elsewhere[f2]], (ii) under Mehrdad (Mithridates) VI (67 B.C.E.), grayanotoxin-containing honey (mad honey) was used against the troops of Pompey the Great, and (iii) under Shapur I (256 C.E.) against the Romans [Current article] (8, 9). Table 1 summarizes some well-known CWA attacks in ancient history. This paper focuses on a major event in which the Persians used chemical agents against the Romans in the Dura-Europos battle in modern Syria. This case is the first confirmed case of the use of chemical warfare agents in ancient history.

[f1]Herodotus VIII, 52 7.
[f2] Herodotus says: "this oil (ἔλαιον) … the Persians call it rhadinakē: it is black and has a heavy smell".

*Correspondence to: Reza Afshari, MD, PhD, MSc. Professor of Clinical Toxicology, Addiction Research Centre (ADRC), Mashhad University of Medical Sciences, School of Medicine, Mashhad, Iran.
Tel/Fax: +98 511 859 8973, E-mail: afsharir@mums.ac.ir
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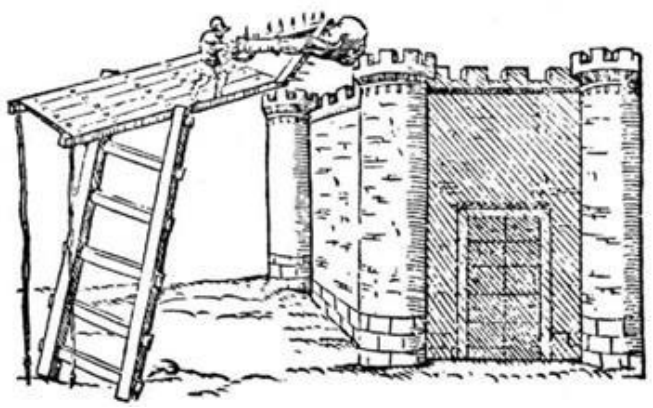

Figure 1. A warrior is shooting fire upon the defenders of a fort with a hand-operated "Strepta". (adopted from Cheronis ND 1937 Veterum Mathematicum, 1693, Paris) (7)

Figure 2. Using Greek fire against the fleet of the rebels (adopted from Codex Skylitzes Matritensis, Bibliteca Nacional de Madrid, Vitr. 26-2, Bild-Nr. 77, f 34 v. b. licenced (taken from Pászthory, p. 31))

Table 1. Use of chemical warfare agents in ancient history.

Date	Used by	Chemical warfare agent
600 B.C.E.	Assyrians	Various toxic fungi to contaminate enemy water supplies (2, 7)
490 B.C.E.	Athenians	Against the Persians during the battle of Marathon, they "asked for fire and rushed into the sea" [to burn the boats of the Persians] [Herodotus VI, 119] (7)
480 - 479 B.C.E.	Persians under Xerxes	Petroleum against the Greeks (incendiary projectiles appear as an arrow bearing a piece of tow with a burning composition) [Herodotus VIII, 52] (7)
67 B.C.E.	Persians under Mehrdad (Mithridates) VI	Grayanotoxin-containing honey (mad honey) against the troops of Pompey the Great (9)
423 B.C.E.	Ancient Hellenic nation states	A basic form of napalm ("Greek Fire"; a blend of sulfur and pitch) during the siege of Athens by Sparta in the Peloponnesian War (2, 10)
256 C.E.	Persians under Shapur I	Against the Romans [Current article]
673 C.E.	Byzantine	Greek Fire (marine fire or prepared fire) to set fire to Arab ships participating in the attack on Constantinople (10, 7)
1346 C.E.	Mongols under Genghis Khan and later	A variant of Greek fire, and also catapulted bodies of plague victims over the walls of the city, causing debilitating outbreaks during the siege of Caffa in the Crimea (biological warfare) (7, 11)
15th Century	Taino warriors of Hispaniola Island	A mixture of powdered hot pepper dispersed in ash (nonlethal irritant and tactical smoke system) against the Spanish conquistadors (2, 12)
15th Century	European colonial expansion	Basic bioweapons to decimate indigenous populations at various times during

History

Dura-Europos (Δοῦρα Εὐρωπός, Salihiyah), which is located bedside the Euphrates River, eastern modern Syria (Figure 1), was located at the Roman - Persian border (Figure 3) and was handed over between the two Empires a few times in the third Century C.E. According to Roman accounts, Emperor Gordianus III sent a letter to the senate to notify them that he had removed the threat of Persian kings (persico reges) from Antioch, Carrhae and Nisibis cities in Syria in 242 C.E.[f3] In a last attempt to defend Dura-Europos, Romans re-enforced and fortified Dura-Europos under Emperor Valerian Caesar in anticipation of Persian attacks.

The Sassanid Persian Emperor, Shapur I (Figure 3), who reigned from 230 to 270 C.E., defeated the Romans in a series of wars, and captured Dura-Europos in 256 C.E. for a second time during his reign (13). Further counter attacks by the Roman Emperor, Valerian the Elder (Figure 4) (193/200 - 264 C.E.), who reigned from 253 to 260 C.E., were unsuccessful during the Battle of Edessa, leading to his capture in 260 C.E. (14). He remained a prisoner of war in Persia (Iran) until his

[f3] SHA: Gordiani Tres 27. 5.

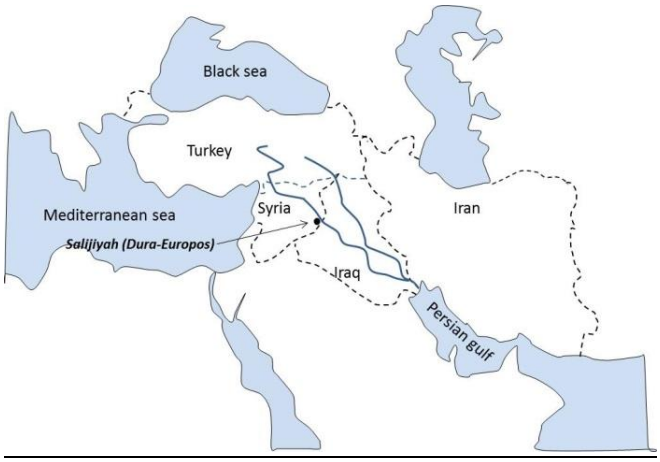

Figure 3. Geographical area of Dura-Europos battle field. Roman-Persian Border in 256 C.E.

death in 264 C.E. (15, 16). Recent studies have shown that chemical warfare gases were used by Persians against Roman soldiers in Dura-Europos (modern East Syria).

Archeological evidence

Dura-Europos is located near the village of Salihiyah in east modern Syria (Figure 3), and bordered on the east by the Euphrates river plain and on the north and south by deep ravines, leaving only the west side of the city open to attack. Multicultural populations of Dura-Europos were located in the crossroads of a major East - West trade route (Persia and Rome) (17).

French archeologist, Robert du Mesnil du Buisson (1895-1986), excavated the Dura-Europos (*Dura* means *fortress*) city wall in the 1920s and early 1930s and reported extensively (18, 19).

His team found a mining duel around Tower 19 on Dura-Europos western wall, in which at least 19 Roman and one Persian soldier, recognised based on their cloths and armaments, had become entombed. One of the tunnels was 3 meters above the other one.

According to the French discoverer, the carbonized top of the tunnels was still in place after 1,700 years. Bodies found were also carbonized. They also discovered pitch, an oil–based substance, and some yellow crystals that could be sulphur, both of which are incendiary chemicals (13).

Recent reanalysis of the excavation archive in 2008 suggested that the Roman soldiers had been deliberately gassed by the attackers (13). Although no historical text is available on the use of chemical warfare agents during capturing Dura-Europos, archaeological remains tell the story clearly (20).

CASE STUDY

During Shaper I's 2nd attack, the army attempted to undermine or sap the city wall during the siege in 256 C.E. This would have been a secret and silent plan enacted at nighttime. Sapping the city wall was a major advantage for the attackers as soldiers could get in easily or the wall could collapse. Sapping trenches during the Siege of Godesberg in 1583, Trace Italienne forts, siege of Newark-on-Trent during English Civil War (1645 - 1646) were more recent applications of saps (21).

Preventing enemy's success by undermining their sap trenches was, however, one of the defenders' major strategies. During this battle, Romans discovered Shapur I's military tactics. Detecting man-made underground activities is easily doable nowadays using sound detectors. In ancient time, a simple but effective technology was used. Defenders were digging small holes and filling them with water, and watching for surface water movements. With surface water movements, more attention was paid and more holes were dug to locate the position more carefully.

Having noticed the invaders' plan, the Romans planned to dig a countermine beneath their own anti-siege embankment behind the city wall hoping to break into the enemy's tunnel. They understandably located it 3 meters above the Persians' to have the dominant hand.

Archeological evidence shows that the Romans' counterattack failed in favour of Persians who took advantage of the defenders' work for their own advancement, according to a recent discovery by Dr. Simon James (22).

Figure 4. Shapur I, the second king (shah) of the Sasanian Empire (215 - 270 C.E.) [coin] wearing his famous crown.

Figure 5. Valerian, Publius Licinius Valerianus Augustus, the Roman Emperor from 253 to 260 (193/200 - 264 C.E.)[f4] [coin].

[f4] GNU Free Documentation License Version 1.2

A. Dura-Europos, aerial view (1932)

B. Schematic views (1932)

C. Roman infrastructure. Dura-Europos. View of the excavation in the sixth season (1932–1933)

D. Dura-Europos. View of the excavation in the sixth season (1932–1933)

E. Dura-Europos. View of the excavation in the sixth season (1932–1933)

F. Persian artefact. Lion, the symbol of the Sassanid Empire.

Figure 6. Excavating Antiquity. Dura-Europos excavated by Yale University and the French Academy of Inscriptions and Letters in the 1920s and 1930s. Dura-Europos is a fascinating crossroads of ancient cultures (Courtesy of Yale University Art Gallery).

The Romans underestimated the invaders as they were also familiar with the detecting technique and saw through their plans. On the doomsday, the Romans broke through into the Persian sap, where they were met with a superior plan by the Persians. The Persians had already placed some *"magic materials"* in their tunnel, retreated behind their brazier and threw materials onto the tunnel, and set fire. Their magic worked; coup de theatre, hot, choking clouds of dense,

poisonous gases passed upward into the Roman tunnel, according to researchers of the University of Leicester (22). Soldiers would have lost consciousness in seconds and dead in minutes. There would have been panic and chaos in the small tunnel, and there would not have been enough time to reorganise and escape backward. It was magic after all. They kept the smoke going until the noises in the gallery above stopped.

They then entered and killed anyone who survived and would have fallen easy prey to a coup de grâce! Imagine how frightening it would have been for the Romans. Invaders were capable of creating magical choking gasses. It was as though they were ordering the dark gas to move at their favour. Dura-Europos' fall into the hands of the Persians and their magic remained in the Roman Psyche for ages to come. The word magic in Latin and consequently English is originated from Magus (plural Maji) that means Persian sorcerers who had supernatural powers carried fire (23).

The fate of the one Persian solder that died in the tunnel is not clear. Placing him in the tunnel to be sacrificed might have been to guarantee the success, or his death may have been an unintended consequence.

Composition of chemical warfare agent

Carbonised top of the tunnels and bodies found confirm fire-related accelerant chemicals, including oily hydrocarbon use. Pitch, an oil–based substance naphtha (bitumen/crude oil), and some yellow crystals that could be sulphur were found in the tunnel (24).

Setting fire to this composition releases dense dark clouds of hot fumes consisting of carbon dioxide, carbon monoxide and sulphur dioxide gas, creating the inferno (22, 25). Hot gases pumped upward to the Roman side of the tunnel as it was 3 meters above the Persian side.

Sulphur dioxide (SO_2) in combination with water on the surface of the eyes, nose, throat, and lungs creates sulphurous acid (H_2SO_3) that is a highly caustic agent causing bronchoconstriction and pulmonary edema (26). Choking and death in a closed underground space would have been inevitable. Human response is imminent, and up to 90% of inhaled sulfur dioxide may be absorbed in the nose and throat (nasopharynx) (27). Exposures to levels of 400 to 500 ppm are considered immediately life-threatening (28).

This cold case mystery is the first archeologically confirmed use of chemical warfare agents in history.

DISCUSSION

The theory of chemical warfare use during the Siege Mines of Dura-Europos belongs to Simon James from the University of Leicester, UK (13). The backbone of the current article is based on his works as well as certain studies by the late French archeologist, Robert du Mesnil du Buisson, and a recent review by Haines and Fox, 2014. Kind co-operation of Miss Tissa Rahim in editing of this article is appreciated.

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