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International Journal of Forensic Sciences
ISSN: 2573-1734

Were Moses and Aaron the First Bioterrorists?

Bullock JD[1,2,3]*

[1]Forensic Scientist, Infectious Disease Epidemiologist, and Medical Historian, Fellow American Academy of Forensic Sciences, USA

[2]Fellow Infectious Diseases Society of America, Fellow American College of Epidemiology, USA

[3]Member, American Osler Society; Member, American Association for the History of Medicine, USA; Member, International Society for the History of Medicine

Research article

Volume 4 Issue 3

Received Date: July 24, 2019

Published Date: August 26, 2019

DOI: 10.23880/ijfsc-16000167

Presented to the Last Word Society at the 69th Annual Scientific Meeting of the American Academy of Forensic Sciences in New Orleans, LA on February 16, 2017 and to the 47th Annual Meeting of the American Osler Society in Atlanta, GA on April 12, 2017

***Corresponding author:** John D Bullock, MD, MPH, MSc, Winchester, MA, and Longboat Key, FL, USA. Tel: (937) 760-7205; Email: johndbullock@post.harvard.edu Fax: (413) 677-5614

Abstract

The exodus of the Israelite slaves from Egypt was a momentous event in religious history. The Pharaoh had refused to free them until a series of ten plagues occurred sometime between 1570-1550 BCE. During the fifth plague, death of livestock resulted and during the sixth, boils appeared upon humans and animals. Anthrax was the most likely cause of both plagues. The carcasses of the animals that died during the fifth plague were probably incinerated in a furnace with resultant ashes which would have contained countless heat- resistant anthrax spores. Exodus 9:8 says: “And the Lord said unto Moses and unto Aaron, ‘Take to you handfuls of ashes from the furnace, and let Moses sprinkle it toward the heaven in the sight of Pharaoh’”. Exodus 9:9 says: "And it (the anthrax contaminated ashes) shall become small dust in all the land of Egypt, and shall be a boil breaking forth with blains (sores) upon man, and upon beast, throughout all the land of Egypt". Cutaneous anthrax is a "boil-like" lesion that ruptures ("breaks forth") into an ulcer ("sore"), affecting humans and animals. Thus, Moses’ airborne release of anthrax spores was the proximate cause of the 6th plague of Egypt. This study suggests a novel interrelationship and transmission mechanism between these two sequential plagues. Chronologically, the next reported use of a bioweapon was in 1325 BCE when the Hittites used sheep infected with *Francisella tularensis* against the Phoenician city of Symra, occurring about 250 years after this first bioterrorism attack by Moses and Aaron.

Keywords: Male babies; Pharaoh; Nile River; Moses; Anthrax; Ten Plagues of Egypt

Introduction

As technical knowledge has increased, a number of Biblical events have been subjected to scientific scrutiny. These include, among others, the Star of Bethlehem [1,2] (now thought to be a conjunction of the planets Jupiter and Saturn), the Shroud of Turin [3-6], the Walls of Jericho [7,8] the blindness of Saint Paul [9], and even the physical death of Jesus Christ [10,11]. After the prediction by Egyptian astrologers that the liberator of the Children of Israel would be born on a certain day, the Pharaoh ordered the contemporaneous drowning of all male babies. To prevent his death, baby Moses was hidden in the bulrushes by his older sister and mother and was soon found along the Nile River bed and given to Pharaoh's childless daughter who brought him up as her own son [12]. Thus, the Pharaoh was Moses' adoptive grandfather. Moses was raised in luxury, but, as he grew older, he witnessed that the Egyptians abused their Israelite slaves and Moses began to sympathize with them. Later, because of this cruelty, Moses and his older brother, Aaron, visited the Pharaoh and in Exodus 9:1 said: "Let my people go…" but the Pharaoh refused.

Scholarly consensus considers Moses as a legendary, mythological, or folk memory figure in the manner of King Arthur, Robin Hood, or Hercules, and not as an historical person [13,14]. He is not mentioned in any independent texts, but only in the Old Testament, written somewhere around 500 to 600 BCE, about a millennium after he supposedly lived. In addition, there is no historical or archaeological evidence of Moses' existence. Most critical scholars and archaeologists today date the writing of the book of Exodus from around the time of the Babylonian exile (circa 586 BCE), and usually hold that the Exodus is an etiological story created by Jewish scribes during the Babylonian captivity to lend credibility and a sense of purpose to their plight[15]. It certainly has no basis, whatsoever, in history or fact.

In the Old Testament Book of Exodus, it is recorded that God helped the Children of Israel escape from their slavery in Egypt by inflicting ten plagues upon the ancient Egyptians before the Pharaoh would release them. Biblical and scientific scholars have been fascinated by these events and numerous theories have been proposed to account for them [16,17]. The 10 plagues of Egypt (dated by the Greek historian Herodotus to between 1570-1550 BCE) include: 1. Nile River water turning to "blood" (becoming red and foul); 2. Frogs swarming over the land; 3. Plague of mosquitoes and gnats; 4. Pestilence of flies; 5. Epizootic outbreak involving hoofed herbivores; 6. Zoonosis with boils and sores on humans and animals; 7. Hailstorms and lightning; 8. Pestilence of locusts; 9. Darkness; and 10. Death of the eldest sons and firstborn cattle (livestock).

This deadly chain of successive plagues has been considered by some authors as an interconnected cascading sequence of natural catastrophes (an "ecological domino effect") [17-22] beginning with one of three possible seminal events: 1. mid-second millennium BCE Minoan eruption on the island of Santorini in the Aegean Sea with the volcano ejecting enormous quantities of reddish/pink ash, rich in acidic sulfates, toxic to fish and other aquatic creatures; 2. a single and extraordinarily severe occurrence of the annual Nile flood by excessive rains on the Abyssinian Plateau with massive deposition of red silt in the river, rich in environmentally toxic iron oxide; and 3. an El Niño Southern Oscillation (ENSO) event which caused a Red Tide algal bloom in the Nile Delta.

Forensic Investigation

The purpose of this study was to investigate forensically the 5th and (transition to the) 6th plagues of Egypt by the application of contemporary scientific knowledge to this remote event, assuming that it is historically accurate and occurring exactly as written in the King James version of Exodus. Death of livestock (especially grazing herbivores) occurred in the fifth plague from an unnamed (most likely, infectious) disease and during the sixth plague, boils and sores appeared upon humans and animals (a cutaneous zoonosis). A number of conditions have been proposed to account for the 5th and 6th plagues and a variety of infectious/noninfectious diseases have been suggested [22]. Bacterial: cholera, glanders, bubonic plague, typhus, ehrlichiosis, and a mixed staphylococcal / streptococcal infection; Viral: African horse sickness, bluetongue disease, West Nile fever, Rift Valley fever, rinderpest, smallpox, and dengue; Parasitic: malaria, babesiosis, surra (*Trypanosoma brucei evansi* infection), and theileriosis (tick [*Hyalomma*]-borne disease caused by *Theileria annulata*; Miscellaneous noninfectious diseases: furuncular myiasis and acid rain burns.

For over a century, a number of authors have hypothesized that the fifth and sixth plagues were both due to anthrax, thought to be Apollo's "burning wind of plague" that begins Homer's *Iliad*. The 5th plague was most likely gastrointestinal anthrax infecting grazing herbivores, while the 6th was cutaneous anthrax involving humans and animals. These two plagues were previously considered to be independent and unrelated events [23-28]. The biblical description of the fifth

plagues is as follows. Exodus 9:3: "Behold, the hand of the Lord is upon thy cattle which is in the field, upon the horses, upon the asses, upon the camels, upon the oxen, and upon the sheep: there shall be a very grievous murrain (plague)." Exodus 9:6 reads: "And the Lord did that thing on the morrow, and all the cattle (livestock) of Egypt died…" Most warm-blooded animals, especially hoofed herbivores, are susceptible to anthrax [29]. The English word "anthracite" is derived from "anthrax," the Greek word for coal (ἄνθρᾰξ), because of the characteristic black skin lesions developed by victims of cutaneous anthrax infections. The Greeks also used the same word to denote a "carbuncle," meaning an inflamed boil on the skin.

To Bury or to Burn; That is the Question

Which method of disposal of the animal carcasses would the ancient Egyptian public health officials have recommended to Pharaoh: burial or burning? Because burying all the dead animals would have been extremely labor-intensive, burning the carcasses seems an easier alternative. Current scientific thinking testifies to the unreliability of burial for the carcasses of animals lethally infected with anthrax. A number of mechanisms effectively nullify the safety of this method of elimination by disturbance of the burial sites due to: ploughing; laying drainage; scavengers; digging by other animals such as dogs, foxes, or wolves; upward transportation by the activities of earthworms; and nesting sites for ants. In addition, even without disturbance of the site, anthrax spores can spontaneously rise up to the soil surface and disseminate. In view of these considerations, burial of anthrax infected animals should be dissuaded in favor of incineration [29-31].

Incineration

In consideration of the above, the carcasses of the Egyptian animals that died during the fifth plague were probably incinerated with resultant ashes. The blood of infected animals can contain as many as 10^{10} vegetative bacilli/ml which sporulate on exposure to free oxygen. Thus, the ashes would have contained countless viable anthrax spores [29].

The sixth plague is described in Exodus 9:8: "And the Lord said unto Moses and unto Aaron, 'Take to you handfuls of ashes of the furnace, and let Moses sprinkle it toward the heaven in the sight of Pharaoh". This is the exact wording of the verse from the King James Bible (KJB). In order to determine that the use of these words was not a translation or transcription error by the KJB, twenty-six other bibles were examined for their wording of Exodus 9:8 (Table 1). The alternative key words which convey the idea that "ashes" were to be found in a "furnace," suggest that the carcasses from plague number five were incinerated in some heated physical structure ("furnace") with resultant residual products of combustion ("ashes"). These words are tabulated in Table 2. All of the key words indicate: [1] a heat source and [2] residual post-incineration material. We see from Table 2 that these words are most likely not translation or transcription errors because they are all so similar: "furnace" is the most frequent word to describe the physical structure of the heat source while "soot" and "ashes" tie for the most frequent words describing the combustion product. Thus, Moses and Aaron collected the infectious anthrax spores mixed with the ashes from the dead carcasses of the animals which died during the fifth plague. Moses' airborne release of these anthrax spores is, therefore, the proximate cause of the sixth plague of Egypt. Exodus 9:9 states: "And it (the anthrax-contaminated ashes) shall become small dust in all the land of Egypt, and shall be a boil (abscess; ulcer) breaking forth with blains (pustules; blisters) upon man, and upon beast…"

Bible	Heat Source	Residual Post-Incineration Material
New International Version	Furnace	Soot
New Living Translation	Brick Kiln	Soot
English Standard Version	Kiln	Soot
Berean Study Bible	Furnace	Soot
New American Standard Bible	Kiln	Soot
Christian Standard Bible	Furnace	Soot
Contemporary English Version	Stove	Ashes
Good News Translation	Furnace	Ashes
Holman Christian Standard Bible	Furnace	Soot

International Standard Version	Kiln	Soot
Net Bible	Furnace	Soot
New Heart English Bible	Furnace	Ashes
God's Word® Translation	Kiln	Ashes
JPS Tanakh 1917	Furnace	Soot
New American Standard 1977	Kiln	Soot
Jubilee Bible 2000	Furnace	Soot
King James 2000 Bible	Furnace	Ashes
American King James Version	Furnace	Ashes
American Standard Version	Furnace	Ashes
Brenton Septuagint Translation	Furnace	Ashes
Douay-Rheims Bible	Chimney	Ashes
Darby Bible Translation	Furnace	Ashes
English Revised Version	Furnace	Ashes
Webster's Bible Translation	Furnace	Ashes
World English Bible	Furnace	Ashes
Young's Literal Translation	Furnace	Soot

Table 1: Biblical key word descriptions in Exodus 9:8 found in 26 different (Non-King James version) Bibles.

Heat Source	#	Residual Post-incineration Material	#
Furnace	18		
(Brick) Kiln	6	Soot	13
Stove	1		
Chimney	1	Ashes	13
TOTAL	26	TOTAL	26

Table 2: Tabulation of Key Words from Exodus 9:8 written in various versions of the Bible

Dissemination of Anthrax Spores

The spread of anthrax spores from the immediate vicinity of Pharaoh to "all the land of Egypt" could have been accomplished by the insects remaining from the earlier plagues. Mosquitoes from the 3rd plague (namely *Aedes aegypti* and *A. taeniorhynchus*) and flies from the 4th plague (both biting [*Hippobosca* and *Tabanus* species and *Stomoxys calcitrans*] and non-biting [blowflies: *Chrysoma albiceps* and *C. marginalis*; and houseflies: *Musca domestica* or the *Calliphoridae* species] have all been incriminated as vectors of anthrax. After the initial airborne release of the anthrax spores by Moses, these insects could then have spread the disease by various modes throughout Egypt [32-35]. (With the exception of the eye gnat which has been linked to the transmission of conjunctivitis in both humans and livestock, gnats [from the 3rd plague] are not known to be disease vectors [36]).

Cutaneous Anthrax

The hallmark of cutaneous anthrax is a painless cluster of boils (abscesses) that ulcerate. The Centers for Disease Control and Prevention (CDC) defines the signs/symptoms of cutaneous anthrax as: a painless skin sore (ulcer) appearing after the blisters. Cutaneous anthrax is usually described as a boil-like lesion that eventually forms a black ulcer, affecting humans and animals, closely matching the description found in Exodus 9:9. The mortality rate is approximately 20% for cutaneous anthrax without systemic antibiotic treatment [34-37]. The 5th and 6th plagues were due to the agency of God while the sixth was facilitated by Moses and Aaron and was meant to frighten the Pharaoh into agreeing to release the Israelite slaves.

Virgil

In the Third Book of his *Georgics*, Virgil (70 BCE-19 BCE) described the difficulty of eliminating anthrax by burning [38]. "For neither might the hides be used, nor could one cleanse the flesh by water or master it by **fire**. They could not even sheer the fleeces, eaten up with sores and filth, nor touch the rotten web. Nay, if any man donned the loathsome garb, feverish blisters and foul

sweat would run along his fetid limbs, and not long had he to wait ere the accursed fire was feeding on his stricken limbs...For, useless to the currier were their hides: Nor cou'd their tainted flesh with ocean tides be freed from filth; nor cou'd **Vuncanian flame** the stench abolish."

Winston Churchill and Gruinard Island

During WWII, Operation *Sea Lion* was Nazi Germany's proposed plan to invade the U.K. In 1942, because Churchill so greatly feared this scenario, the British military planned a retaliatory "doomsday" strike [39, 40]. In the event of an invasion, Churchill would have ordered the development of tens of thousands of anthrax bombs to be dropped over every city and town in Germany. These anthrax bombs would have devastated Germany's population and economy, rendering the country virtually uninhabitable because prior to 1942, no effective antimicrobial therapy had been available in Germany for the treatment of anthrax. Consequently, British scientists from Porton Down's Laboratory of Science and Technology developed and then tested a small anthrax (containing the *Vollum* 14578 strain) bomb on Gruinard Island, a small oval-shaped isle in the Hebrides, off the northwest coast of Scotland [40-42]. Eighty sheep were taken to the island and caged. Anthrax bombs were detonated and all of the sheep died of anthrax infections within a week. The project was stopped after an anthrax outbreak in cattle and sheep occurred on the Scottish coast that directly faced Gruinard Island. This 484 acre (196 hectare) island (approximately 0.0000055 the size of Germany) was still contaminated with anthrax spores until 1986, when tons of top soil were removed, incinerated, and replaced. Because the nearly indestructible, highly heat-resistant spores persisted, 280 tons of formaldehyde mixed with sea water (and saturated to a depth of 6 inches) was needed to complete the clean-up, thus confirming Virgil's observations about the ineffectiveness of "fire" and "Vulcanian flame" in eliminating anthrax. It took four years to decontaminate the island which was eventually declared "safe" in 1990 and resold to the original owners for the original purchase price of 500£. In 1997 the history of the project was declassified for the first time.

Mortality and Economic Estimates of Theoretical and Actual Anthrax Attacks

A 1993 report by the US Congressional Office of Technology Assessment estimated that between 130,000 and 3 million deaths could follow the aerosolized release of 100 kg of anthrax spores upwind of the Washington, DC, area, with lethality matching or exceeding that of a hydrogen bomb [43].

Following the 2001 U.S. attacks of the postal system by the anthrax letters, the estimate to decontaminate all the postal facilities, other governmental properties, and corporate offices (42 total buildings) was $320M - ~$1B from only 7 letters. Three thousand tons of contaminated waste was produced and remediation efforts took years. The cost associated with a real or perceived attack using anthrax spores has been estimated to be >$26 billion per 100,000 persons exposed [44-48].

Recent Studies Regarding the Stability and Lethality of Anthrax Spores

Modern bacteriological studies have demonstrated the renowned capability of anthrax spores to remain viable for very long periods of time, even in extraordinarily harsh environments including extremes of temperature, pressure, pH, ionizing radiation, and UV light [49,50]. Anthrax spores which had been prepared in 1888 by Louis Pasteur himself were still noted to be viable for at least 68 years, while samples of anthrax from bones retrieved during archaeological excavations of past sites from the Kruger National Park in South Africa were estimated by carbon dating to be 200±50 years old [50]. Indeed, "armor plated" spores (composed of the protein poly-gamma-D-glutamic acid) of the *Bacillus* genus are known to have an approximate half-life of about 100 years [51], which means that 6.25% of them will theoretically survive for at least 400 years [52]. The recent Amerithrax Investigation showed that one millionth of a gram of anthrax spores is invariably fatal (i.e., LD100). Between 100 billion and one trillion spores per gram were noted in the post office powder meaning that between 100,000 and 1 million spores are invariably fatal. However, the LD50 was estimated to be only 4,100-10,000 spores.

Incineration Studies

Scientific studies of animal carcasses at incineration sites revealed that: 1. anthrax spores may survive fire; 2. *Bacillus* species have been noted to survive incinerator temperatures of 800-1000°C; 3. a badly constructed pyre producing smoke might result in a higher survival rate of organisms; and 4. the spores are usually confined to where blood has been shed through the body orifices (mouth, nose, and anus) and will most likely be in the soil beneath these points [53].

Definitions of Terrorism, Bioterrorism, and Religious Terrorism

The United States government has defined terrorism under the Federal Criminal Code (Title 18 §2331 of the

United States Code) as: "…activities that involve violent… or life-threatening acts… that are a violation of the criminal laws of the United States or of any State and… appear to be intended (i) to intimidate or coerce a civilian population; (ii) to influence the policy of a government by intimidation or coercion; or (iii) to affect the conduct of a government by mass destruction, assassination, or kidnapping" [54,55]. The Patriot Act of 2001 states that terrorist activities include… any crime committed with "the use of any weapon or dangerous device," when the intent of the crime is determined to be the endangerment of public safety or substantial property damage rather than for "mere personal monetary gain" [55]. The United States Department of Defense defines terrorism as "the unlawful use of violence or threat of violence to instill fear and coerce governments or societies. Within this definition, there are three key elements - violence, fear, and intimidation - and each element produces terror in its victims [56]. The FBI uses the following definition: "Terrorism is the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives" [55]. The U.S. Army's definition of terrorism is the "calculated use of unlawful violence or threat of unlawful violence to inculcate fear. It is intended to coerce or intimidate governments or societies ... [to attain] political, religious, or ideological goals" [55]. The U.S. Department of State defines terrorism to be "premeditated politically-motivated violence perpetrated against non-combatant targets by subnational groups or clandestine agents, usually intended to influence an audience" [57].

The CDC's definition of a biological attack or bioterrorism is: "the intentional release of viruses, bacteria, or other germs that can sicken or kill people, livestock, or crops" [58]. The Department of Homeland Security defines a biological attack as "the intentional release of a pathogen (disease causing agent) or biotoxin (poisonous substance produced by a living organism) against humans, plants, or animals." An attack against people could be used to cause illness, death, fear, societal disruption, and economic damage. An attack on agricultural plants and animals would primarily cause economic damage, loss of confidence in the food supply, and possible loss of life [59].

Religious terrorism is terrorism carried out based on motivations and goals that have a predominantly religious character or influence [60,61]. The National Defense University in Washington, DC states that religious terrorism "…involves violence that is committed with the stated aim of fulfilling a divinely commanded purpose or that is argued to be sanctioned or demanded by religious belief."

History of Bioterrorism

Most sources cite the Assyrians as the originators of bioterrorism (biowarfare) when, in ~600 BCE, they poisoned the wells of their enemies with rye ergot, a fungus (*Claviceps purpurea*) that produces ergotamine, an alkaloid similar to LSD [62]. Ergot poisoning causes nausea, vomiting, diarrhea, delusions, psychosis, and cardiovascular dysfunction that can lead to death. Others note that, at about the same time, Solon of Athens, during his siege of Kirrha (a village in central Greece), is said to have used hellebore roots (*Helleborus niger*, also known as Christmas Rose) to poison the water in a conduit leading into that city. In addition to violent and uncontrollable diarrhea, this purgative toxin (protoanemonin) caused nausea, vomiting, dizziness, spasms, acute hepatitis, jaundice, and paralysis, thus facilitating a quick victory by the Athenians [63].

More recently (December, 2007), however, *Francisella tularensis* (the causative organism of tularemia) was thought to have been used as a biowarfare agent by the Hittites of Anatolia, whose empire stretched from northern Turkey into Iraq and Syria. It was hypothesized that the Hittites first used sheep infected with tularemia in their 1325 BCE defeat of the Phoenician city of Symra. They left the infected sheep outside of the city; the inhabitants would then eat and breed them, thus spreading this severe respiratory, cutaneous, ocular, and oropharyngeal disease [64,65].

Conclusions

This study agrees that anthrax was the most probable cause of the fifth and sixth plagues of Egypt, and suggests a novel interrelationship and transmission mechanism between these two contingent plague events. Burning the animal carcasses resulting from the 5th plague provided the organisms (heat-resistant anthrax spores) for the sixth plague. Obeying the Lord's instructions, Moses and Aaron knowingly and intentionally gathered the ashes in Exodus 9:8 which caused sores upon man and beast, now recognized as a cutaneous zoonosis with an untreated 20% mortality rate in humans. Therefore, Moses (assisted by Aaron [making him an accessory before the fact]) deliberately disseminated this pathogenic dust in front of the Pharaoh, which was subsequently spread by various insects "throughout all the land of Egypt."

As stated previously, the Greek historian Herodotus dated the Ten Plagues of Egypt to between 1570-1550 BCE. The Assyrians and Athenians had used water-borne organisms and botanical toxins against their enemies in about 600 BCE and the Hittites reportedly used *Francisella tularensis* in 1325 BCE. This would give an interval of at least 245 years between the Moses-Aaron attack and that by the Hittites. Thus, this airborne release of pathogenic anthrax spores, by definition, makes Moses and his brother/accomplice Aaron, if real people, co-conspirators who were the first individuals by about 250 years to perpetrate bioterrorism.

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