

Titus' Plague, Hypotheses on its Origin and Causes: A Consilience Study

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“quem non fors ignara dedit” [1]

Abstract

In the period between the years 77 and 81 CE, during the Principate of Titus, some catastrophic events occurred in the Roman Empire. Sources report: the eruption of Vesuvius, 79 CE, a devastating fire in the city of Rome, which alone caused the destruction of a large part of sacred and public buildings, and an epidemic, best known as the Titus' plague. This would have occurred between the year 77 and the year 80 CE, perhaps over a period including more than a year. It is not entirely clear whether it was limited to the territory of the city of Rome or spread to other regions.

Cassius Dio [2], Suetonius [3] and Jerome [4,5] and Baronius [6] placed the origin of the epidemic in the city of Rome.

The relevance of the epidemic may have been very large, with a mortality rate of over 10,000 units per day [3-5]. This research investigated the causes of the epidemic, exploiting the philological analysis of the sources and by inferential statistics. Based on the information obtained from the sources, the identikit of the disease that could have been responsible for the epidemic was created. The information reported in the sources were considered as independent variables and some possible diseases as dependent variables, in a multiple regression test. Results show the influenza virus group as the most probable candidate for the genesis of the epidemic episode, with a test significance of $F 7.6$; $P < .002$. The historical news reported in the sources, with reference to the massive importation, killing and consumption of an impressive number of wild animals, including cranes, on the inauguration of the Flavian amphitheater (Colosseum), which took place in the year 80, also suggest the possible emergence of a lineage of H5N1 virus, commonly named avian flu, as a very likely etiological agent of the Titus' plague, with an even greater statistical significance: $F 23.33$; $P < .001$.

Keywords: Pandemic; Epidemics; Roman History; Titus; Plague; Virus; Influenza; H5N1; Avian Flu; Emerging Diseases; Consilience

Introduction

There is a mutual connection between human-created ecologies and the history of emerging infectious diseases. The relationships between the environment and the human society

were – vice versa – often mediated by epidemic. Complex systems, and the Roman Empire can be assimilated to this model, have intrinsic possibilities of absorbing solicitations and stress, re-adapting and reorganizing themselves: in the



case of the Roman Empire, this really happened, and it kept happening for at least six centuries. However, the interactions between the power of the empire and the environmental aggression acted to detriment of political and social identity of the empire: they undermined its economic and demographic structure.

This research aims to investigate the probable origin and causes of the pandemic which, according to sources [2-6], occurred during the reign of Tito, the Titus' plague. A summary and historical contextualization of the events of that age follows.

The Historical Scenario

Titus Flavius Caesar Vespasianus Augustus, (in the epigraphs Titus Caesar Vespasianus Augustus, Pontifex Maximus, Tribunicia Potestas CIL XVI, 24), Roman Emperor, Vespasian's eldest son, succeeded his father, who had died on June 24th 79: simply known as Titus, he was the tenth Roman emperor, belonging to the Flavian dynasty (Suetonius, Duod. Caes. Vit., Titus, I-XI. [3]). The tradition available on this period is poor, generic, and repetitive, with frequent clichés, often attributable to the biography in Suetonius [3].

Titus' principate was short – two years and eight days, from 79 to 81 CE (Cassius Dio, Historia Romana LXVI, 26.4. [2]) – but it is worth noting that he already had played a leading role during his father's rule. His work was positively judged by his contemporaries, both for the collaboration he established with the Senate and for the favor enjoyed among neo-Stoic philosophers. The sentence with which the biography of Suetonius opens - «Amor ac deliciae generis humani» [3] appears propaganda, and the official apologetics, aiming to oppose Tito to predecessors belonging to the gens Julius-Claudia, confound, in a way that is difficult to reconstruct, the chronology [7-9].

The celebratory intention was intended to cast a negative light on the two predecessors, Gaius and Nero, openly supporters of unpopular oriental setting of the monarchy, and to advantage the principality of Vespasian and his successor. Tito's personality was fully manifested during the Jewish War (66-71), with aftermath up to 73 CE. The propaganda machine was working to bring Titus alongside his father, through triumphs, oracles, sacred celebrations, and repeated cones of coins: this latter method allowed the message to be

widened up to remote corners of the Empire. Any victory achieved, the spoils of war and the peace achieved, were repeatedly represented, and accompanied by huge human displacements, due to deportation and transmigration, as well as by massive imports of wild animals of all kinds, destined for shows, hunting, and not infrequently, eventually intended for food consumption. These customs played a non-negligible role in the spread of many diseases [10].

Modern and contemporary historians largely conformed to the apologetic tradition and Titus' good reputation has remained intact over the years, so much so he was chosen as a model of the "Five Good Emperors" of the 2nd Century:

Nerva, Trajan, Hadrian, Antoninus Pius and Marcus Aurelius [11,12].

Historians agree in affirming that the principality of Tito was marked by some natural calamities, at the time also attributed to supernatural causes and heralded by prodigies, such as the appearance of comets^a, which hit Rome and the empire [13].

1. In the year 79 CE the cities of Herculaneum, Stabiae and Pompeii were destroyed by the eruption of Vesuvius and a geo-seismic catastrophe.
2. A serious plague struck Rome and large territories of the Empire, but its epidemiological characteristics are not known to us, its precise dating appears uncertain and can be placed between the years 77 and 81 CE.
3. In the year 80 CE a fire devastated several districts of Rome, including the Capitoline Hill. Tito drew on his personal treasury to provide aid to affected populations.

The years of the principality of Titus are summarized with a very effective synthesis by Piganiol, in the Histoire de Rome: "Titus (79-81) Son règne très court ne fut marqué que par des catastrophes, une peste, un incendie de Rome, l'éruption de Vésuvie (24 aout 79) [14].

The celebration of hunting shows and gladiatorial games, 80 CE, on the dedication of the Flavian Amphitheater, or Colosseum (Suet. Tit. 7,3) [3], attracts the greatest attention. For the occasion, 5,000-10,000 wild animals, of all kinds, were imported from all over the empire.

According to Cassius Dio in the games were involved and fought cranes and elephants, killing each other, while the total balance of dead animals amounted to 9,000. Gladiators and extras of both sexes took part in the hunts, fights, and shows,

Which lasted for a hundred days, on land and in the water, for a number of over 3,000. The Roman people were actively involved in banquets, lotteries and competitions of all kinds. (Cass. Dio. LXVI, 25; Mart. De Spectaculis)

[3,15].

Tito died suddenly in 81, at the age of forty-two, due to an unspecified morbid condition. He fell ill and died in a villa he owned, in Aquae Cutiliae, on 13th September 81.

Sources [2,3] tell of a high fever, according to Suetonius malarial, contracted while assisting sick fellows [3], or poisoned by his personal physician, Valenus, on the orders of

his brother Domitian. The Talmud, whose text portrays him with a presumptuous and cruel character, also narrates the origin of his illness and its epilogue.

Upon his death, Titus was deified by the Senate, and a triumphal arch (Fig.1, 2) depicting his apotheosis was erected in the Roman Forum^b (Fig. 3) by Domitian himself to celebrate his military exploits in Judea. Titus was first buried in the Mausoleum of Augustus and later in the Temple of the Gens Flavia, the family mausoleum. In the Roman Forum his "genius" was glorified together with that of his father in the temple of Vespasian.



Fig 1. The Arch of Titus. The photo shows the upper part of the Arch, from the east side. The dedication inscription can be read on the pediment. (By: The Photographer - Opera propria, CC BY-SA 4.0)



Fig 2. Detail from a plate portraying Rome's palaces and ruins and even reconstruction of ancient buildings in Rome. The second states of these etchings were collected in the publication by Peter Schenck (1660-1711): 'Roma aeterna, sive ipsius aedificiorum Romanorum, integrorum collapsorumque, conspectus duplex.' In the 'Aedificiorum Index': '16. Arcus Imperatoris Titi Vespasiani', view on the Arch of Vespasianus. Inscribed on the bottom in Latin: 'ARCUS Imperatoris TITI VESPASIANI Temporis hostiumque favite foede mutilatus.' (Detail from "Enciclopedia di Roma" [16]. For the history of the Arch see the note b, in the text.



Fig 3. The Roman Arch of Titus, in the Forum. The picture shows the Arch of Titus in the center of the Roman Forum. The Flavian Amphitheater (Colosseum) is in the background. (Alexander Z. - Opera propria, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=53829>)

Epidemics in the Roman world

All the descriptions of the Titus' plague we have, reported between the year 77 and the year 80, come from later sources. Epidemics were neglected in the ancient works of theoretical medicine, since the writers had no knowledge of micro-organisms and poor confidence with hygiene, so the interpretation of sources is controversial. The oldest documented description of a plague in Roman history is reported by T. Livius: "Inde L. Genucio et Q. Seruilio consulibus et ab seditione et a bello quietis rebus, ne quando a metu ac periculis uacarent, pestilentia ingens orta." (Liv. VII,1-2) [17]. Livy wrote in the 1st century CE about events that took place in 364 BCE and, from the short description he provides, pervaded by fatalism, useful clues cannot be obtained to trace an etiological cause of the disease: the approach of Roman historians did not change in the following centuries.

The Titus' plague, seen in the light of current knowledge, seems to realize a sign of the effects that multiple social and environmental factors can exert on a geopolitical and climatic system hitherto favored and rich in resources, but intimately fragile [10,18]. The Roman Empire inherited from previous centuries an extreme vulnerability to diseases, which represented the first cause of death: typhoid, malaria, tuberculosis and numerous parasitosis had always been endemic, together with countless other infections, favored by the concentration and by demographic shifts, from malnutrition and lack of hygiene. In such an endemic scenario, which also could include diseases now disappeared [18], the spill over and the spread of emerging infections

found first rate conditions. Geological catastrophes, such as earthquakes, floods, or volcanic eruptions, fit into the big picture of a religious fatalistic approach, tended to reconcile everything.

The citation of events considered supernatural and impressive, such as the appearance of a comet, recurs in the narratives, as explanation or omen of facts due to inscrutable divine powers.

The historical documentation has privileged, during the short reign of Titus, the eruption of Vesuvius, which occurred in 79 CE. The sources we have also mention the epidemic, which developed in the following year or had begun in previous years, but they are not similarly detailed.

Some authors [2,3] hypothesized a causal relationship between the volcanic eruption and the epidemic itself. However, due to obvious limitations, ancient historians could not provide any element to support a possible link between a geophysical event and an epidemic: indirect information can only be extracted through linguistic and philological analysis. According to some authors [10,18,19] some decisive turning points led the Roman Empire to its decay, through a process begun with the pandemic occurred during the reign of Marcus Aurelius (161-180 CE). The Titus' plague places the hands of the historical epidemiological clock in a more remote period. A text by N. Webster (18th century) [20] follows and provides an extra documentation to support the historical scenario rebuilt so far, also underlining the arguments, sometimes fanciful, on a cause-effect relationship between some natural phenomena.

"The next pestilential period is one of the most remarkable in



all the circumstances, that is recorded in History. In the year 79 [some authors say a year later, but the difference is of no moment, as they agree in the order of the events related] just before the death of Vespasian, appeared a comet with a long coma in the month of June. On the first of November following, a most tremendous ebullition of fire and lava issued from Vesuvius and laid waste the neighboring country. At the same time, happened a violent earthquake, which buried the cities of Herculaneum and Pompeium; and so sudden was the shock, that the people, who were attending a play, had not time to quit the theater, and were all buried in a mass. This dreadful catastrophe was preceded by rumbling noises in the earth, and the earth was heated to a great degree. Violent agitations of the sea, thunder and lightning also announced the approach of some dreadful event. The eruption lasted three days, during which time such immense quantities of ashes and smoke were discharged, that day was turned into night, and the ashes were driven by different winds to Rome, Syria and Africa. The agitations of the earth and the elements were tremendous and frightful. Baronius remarks, that some persons supposed the world would be reduced to chaos or consumed with fire. The fish in the neighboring seas were destroyed. This explosion of subterranean fire was preceded by a severe drouth in Italy. The next year, 80, was remarkable for a terrible inundation in England; the Severn overflowing a large tract of country and destroying multitudes of cattle. These violent effects of subterranean fire were attended by one of the most fatal plagues recorded in history. A remark of Dion is here very important. He says that the "Ashes from Vesuvius caused, at the time, only slight indispositions or diseases; but afterwards produced an Epidemic distemper," The remark is incorrect, in ascribing even slight diseases to ashes; but it leads to a conclusion, which is of moment. The slight complaints which prevailed in the autumn of the year of the eruption, compared with modern observations, appear to have been the precursors of the plague, which broke out the next year, and as authors assert, destroyed, for some time, 10,000 citizens of Rome in a day. The same year, while the Emperor Titus was viewing the ruins in Campania, a fire broke out in the city, which laid in ashes a great number of buildings. The order of the events in this period was, a comet, drouth, slight diseases, and an eruption of Vesuvius, with the

earthquakes, the first year. In the second, appeared the pestilence with its most malignant effects. In this eruption of Vesuvius, the first recorded in history, perished the elder Pliny; and the Emperor Titus fell a victim to his paternal care of his subjects. Suetonius, 23. Aurel. Victor. Epit. Dion Cassius. Pliny Epis. Baronius An. vol. 1. 713. Magd. lib. 2. 14. In the year 90 appeared a comet. The plague is said to have appeared in the north of England in 88, and in 92, to have destroyed 150,000 lives in Scotland. Short, vol. 2. 207. In 102 a plague is said to have arisen from dead fish driven on shore, but I have no other particulars. In the year 107 four cities of Asia, two in Greece and three in Galatia, were overwhelmed by an earthquake." ("A brief history of epidemic and pestilential diseases; with the principal phenomena of the physical world, which precede and accompany them, and observations deduced from the facts stated.: In two volumes." / By Noah Webster. Vol. I[-II]. Webster, Noah, 1758-1843).

Methods - Part one

Introduction to authors and text analysis of sources

In the first part of this study seven classical records related to or consistent with the event – the Titus' plague - are analyzed, compared and commented. Their key paragraphs are examined to find consistent and exploitable information on the epidemics. The analytical philological comparison between the texts of Pliny the Elder, Pliny the Young, Suetonius, Cassius Dio, Jerome, Rutilius Namatianus and Baronius has been performed.

The seven compared sources follow and are summarized in **Tab. 1**, including their publication year and reference.

- A. Pliny the Elder, The Natural History, Books 1-11. [13]
- B. Pliny the Young, Epistulae, XVI-XX. [21]
- C. Caius Suetonius Tranquillus, De Vita Duodecim Caesarium, libri VIII, IV 1, 23, 1. [3]
- D. Cassius Dio Cocceianus, Historia Romana - Ἱστορία LVI, 23, 5. [2]
- E. Jerome, Chronicle (Chronicon Temporum liber), AD 78. [4,5]
- F. Rutilus Namatianus, De Reditu Suo, 1, 395. [22,23]
- G. Baronius, Annales, vol. 1, 703. [6]



Tab 1: Sources reviewed for text philological analysis (“Source”: author and title of the cited work, in the first column) and age of publication (“Age”, in the second column), references are in square brackets and their numeration follow the text.

Source	Age
Pliny the Elder, <i>The Natural History</i> , Books I-II. [13]	79 CE
Pliny the Young, <i>Epistulae</i> , XVI-XX. [21]	107 CE
Svetonius, <i>De Vita XII Caesarum</i> , VIII, 8; 10,11. X, 13 [3]	121 CE
Cassius Dio, <i>Roman History</i> LXVI, 23-5. [2]	320 CE
Jerome, <i>Chronicon (Temporum liber)</i> , AD 78. [4,5]	380 CE
Rutilus Namatianus, <i>De Reditu Suo</i> , 1, 395. [22,23]	415 CE
Baronius, <i>Annales</i> , vol. 1, 703. [6]	1588 CE

A. Pliny the Elder, *The Natural History*, Books I-II

The author. Gaius Plinius Secundus (CE 23/24 – 79), called Pliny the Elder, was an author, a military officer, natural philosopher, and a friend of the emperor Vespasian. He wrote the encyclopedic *Naturalis Historia* (*Natural History*) [13], which became an editorial model for encyclopedias. He spent most of his spare time studying, writing, and investigating natural and geographic phenomena in the field. Pliny the Elder, according to Pliny’s the Young *Epistula XVI* [21], perished on Aug 24th 79, in Stabiae, while attempting a rescue mission to save from the eruption some citizens doomed on and near the Mount Vesuvius’ flanks and lingering on the mountain, “magnum propiusque noscendum, ut eruditissimo viro, visum” – (to observe the phenomenon more closely, as was fitting for a person of his erudition) (*Ep. XVI, 7. [21]*).

The text. *Nat. His.* 2.22.1 “... these are a very terrible portent. To this class belongs the comet about which Titus Imperator Caesar in his 5th consulship wrote an account in his famous poem, that being its latest appearance down to the present day. ... 2.23.1 ... Aristotle also records that several may be seen at the same time - a fact not observed by anyone else, as far as I am aware — and that this signifies severe winds or heat. Comets also occur in the winter months and at the south pole, but comets in the south have no rays.” (Pliny the Elder, *The Natural History*, Books 1-11, translated by Henry T. Riley (1816-1878) and John Bostock (1773-1846), first published 1855, text from the Perseus Project, licensed under a Creative Commons Attribution-Share-Alike 3.0 U.S. License. <https://topostext.org/work/148>) [13]

Analysis and comment

In Pliny's text there are no direct and explicit references to the Titus' plague. Considering both his relationships of acquaintance and friendship with the emperor, and his meticulousness in noting and describing all sorts of natural events, the most probable explanation is that the disease had not yet spread during the period in which the reported text was written. This suggests useful indications for the chronological collocation, in support of the dating that places the epidemic, at least in its most conspicuous manifestations, after the year 78 CE. The passage welcomes and reaffirms the cultural tradition that indicates the appearance of comets as a premonitory sign of fatal events. The link between the apparition and unfavorable climatic phenomena (heat waves, strong winds and the winter months) reveals an ancient awareness of a relationship between the climate and human activities, even if cloaked in fatalism.

B. Pliny the Young, *The Natural History*, *Epistulae XVI-XX*

The author. Gaius Plinius Caecilius Secundus, born Gaius Caecilius or Gaius Caecilius Cilo (61 – c. 113), better known as

Pliny the Younger, was a public officer, magistrate, author and friend of the emperor Traian. Pliny's uncle, Pliny the Elder, helped raise and educate him. Pliny the Younger wrote many letters, addressed to reigning emperors or to notables such as the historian Tacitus or the philosopher Artemidorus. Around 250 of these letters survive and since Pliny served as an imperial magistrate under Trajan (98–117) and cooperated with Suetonius, their content is regarded as an excellent



record about the Imperial office and government.

The Latin text. Ep. XVI, 18-20 “18. ibi super abiectum linteum recubanssemel atque igitur frigidarum poposcit hausitque. Deinde flammae flammarumque praesuntius odor sulphuris alios in fugam vertunt, excitant illum. 19. Innitens servorum duobus adsurrexitet statim concidit, ut ego colligo, crassiore caligine spiritu obstructo clausoque stomacho, qui illi natura invalidus et angustus et frequenter interaestuans erat. 20. Ubi die redditus (is ab eo quem novissime viderat tertius), corpus inventum integrum, inlaesum opertumque, ut fuerat indutus: habitus corporis quiescenti quam defunto similior.” [21].

English text. “There, resting on a spread sheet, he asked and requested fresh water and drank it greedily. Then the flames, and the smell of sulfur that preceded them, put some to flight but urged my uncle. He, supported by two slaves, rose to his feet but, immediately soon, fell back since, I suppose, the air, thickened with ash, had obstructed his breathing, and blocked his throat, which was already delicate and narrow, by nature, and frequently inflamed.” (Translated by the author. [24]).

Analysis and comment

The text is taken from the Epistle XVI [21,] sent by Pliny the Younger to Tacitus, in response to his request to inform him about the death of his uncle Pliny the Elder. The fame of the passage comes from the description of the eruption of Vesuvius and its famous narration stops at paragraph 20 and resumes in Epistula XX [25]. There is no direct reference to the epidemic. Symptoms that precede the death of the ancient naturalist are related to the volcanic eruption: his suffocation, which occurred by breathing a mixture of air mixed with ash and toxic and irritating gases, is described. The appearance of Pliny's body does not show signs: he looks like a resting man. This detail suggests a death occurred in absence of consciousness, as due to a poisoning, i.e., from CO₂, and cardiac arrest.

All the signs and symptoms can be traced back to the catastrophic mishap in which the elderly naturalist stumbled. It should be noted that, even in the culture of the time, the identification of disease predisposing factors or organic frailties: Pliny had delicate respiratory tracts often affected by inflammation.

At the same time, the passage "crassiore caligine spiritu obstructo clausoque stomacho" ought to be underlined: in it a harmful action and a precise pathogenetic role are attributed to the ash. In later authors this report will become a source of etiological link between the ash and the appearance of a disease. See to the etymological and philological analysis of the Greek term τέφρα (ash), used by Cassius Dio, which is discussed below.

Svetonius: De Vita XII Caesarum, VIII, 8; 10,11. X, 13

The author. Gaius Suetonius Tranquillus (69/70 - 122), Suetonius below, is a scholar, biographer, and historian, but also a rhetorician and grammarian. His authority derives from the possibility of easily accessing even confidential sources, as he was Prefect of the Praetorium of the emperor Hadrian, holding the office of secretary for him: procurator a studiis and ab epistulis, or superintendent of the archives and curator of imperial correspondence. By virtue of his office, he had access to the most important documents of the imperial archives, an opportunity that he probably enjoyed also under Trajan. To the latter he had in fact been recommended by Pliny the Younger, a mutual friend. In his studies and books, he drew inspiration from the models of Antiquaria, through the works of Varro, delighting in the biographical genre.

The Lives of the Caesars [3], the work from which the quoted passage comes, composed between the years 115 and 120, belongs to the period in which the author was employed and well regarded at the court of the emperor Hadrian.

The style, unscrupulous and detached, reviews the documents of the period, revealing even the scandalous and decadent aspects of the Empire in a ruthless way [26].

The facts, as handed down in Suetonius [3], are reported in the following passages (A and B), both in the original Latin text and in English.

The Latin text, A. “Quaedam sub eo fortuita ac tristitia acciderunt, ut conflagratio Vesevi montis in Campania, et incendium Romae per triduum totidemque noctes, item pestilentia quanta non timere alias. In iis tot adversis ac talibus non modo principis sollicitudinem sed et parentis affectum unicum praestitit, nunc consolando per edicta, nunc opitulando quatenus suppeteret facultas. Curatores restituendae Campaniae consularium numero sorte duxit; bona oppressorum in Vesevo, quorum heredes non exstabant,



restitutioni afflictarum civitatum attribuit. Vbis incendio nihil nisi sibi publice perisse testatus, cuncta praetorium suorum ornamenta operibus ac templis destinavit praeposuitque complures ex equestri ordine, quo quaeque maturius pararentur. Medendae valitudini leniendisque morbis nullam diuinam humanamque opem non adhibuit, inquisito omni sacrificiorum remediorumque genere.” (Suetoni Tranquillii Vita Divi Titi, VIII) [3].

The Latin text, B. “ Spectaculis absolutis...Sabinos petit aliquanto tristior, quod sacrificanti hostia aufugerat quodque tempestate serena tonuerat. Deinde ad primam statim mansionem febrim nactus, cum inde lectica transferretur, suspexisse dicitur dimotis pallutis caelum, multumque conquestus “eripi sibi uitam immerenti; neque enim extare ullum suum factum paenitendum excepto dum taxat uno.” (Suetoni Tranquillii Vita Divi Titi, X. [3,27]).

English text, A. “There happened in his reign some dreadful accidents; an eruption of mount Vesuvius, in Campania, and a fire in Rome, which continued three days and three nights; besides a plague, such as was scarcely ever known before. Amidst these many great disasters, he not only manifested the concern which might be expected from a prince, but even the affection of a father, for his people; one while comforting them by his proclamations, and another while relieving them to the utmost of his power. He chose by lot, from among the men of consular rank, commissioners for repairing the losses in Campania. The estates of those who had perished by the eruption of Vesuvius, and who had left no heirs, he applied to the repair of the ruined cities. With regard to the public buildings destroyed by fire in the City, he declared that nobody should be a loser but himself. Accordingly, he applied all the ornaments of his palaces to the decoration of the temples, and purposes of public utility, and appointed several men of the equestrian order to superintend the work. For the relief of the people during the plague, he employed, in the way of sacrifice and medicine, all means both human and divine.” [28].

(Suetonius: The Lives of the Twelve Caesars; An English Translation, Augmented with the Biographies of Contemporary Statesmen, Orators, Poets, and Other Associates. Suetonius. Publishing Editor. J. Eugene Reed. Alexander Thomson. Philadelphia. Gebbie & Co. 1889).

English text, B. After a show... he left for Sabina. He was very sad because the victim escaped him during the sacrifice and because it had thundered out of the blue. On the first stage he was struck by fever and then, as he continued the journey in a litter^c, it is told that he slightly opened the curtains and, looking at the sky, he bitterly complained about the fact that "his life was taken while he was innocent and he has not repented for any of his deeds, but for one." (Transl. by the author. [24]).

Analysis and comment

The two passages come from the Vita Divi Titi, VIII & X [3,27,28].

The first (VIII) refers to the catastrophic events that marked the reign of Titus. The epidemic is openly mentioned: “item pestilentia quanta non timere alias”. The plague is chronologically placed after the eruption of Vesuvius and the fire of sacred buildings in Rome, therefore around years 78-79. The Roman narrative annalistic style followed a strict chronological order then the reported episode, missing of a precisely stated date, should be placed after the eruption and the fires. However, there is no direct reference to the duration of the plague: since, as said, Suetonius drew on official historical sources, these presumably registered the fact without indicating a beginning and ending date. The documentation was obviously not oriented to look for an index case or deal with the epidemic evolution: no knowledge to do it. It was a very large epidemic, so it was estimated unprecedented.

The second excerpt (X) narrates the episode of Titus' death. The emperor is seized by a sudden fever, soon after a public engagement. He is on his way to Sabina. He realizes he is about to die. The hypothesis that he had been exposed to contagion with a disease characterized by a sudden and severe fever and with an inauspicious course is not documented, but it is highly plausible if we the reaction and the words of Titus, who warned of his imminent end are considered.

D. Cassius Dio Cocceianus. Historia Romana - 'Ρωμαϊκή ιστορία LVI, 23, 5

The author. Cassius Dio Cocceianus of Nicaea (Bithinia), (155 -235), became consul under Commodus and, a second time, under Alexander Severus. He wrote a Roman History from the beginning to 229, based on republican annalistic



tradition of Livy's sources, imperial annalistic tradition and, for contemporary events, his own experience. The narration is concentrated on facts, giving a rhetorical narrative in Atticist style. In accordance with this stylistic choice and with his ideal model, represented by Thucydides, Dio avoids expressing personal any judgment or comment. The criterion for choosing the truth relies upon identifying the exact trend of tradition. The Greek text of Dio is aimed to tell history as through the relationship between the author and his sources, composing every contrast or contradiction.

Historia Romana - 'Ρωμαϊκή ιστορία, LXVI, 23 - 5. [2,29].

Greek text.

Cassius Dio, LXVI, 23, 4-5. 24, 1.

τοσαύτη γὰρ ἡ πᾶσα κόνις ἐγένετο ὥστ' ἀπ' αὐτῆς ἦλθε μὲν καὶ ἐς Ἀφρικὴν καὶ ἐς Συρίαν καὶ ἐς Αἴγυπτον, ἦλθε δὲ καὶ ἐς τὴν Ῥώμην, καὶ τὸν τε ἀέρα τὸν ὑπὲρ αὐτῆς ἐπλήρωσε 5. καὶ τὸν ἥλιον ἐπεσκίασε. καὶ συνέβη κἀνταῦθα δέος οὐ μικρὸν ἐπὶ πολλὰς ἡμέρας οὐτ' εἰδόσι τοῖς ἀνθρώποις τὸ γεγονὸς οὐτ' εἰκάσαι δυναμένοις, ἀλλ' ἐνόμιζον καὶ ἐκεῖνοι πάντα ἄνω τε καὶ κάτω μεταστρέφεσθαι, καὶ τὸν μὲν ἥλιον ἐς τὴν γῆν ἀφανίζεσθαι, τὴν δὲ γῆν ἐς τὸν οὐρανὸν ἀνιέναι. ἡ μὲν οὖν τέφρα αὕτη οὐδὲν μέγα τότε κακὸν αὐτοῦς εἰργάσατο. ὕστερον γὰρ νόσον σφίσι λοιμώδη δεινὴν ἐνέβαλε. [2,29].

Cassius Dio, LXVI, 25, 1. 1...καὶ ἐπὶ μὲν τοῖς ἄλλοις οὐδὲν ἐξαίρετον ἔπραξε, τὸ δὲ δὴ θέατρον τὸ κυνηγετικὸν τὸ τε βαλανεῖον τὸ ἐπώνυμον αὐτοῦ ἱερώσας πολλὰ καὶ θαυμαστὰ ἐποίησε. γέρανοί τε γὰρ ἀλλήλοις ἐμαχέσαντο καὶ ἐλέφαντες τέσσαρες, ἄλλα τε ἐς ἐνακισχίλια καὶ βοτὰ καὶ θηρία ἀπεσφάγη, καὶ αὐτὰ καὶ γυναῖκες, οὐ μέντοι ἐπιφανεῖς, συγκατεἰργάσαντο. [2,29].

English text.

23 1 Thus day was turned into night and light into darkness. Some thought that the Giants were rising again in revolt (for at this time also many of their forms could be discerned in the smoke and, moreover, a sound as of trumpets was heard), while others believed that the whole universe was being resolved into chaos or fire. 2 Therefore they fled, some from the houses into the streets, others from outside into the houses, now from the sea to the land and now from the land to the sea; for in their excitement, they regarded any place where they were not as safer than where they were. 3 While

this was going on, an inconceivable quantity of ashes was blown out, which covered both sea and land and filled all the air. It wrought much injury of various kinds, as chance befell, to men and farms and cattle, and it destroyed all fish and birds. Furthermore, it buried two entire cities, Herculaneum and Pompeii, the latter place while its populace was seated in the theatre. 4 Indeed, the amount of dust, taken all together, was so great that some of it reached Africa and Syria and Egypt, and it also reached Rome, filling the air overhead and darkening the sun. 5 There, too, no little fear was occasioned, that lasted for several days, since the people did not know and could not imagine what had happened, but, like those close at hand, believed that the whole world was being turned upside down, that the sun was disappearing into the earth and that the earth was being lifted to the sky. These ashes, now, did the Romans no great harm at the time, though later they brought a terrible pestilence upon them. (Translated by Loeb Classical Library edition, 1925 [30]. Revised by the author. [31,32]).

25 1 Most that he did was not characterized by anything noteworthy, but in dedicating the hunting-theatre⁷ and the baths that bear his name he produced many remarkable spectacles. There was a battle between cranes and between four elephants; animals both tame and wild were slain to the number of nine thousand; and women (not those of any prominence, however) took part in despatching them. (Translated by Loeb Classical Library edition, 1925 [30]. Revised by the author [31,32]).

Analysis and comment

The extended narrative of Titus' period of principate is found in chapters 18-26 of book LXVI of the Roman History [2]. The text of Cassius Dio represents, together with that of Suetonius [3], the most frequently cited source by historians and commentators. The description of the eruption of Vesuvius is recorded in the chapters 21-23 of the Roman History and provides valuable information. For a full reading refer to the complete text [2].

The first excerpt makes direct reference to the plague. The Greek term “ἡ τέφρα” (ashes) which serves as the subject in the writing, has a Pre Indo European (PIE) root [31,32], whose etymology relies upon different signifiers, connected to heat and (consequently) to disease and pestilence, situation



these in which heat manifests itself in the body, personified or deified as a living being: the Latin terms "febris" and "tepidus" are i.e. derived, due to phonetic developments with which different languages modified the pronunciation over time and places. The phoneticlinguistic evolution cannot be dealt with in depth here^d but its effects induced ambiguity and ambivalence and may have affected later copyists, readers, and historians, leading them to recognize a cause-and-effect relationship between the ash and the epidemic. In fact, Dio makes explicit reference to such a relationship. A relationship that had been seen in Pliny's text, where the thickness of the air, thick with ash, was discerned as a pathogenic noxa.

The second excerpt, extracted from the chap. 25 [2,29], testify the importation of animals and the hunts, characterizing the big shows celebrating the Colosseum opening. They describe a scenario full of serious hygienic risks, of which the Roman people were completely unaware.

E. Jerome of Stridon. Chronicle (Chronicon Temporum liber), AD 78

The author. Eusebius Sophronius Hieronymus (Greek: Εὐσέβιος Σωφρόνιος Ἱερώνυμος), (c. 343/420), commonly named Jerome of Stridon but better known as Saint Jerome, was a Christian priest, theologian, translator, and historian. Jerome was fluent in Greek, Latin and Hebrew. His best-known translations are the Latin version of the Bible (the Vulgate) and his commentaries on the whole Bible. The Epistulae are extremely important in his plan for understanding the interpretative and doctrinal approach of St. Jerome [33]. Due to his work, Jerome is recognized as a saint and Doctor of the Church by the Roman Catholic Church, and as a saint in the Eastern Orthodox Church, the Lutheran Church, and the Anglican Communion.

The Titus' plague narration in the Chronicle is below, in Latin and English language. (Jerome, Chronicon (Temporum liber), AD 78) [4,5,33].

The Latin text.

77 AD - CCXIV Olympias g Tres civitates Cypri terraemotu corruerunt. h Lues ingens Romae facta, ita ut per multos dies in ephemeriden decem millia ferme mortuorum hominum referrentur. **78 AD** i Vespasianus Colonias deduxit, et mortuus est profluvio ventris in villa propria circa Sabinos,

anno aetatis LXIX. Romanorum VIII, TITUS, regnavit annis II, mensibus II.

79 AD

a Titus filius Vespasiani in utraque lingua disertissimus fuit, et tantae bonitatis, ut cum quadam die recordatus fuisset in coena, nihil se illo die cuiquam praestitisse, dixit: 'Amici, hodie diem perdidit.' b Mons Vesuvius ruptus in vertice tantum ex se jecit incendii, ut regiones vicinas et urbes cum hominibus exureret. c Titus Musonium Rufum philosophum de exsilio revocat. d Titus amphitheatrum Romae aedificat et in dedicatione ejus quinque millia ferarum occidit.

AD e Romanae Ecclesiae II constituitur Episcopus, CLETUS, annis XII. f Romae plurimae aedes incendio concremantur.

AD g Titus morbo periit in ea villa, qua pater. pridie Idus Septembres, anno aetatis XLII. **CCXV Olympias**

The English text.

Event Date: 77 LA

§ **A78** A massive plague happened at **Rome**, so that for many days about 10,000 men were listed in the daily register of the dead.

Vespasian planted colonies, and he died from an issue from his stomach in his own villa among the Sabines, aged 69.

(78 CE)

Event Date: 78 LA

§ **A79** 8th of the Romans, Titus reigned 2 years and 2 months. Titus, the son of **Vespasian**, was an expert in both languages and of such goodness that once when he recalled at a meal that he had been of no service to anyone on that day, he said: 'Friends, today I have wasted a day.'

Mount **Vesuvius** having erupted, it blasted upwards from itself such a great amount of fire that the neighbouring regions and cities were consumed in the fire, together with the people in them.

Titus recalls Musonius Rufus the philosopher from exile.

Titus builds the amphitheatre in Rome, and at its dedication he sacrifices 5000 wild beasts. (79 CE)

Event Date: 79 LA

§ **A80** Cletus (also called Anencletus) is appointed second bishop of the Roman church for 12 years. (80 CE)

Event Date: 80 LA

§ **A81** In **Rome** many buildings are burned to the ground in a fire.



Titus died from an illness at the same country-house where his father died, on the day before the Ides of September, at the age of 42. (81 CE)

Event Date: 81 LA Jerome, Chronicle Ad Ann. 78.

(Translated by the author)

Analysis and comment

The **Chronicon** (Chronicle) or **Temporum liber** (Book of Times) [4,5,33] was a universal chronicle. It is regarded as the earliest Jerome's attempts at history. It was composed around 380 and the text [33] is a translation into Latin of the chronological tables which composed the second part of the Chronicon of Eusebius: Jerome upgraded it with a supplement covering the period from 325 to 379, probably based on later lost sources. The first part of Eusebius' chronicle - the source text - is known to us through an Armenian translation; the Armenian translator did not possess the original work and Jerome carried out a real work of restoration and integration. Eusebius' chronicle was a collection of materials precious to us, in which the apologetic purposes in the Latin language use already appeared. The translation of St. Jerome therefore recovered the original text, rectified, and integrated many missing contents and updated the whole, thanks to the profound familiarity with manuscripts, the textual knowledge, the mastery in target languages.

Further, he could access to classified documents. Jerome produced a valuable work of universal history, if only for the example which it gave to such later chroniclers as Prosper of Aquitaine, Cassiodorus, and others to continue his annals.

The text of the chronicle of St. Jerome is authoritative: the Church attributes title and right to the author, of whom it approves the translations of sacred texts - i.e., the Old and the New Testament – acknowledging his scrupulosity in translating any term in conformity with the Doctrine. Jerome worked during an extremely conflictual era in matters of signifier and meaning: the Chronicle was composed in the years characterized by the Trinitarian dispute. The edict of Theodosius had intervened, precisely in the year 380, to restore a situation of uniformity and agreement, within the interior of the empire, concerning heresy and the definition of the Roman Catholic religion.

The Edict specified religious matters in accordance with the joint authority of the emperor himself, Pope Damasus and the bishop of Alexandria. A climate of rigid care on the meaning of any word constantly influenced the drafting of all St. Jerome's works and translations. The account of the events that occurred between 77 and 81 in the Chronicle is historically very credible and, if it may present some idiosyncrasies or chronological incompleteness, these discrepancies are attributable to pre-existing sources. It is therefore to be considered reliable. The Chronicle can be judged historically and textually as a reliable source.

On regard of the text, it is worth quoting the use of term "Lues" (Lues ingens Romae facta) to talk about the plague: it completely disambiguates, and pinpoints on the diffusion of a real disease.

F. Rutilus Namatianus. De Reditu Suo, 1, 395

The author. Claudius Rutilus Namatianus (? – c. 417) was a poet and magistrate. Born in Gaul, the information about his life is very poor. In Rome he held the positions of magister officiorum and praefectus Urbi. Between 416 and 417 Rutilius was forced to hastily return to homeland. Due to unsafe and often impassable roads, on his way back he embarked at Portus Augustus and skirted Italy. While sailing, he wrote the poem De reditu suo [22,23].

De Reditu Suo, 1, 395

The Latin text.

"atque utinam numquam Iudaea subacta fuisset Pompeii bellis imperiisque Titi! latius excisae pestis contagia serpunt, victoresque suos natio victa premit." (R. Namatianus. De Reditu Suo, 1, 395 [22,23]).

The English text.

And would that Judaea had never been subdued by Pompey's wars and Titus' military power!

The infection of this plague, though excised, still creeps abroad the more: and ~~his~~ their own conquerors that a conquered race keeps down. (Translated by the author. [31,32]).

Analysis and comment

The poem De Reditu Suo was in two books, in elegiac couplets. Most of the existing manuscripts of Rutilius come from an ancient copy found at the monastery of Bobbio by Giorgio Galbiato in 1493. The work is pervaded by nostalgia



and admiration for the lost Roman world and is regarded as the last testimony of Latin profane poetry [34]. The brief quote given above is of interest, as the author wrote during his journey by ship and used to draw on direct sources. His information, therefore, often derives from oral tradition, albeit indirect, and is recalled by interlocutors involved in the administration of the Empire. The quotation, therefore, stands as evidence of the semantic ambiguity of the Latin terms *pestis* and *contagium*, moreover brightly formulated and composed in rhetorical figures, as metonymies, parataxis and metaphor: the two stanzas of the text lend themselves to different interpretations and, given the semantic capacity inherent in the Latin language and the speech skill of authors (Rutilius included) in using it, the expressive involuntariness is excluded. Double meanings were in fact deliberately sought after in literary works. Rutilius was the first to introduce an association of ideas and contents between the "pestis" (albeit in a broad sense) and the end of the Roman Empire.

G. Baronius

The author. Caesar Baronius (Cesare Baronio) (30 August 1538 – 30 June 1607) born at Sora in Italy, was an Italian cardinal and historian of the Catholic Church. Baronius strictly collaborated with Pope Clement VIII, Pope Leo XI and Pope Paul V and was himself twice considered to become Pope. He took part in the controversy about the thesis of Copernicus and Galileo, demonstrating intellectual honesty and doctrinal mastery: in that context, according to an anecdote, he said: "The Bible teaches us how to go to heaven, not how the heavens go." [35]. Baronio also undertook a new edition of the Roman Martyrology (1586) particularly appreciated by Pope Clement VIII. His best-known works are *Annales Ecclesiastici* [6] ("Ecclesiastical Annals"), published in 12 folio volumes (1588-1607).

Annales, vol. 1, 703 [6]

The Latin text.

Christi, 81; Titi, 1: I, I. Itaque etiam ii putare coeperunt omnia sursum deorum ferri, Solemque in terram cadere, aut terram in coelum conscendere. Quamquam autem hic cinis non attulit statim gravia incommoda populo Romano, tamen postea morbum pestilentem & gravem immisit. Hucusque Dio.

Christi, 82; Titi, 2. 31. Atque idemtidem exercituum caedes, famem, pestilentiam, incendia, hiatum aliquando terrae. optabat. Haec de Caio Suetonius.

The English text.

Christi, 81; Titi, 1: I, I. And so, they too had the feeling that everything was being turned upside down by the gods, and that the sun was falling to the earth, or the earth was rising to the sky. Although the ash did not immediately cause injuries to the Roman people, it nevertheless later triggered a serious and diffusive disease. This in Cassius Dio.

Christi, 82; Titi, 2. 31. Likewise, there were massacres of armies, famines, epidemics, fires, land desertification. Such in Caius Suetonius. (Translated by the author. [31,32]).

Analysis and comment

Baronius was appointed to head the Vatican Library by Pope Clement VIII and thank to this he enjoyed great opportunity to access manuscripts, books, and documents. His *Annales Ecclesiastici* (Annals) stands as a very honest production at historiography [36], appreciated for narrative objectivity and meticulousness in consulting sources. The two quoted excerpts support the relevance of the works of Cassius Dio and Suetonius, albeit wrote during the age of the Counter-Reformation and subjected to a marked ecclesiastical ideological influence or control. The reference to the epidemic event is explicit, confirming the historical events. Semantic associations appear fully accepted in the seventeenth century.

Methods - Part two

This research is a consilience [37] study and investigates the causes and origin of an epidemic event that occurred in the Roman Empire, in a period between the year 78 and the year 80 CE.

The ancient texts hand down the memory of this episode, providing us with different information on its location and scope. The epidemiological description of the event is not always complete by the shortage of adequate sources, by natural imprecision to report, from an epidemiological point of view, the episode in its whole complexity. The sources we have agree in reporting the epidemic but, obviously, fail to identify a responsible microorganism. This study approaches by using together a descriptive and analytical model based on



linguistic, literary, and historical criteria, and an epidemiological and statistical analysis.

Very similar procedures were employed in previous studies concerning questionable events of Roman history, as an Ebola virus outbreak [38] or the death of Germanicus [39]. According to such a procedure, the information retrieved from texts is subsequently transformed into qualitative-quantitative variables and processed by logistic regression [40,41,42] as inferential analysis.

The philological analysis aimed to look for information in the description of the event was performed, as said, on the texts of seven authors. The authors, the title, the reference to the text in the identified work, and the year of publication of the text, have been listed in **Table 1**.

The texts report one epidemic outbreak in Rome and maybe somewhere else, between the years 77 and 81, perhaps outlining a multiphasic scenario in terms of location and seasonality. This was not unusual with the hygienic and endemic situation in the 1st Century Rome [18]. At the turn of the year 80 (but already in 77-78), however, the narrative records a surge in morbidity and mortality. In the same period some catastrophic events are registered: the earthquake and the eruption of Vesuvius, important fires in Rome and the historic celebratory occasion, an event of memorable importance: the inauguration of Colosseum. This celebration lasted more than three months, with huge population movements, massive importation of wild animals, hunting, killing and libations, all in the City context. The factual description each of the authors provides was the source from which twelve "index terms" were derived, used to describe epidemiologically and clinically, and characterize the Titus' plague. Each term, considered as a single independent categorical variable, is given the value "1," when present, and "0," when absent. These values provide contributions - positive or negative- to draw an identikit profile, to choose the disease most closely matching the facts described. Symptoms and other information (incubation, course, epidemiological characters) were considered as independent variables, diseases as dependent variables.

The twelve terms – Flag terms - express features and conditions of common medical meaning and use: they are listed below.

Flag terms or Condition: 1. Feeling conscious; 2. Abrupt Onset; 3. Fever; 4. Sensory; compromised; 5. Engraving; 6. Rash; 7. Alternate/relapse; 8. Contagious; 9. Zoonosis; 10. Birds ("crane fighting"); 11. Coma; 12. Death.

The twelve flag terms represent various conditions, symptoms, and clinical or epidemiological features, were drawn from the sources reviewed earlier. Their individual and ensemble contributions were measured in a group of diseases well suited or consistent with the reference age. In the multivariate analysis the diseases most likely during the investigated age assume the value of dependent variables. The purpose of the analysis was to identify the Flag terms and disease(s) with a significantly high correlation. The selected set of diseases included: Influenza viruses (all strains grouped); Variola viruses; H5N1 "avian flu" virus; Rickettsioses; B19 Virus; SARS Viruses; *Y. pestis* plague; Malaria spp., grouped. For the full nosography of these diseases refer to Textbook of Internal Medicine "Goldman Cecil Medicine" [43].

The integration and convergence between information deriving from different disciplines, such as natural, mathematical, physical, social, and humanistic sciences, is called consilience [37] and consists in the search for converging elements and concordances between the information deriving from different disciplines.

Results

The mentioned twelve selected categories of conditions/symptoms (Flag terms), regarded as independent variables, were matched to a selection of possible diseases (dependent variables), according to their descriptions in GoldmanCecil Medicine [43], and tested by multivariate analysis statistical methodology [41,42].

The Influenza viruses group showed a significant association (F 7.6; $P < .002$), with the clinical and epidemiological scenarios reported by sources. The H5N1 virus (avian flu) shows the strongest association (F 23.33; $P < .001$). This is influenced by the inclusion of the variable "Birds-crane fighting", strongly affecting the statistical result. The association can be supported on an epidemiological and pathogenetical [44,45] basis.

No other diseases, among those considered in the analysis as



dependent variables, showed a significant correlation with the independent variables (Flag terms) derived from the sources.

The complete results of the statistical analysis are summarized in **Tab. 2**.

Tab 2: Diseases (dependent variables) occurrence probability, according to reported symptoms (independent variables), in Titus' plague: Multiple regression analysis results.

Dependent variable (disease)	Coefficient	Std Err	t-ratio	F	R2	F-ratio	F p <
Influenza – strains grouped	0.657	0.238	2.756	7.6	0.431	18.67	.002
Variola viruses	0.029	0.316	-0.09	0.008	0.001	0.015	.93
H5N1 – avian flu	0.875	0.181	4.83	23.333	0.7	78.881	.001
Rickettsioses	-0.25	0.321	-0.778	0.606	0.057	1.155	.454
B19 Virus	0.5	0.387	1.29	1.666	0.142	3.333	.225
SARS Virus	0.5	0.268	1.86	3.46	0.257	7.436	.092
Y. pestis plague	-0.111	0.358	-0.310	0.096	0.009	0.178	.762
Malaria, grouped	0.028	0.316	0.09	0.008	0.008	0.015	.929

Discussion

The possibility that the outbreak named "Titus' plague" was due to an emerging virus, easily spread in a susceptible population, becoming a pandemic, well fits with an influenza disease. High contagiousness, transmission both airborne and through other kinds of direct and indirect contact, lack of knowledge and preventive tools, and inadequate treatment systems are all reasons in favor of an epidemic spread, with high mortality in an immunologically naive population. The discrepancies between the epidemic dates could be attributable not to uncertainty of documentation or notation in the sources, but to relapses and seasonal epidemic surges, over the course of a few years. Finally, demographic movements, hygiene, and food shortages, climatic inclemency, and, above all, uncontrolled cohabitation and slaughtering-even public and followed by food consumption-of wild animals, imported from all regions of the empire, represent strong concourses to rods spill over. The reasoning on clinical etiopathogenesis argues in favor of an Influenza virus. Statistical analysis strongly supports this hypothesis. The indication of an H5N1 virus is also compatible with the clinical reasoning and the result of the multivariate analysis but, of course, would require a confirmation by etiologic ascertainment of the agent, for which appropriate paleogenetic studies are needed.

Roman history was constantly affected by epidemics, and the

Imperial age was repeatedly rocked by spikes in mortality from disease with such a wide geographic extent that they rightfully deserved the designation of pandemics. In 169 CE the epidemic known as the Antonine Plague broke out, probably caused by a newly emerged smallpox virus [18,19]. In 249 CE a pathogen that, to this day, is not definitely identified, but could have been an influenza virus. Beginning in 541 CE the great pandemic caused by *Yersinia pestis*, commonly known as bubonic plague, is documented: it persisted for about three centuries and, through repeated cycles, never disappeared [19]. Those mentioned are just few examples; a full chronological discussion is beyond the scope of this article. If we limit ourselves to the most conspicuous documented cases, the pandemic of 80 CE deserves to be added to the three epidemic crises mentioned above.

Instead, it is essential to draw some more general considerations. The killer diseases of the Roman Empire were generated by nature, in the broadest sense of the meaning attributable to this term. Rome history was naturally intertwined with the global environment, for centuries, without any human awareness. Countless social and political reasons stimulated and increased frantic movements of people, animals, and all kinds of products, fresh, manufactured, preserved. No latitude or longitude was outside the routes of merchants, slaves, or armies [38].

Exotic animals of all kinds and species were crammed and led to slaughter in Roman arenas or other imperial cities.



Interference with global biodiversity, functional to the latitude gradient of species, which concentrates the highest values of biodiversity in tropical areas, was systematic and protracted, heedless of biomes. It configured an ideal pattern for the wide scale triggering of epidemic diseases. In the city of Rome, the confluence and spillover of germs and viruses (new or old, but nonetheless emerging) followed the impact on the environment of the imperial territory, replenishing itself in the time-tested resource of horizontal gene transfer [46]. Many viruses that are endemic in wild fauna can cause disease, also fatal, when they cross into hosts of new species. This is particularly true when they do not require adaptations to the new host. Further, humans are often immunologically naïve to animal viruses and basically rich of proteins require for viral entry and replication [47]. It is an old mechanism that influenced and regulated evolution, acting as a brake, shock absorber, or accelerator, according to “chance and necessity” [48]. The Roman population was an unaware and unwitting interpreter of it.

Conclusion

This study answers the questions about the Titus' plague indicating its possible cause and origins. An influenza virus probably caused the epidemics. According to Sources and statistical analysis a strain of H5N1 virus took profit of social and environmental condition. It maybe spilled over from cranes, and diffused as it was, or mutated, hybridizing with preexisting circulating rods.

Mutation is a usual habit in the natural world: transformations -the "metamorphoses," in Ovid-are never the result of a blind becoming. The sentence "quem non fors ignara dedit" (see the opening quotation [1]) is used by Ovid in narrating the metamorphosis of Daphne^e and, in possibly different formulations, it is also found in some modern film language: “chance does not exist”.

The Roman Empire, long before the age of Titus, facilitated spreading diseases, old or emerging. What happened between 77 and 80 CE was so conspicuous to leave a record in the Sources. Indeed, it represented a consequence of the past, and the forerunner of many subsequent relapses and re-emergences. Epidemics succeeded each other through the years and the centuries.

The Roman people and, like them, the populations that followed one another on the planetary stage until recent times, were lacking knowledge and adequate tools to properly interpret and deal with to biogenetic phenomena. The Earth's Biome, with its complex geo-climatic interactions, is a scene of continual genetic circulation. All life forms present take part in that flow. In brief, all creatures carrying and swapping their genetic information. Communicable diseases are just a manifestation of this. Human interventions in the biome and a combination of geo-climatic occasions helped the Titus' Plague, an emerging disease capable of ravaging effects, which then, and for centuries to follow, remained obscure and, therefore, left to fanciful interpretations. The careful study of past pandemics and emerging diseases can be a rewarding blueprint for future investigation and prevention.

Limits: The results and interpretations presented in this study are based on current knowledge, which is evolving. The acquisition of any additional evidence or information, useful for a better understanding of the discussed events is therefore possible and desirable, at any time.

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Notes:

^aOn the appearance of comets, harbingers or heralds of catastrophic events see Pliny, *Nat. Hist.* [13]. The belief occurs widely in works spread during the classical, ancient, and medieval periods.

^bThe Arch of Titus was erected to celebrate the triumph of Vespasian and Titus in the Jewish War and the capture of Jerusalem in 79 CE. It was completed by Domitian after 81. It is 15.40 meters high. and 13.50 wide, with a single arch: inside it bears carved the phases of the triumph, including the transport of the treasure of the Temple to Rome. According to tradition, the Jews never passed under the arch, so as not to pay homage to the destroyers of their Temple. In the Middle Ages it was called “Arco delle Sette Lucerne”, in reference to the seven-branched gold candelabrum, part of the treasure, probably sunk and lost in the Tiber during the war spoils transport to Rome. The Arch was fortified, together with the Colosseum, by the Frangipane family (11th century) and, partially, freed by Pope Sixtus IV (Francesco della Rovere), after 1471. The state in which it can be admired today is the result of the work of complete liberation, and restoration of lost parts, by Giuseppe Valadier, in 1821 [16].

^cThe Latin term *lectica* (litter. Historical) indicates a “vehicle containing a bed or seat enclosed by curtains and carried by men or animals.” (Oxford English Dictionary (2008). Oxford University Press OUP, Oxford).

^dOn regard of the transformation processes that took place in the afore mentioned terms, please refer to:

A.L. Sihler, *New Comparative Grammar of Greek and Latin* (1995). OUP Oxford University Press, New York, Oxford.

^e“452 *Primus amor Phoebi Daphne Peneia, quem non 453 fors ignara dedit, sed saeva Cupidinis ira, 454 Delius hunc nuper, victa serpente superbus...*” Publius Ovidio Naso (43 BCE-18 - C. 2-8 CE), *Metamorphoseon libri XV, Liber I, 452567 No*