Jazz Demetrioff
Brock University

Miasma: Malaria's Breeding Grounds and Effects on Ancient Rome

Introduction

The ancient world was full of air pollution – what contemporaries called *miasma* – that affected the environment. *Miasma* was the defilement or pollution of persons, which usually encompassed a heinous crime or action.[1] The term is used here as a framing device for air pollution, better known as 'bad air,' that the ancients were surrounded by. Bad air could be anything from the presence of a stench to germs that negatively affected an individual, the environment, and the hygiene of the area, to the various diseases that were present in antiquity. Hippocratic writers believed that disease was the result of an interaction of the individual, their nutrition, and their environment, which correlates with the description of 'bad air' above.[2] Various diseases are noted in the ancient sources, where, because of these interactions, authors described the symptoms and even the precautions to take when settling in a rural or urban environment; these parallels are discussed at length with emphasis on the examination of malaria.

Within the study of malaria in antiquity, there is an interrelationship between *miasma* and the disease as an environmental issue. In antiquity, malaria's destructive path went from North Africa, up through Italy and brought fear to those in the environments in which it arrived. Though disease of all kinds was rife, malaria made an impact, killing thousands of people. The

[1] Hipp. *Aer.* 1-4; *LSJ*, s.v. II "*μίασμα*"; In 1740 malaria became a known English term, introduced by Horace Walpole. See Cilliers and Retief 2004: 127 and Sallares 2002: 9.
[2] Koask 2000: 38; Cel. *De Med.* 3.4.

people of ancient Rome did not know what malaria was or the connection between fever and mosquitos; rather they knew that bad air (*miasma*) gave feverous symptoms that could cause death.[3] Furthermore, some people, such as those who observed the progress of fevers through Hippocratic medicine, developed ideas on the nature of the disease, though they continued to revolve around typifying fevers .[4] The following discusses the symptoms of malaria and its impact on the environment and the people. As well, by considering different physical landscapes, the city and the marshland, it becomes clear that malaria had an impact on the physical environment as well as people. Relevant to this study is one archaeological site that unearthed peculiar evidence, the Lugnano child cemetery, which has allowed researchers to gain further insight concerning the effects of malaria on towns and rural landscapes. This paper examines the interconnection between malaria and the environment, demonstrating that malaria played a destructive role in the livelihood of Roman society and their physical environment.

The Origin of Malaria

Before the nineteenth century malaria was believed to be simply bad air that attacked humans in a miasmatic form; however, recent studies have concluded that the malarial parasite came from *Anopheles* mosquitos.[5] It was not until 1800 that this miasmatic idea was discarded when Dr. Charles Laveran discovered the connection between mosquitos and the fevers people experienced with malaria.[6] There are two-hundred species of malarial parasites which primarily infect primates, rodents, bats, birds, and humans. The species of mosquitos which are vectors for

[3] Sallares 2002: 49; Crudeli 2015: 45.

[4] Nikita *et al.* 2016: 466-7.

[5] Sallares 2002: 7; The miasmatic theory was first proposed by Giovanni Maria Lancisi in 1717 in his work *de noxiis paldum effluviis eorumque remediis*, see Sallares 2002: 45-46; Crudeli 2015: 103-4.

[6] Sallares 2002: 46.

the human forms of malaria have a wide range geographically, and are central in the study of malarial fevers in Italy.[7] The particular mosquitos that carry the parasite are the *Anopheles sacharovi* and *Anopheles labranchiae,* which some scholars believe migrated from North Africa to the shores of Italy and Greece by way of ships in the fifth century BCE.[8] Mosquitos keep to a small focal area because they do not travel long distances from their breeding grounds; moreover, this is a practical reason as to why they moved with the ships from North Africa to Italy.[9] Other scholars have suggested, rather, that the *Anopheles* were present during the Neolithic period and developed over time to thrive in warm and wet climates.[10]

The four species of malarial parasites known to infect humans are *Plasmodium falciparum* (malignant tertian), *Plasmodium vivax* (benign tertian), *Plasmodium malariae* (quartan), and *Plasmodium ovale* (mild).[11] All four thrive in the weather conditions of warmer temperate zones and as such, the climate of the Mediterranean was a perfect region for these species.[12] This paper strictly focuses on the *P.f.* form of malaria and its effects on people, as it is more robust in the ancient literary sources and modern scholarship. In addition, mosquitoes benefit from a fertile landscape that lacked proper drainage, and with the beginnings of human intervention on the natural landscape through cultivation and occupation, the ecology of the land transformed, creating more breeding areas for mosquitoes, which allowed the transmission of

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[7] Sallares 2002: 7.

[8] Zulueta suggests where these types of mosquitos came from, see Sallares 1991: 274.

[9] Sallares 2002: 30.

[10] Cilliers and Retief 2004: 128; Cruse 2011: 107; Nutton 2002: 32; Sallares 2002: 28-9

[11] For the rest of this paper the four types of malaria will be referred to as follows: *Plasmodium falciparum = P.f.; Plasmodium vivax = P.v.; Plasmodium malariae = P.m.; Plasmoidum ovale = P.o.*. *P.o.*, was not common in antiquity, moreover it is only mentioned in passing since it is not relevant to this study; Sallares 2002: 9; Arnott 2005: 17; Shaw 1996: 133.

[12] Crudeli 2015: 2; Sallares 1991: 271; Shaw 1996: 132. However, only certain mosquito populations, noted above, can carry the parasite that affected humans, see Sallares 2002: 8, Table 1.

this parasite to sky-rocket. Classicist Federico Borca argues three conditions set a climate's baseline: the proximity of the sea, relative altitude to the coastline, and the particular location of the landscape. However, when people occupy or cultivate an area the landscape changes and this alters its original healthy state.[13]

The Horseman of Malaria: *Plasmodium falciparum*

The quotidian,[14] also known as the malignant tertian fever, derived from *P.f.* infection, was well known to ancient authors and the people of Rome by the fifth century BCE, and it was capable of tremendous mortality rates as high as 30% more than the average annual rate.[15] Asclepiades (c. 124/129 – 40 BCE) believed that quotidian fever was the most common in the capital and more than two centuries later Galen offered the same conclusion: "just as other diseases thrive in other places, this one abounds in the city."[16] This begs the question of how malaria made its way into the city of Rome and spread to its inhabitants. Scholar William H.S. Jones suggests that malaria was introduced to the Greco-Roman world when Hannibal and his soldiers brought their ships over during the Second Punic War (218 – 201 BCE).[17] This is a valid suggestion, however, according to ancient sources malaria was already present in Italy before the Second Punic War; therefore, Hannibal's ships could not have been the on-set of malaria in Italy.[18] Instead, this suggests that the Carthaginians just intensified what was already present in the area.

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[13] Borca 2000: 78; Sallares 2002: 94, 186, 219; Hays 2005: 10-12; Arnott 2005: 15; Mitchell 2003: 174.

[14] Quotidian is a daily reoccurring fever that persistently spikes a high body temperature and is the primary symptom for *P.f.* outbreaks.

[15] Sallares 2002: 12-13, 16; Cel. *De Med.* 3.4; Oerlemans and Tacoma 2014: 214; Nutton 2002: 32.

[16] Caelius Aurelianus 2.63-4; Galen 7.465; Scheidel 2003: 164; Sallares 2002: 117.

[17] Sallares 2002: 13.

[18] Sallares argues that the *Hippocratic Corpus* shows that *P.f, P.m.* and *P.v.* were present before Alexander the Great's lifetime, see Sallares 1991: 274; Sallares 2002: 9, 16-17.

Anopheles larvae require clear well-oxygenated water to thrive, particularly marshy brackish waters.[19] *P.f.* fully develops in the mosquito during warm weather, averaging 15-20 ºC.[20] This form of malaria attacks the red blood cells causing fevers of 41 ºC, chills, sweats, enlargement of the spleen, nausea, abdominal pain, delirium, anemia, headaches, and dropsy. *P.f.* – being the deadliest of the four types contracted in humans – can result in death.[21] The fever induced by the parasite was capable of infecting everyone, but would primarily affect young children, pregnant women, and anyone that lacked the immunity.[22] For pregnant women, both she and the fetus were vulnerable to *P.f.* as the parasite would cause the fetus to be malnourished and inhibit growth, which could trigger a miscarriage.[23] Hippocrates observed this effect in his work: *ῥῶτον μὲν τὰς γυναῖκας νοσερὰςκαὶ ῥοώδεας εἶναι·*
ἔπειτα πολλὰς ἀτόκους ὑπὸ νούσου καὶ οὐ φύσειἐκτιτρώσκεσθαί τε πυκνά… ("In the first place, the women are unhealthy and subject to excessive fluxes. Then many are barren through disease and not by nature, while abortions are frequent").[24] Adults and seniors could develop an immunity to the disease. However, when they were fighting off another affliction, they were prone to contract other pathogens including malaria.[25] Dr. Robert Sallares suggests that malaria was an agent of

[19] Palladius *Opus Agriculturae* 1.5.5; Sallares 2002: 69-70, 74.

[20] Sallares 1991: 271.

[21] Hays 2005: 11; Scheidel 2003: 164-167; Lane 1999: 635; Cel. *De Med.* 3.3; Scheidel 2003: 164. It should be noted that if a person's immune system is strong enough, they could essentially fight off an attack. However, this will not be discussed in detail in this paper, as the primary focus here is to discuss the effects of malaria in the ancient environment and possible treatment plans. Please refer to the scholarship and ancient sources, specifically Soren and Soren eds. 1999; Pliny the Elder, Hippocrates, Scheidel 2003, 2013, and Sallares 2002 for more details on this topic. Please see 'Further Reading' below.

[22] Scheidel 2003: 164; Sallares 2002: 29, 223; Sallares 1991: 273; Hays 2005: 10; Galen 7.435; Mattern 2013: 118; Shaw 1996: 132; Hipp. *Aer.* 7; See 'The Pontine Marshes', 'The City', and 'The Peculiar Case Study: Infants of the Lugnano Cemetery' below.

[23] Cilliers and Retief 2004: 129; Oerlemans and Tacoma 2014: 220-1.

[24] Hipp. *Aers.* 3.19-20.

[25] Cilliers and Retief 2004: 129; Oerlemans and Tacoma 2014: 221

natural selection between humans and the disease itself. Furthermore, it was this tension that aided in humans developing an immunity to the disease in the Italian regions.[26] Anyone who was born in Rome or a similar environment with malarial breeding conditions developed some immunity against malaria, yet during the peak season, it became hyperendemic causing even those with some immunity to be vulnerable.[27] As will be discussed below, a person's exposure to the parasite was also determined by their living situation and the habitat surrounding them. The types of habitats where individuals settled in were chaotic,[28] as they would either be overcrowded with people and germs, or they were fertile marshy landscapes where mosquitos flourished. These factors played a role in both the growth of malarial parasites and the contagion's spread across the Roman landscape.

The presence and evidence of *P.f.*, and the mortality rates in ancient Rome were connected to the environment and conditions of the city and the countryside, leading to the widespread outbreaks of malaria. *P.f.* fevers are a malignant tertian fever and reoccur every 48 hours, and complications could lead to death.[29] Humans are susceptible to two other malarial fevers, which have similar symptoms to that of *P.f.*, and it should be noted that the ancient writings discern between them.[30] *P.v.* fevers, which are benign tertian fevers, also reoccur every 48 hours and were prone to relapse, but rarely caused death. Quartan fevers, common with *P.m.*,

[26] Sallares and Gomzi 2000: 196; W.H.S Jones believed it to be *deus ex machina*, see Sallares 1991: 256-7, 271, 279.
[27] Oerlemans and Tacoma 2014: 223; The rate of infection increased by c. 50% for children, and a substantial part of adults were prone too, see Scheidel 1994 for further reading.
[28] Chaotic is used here in terms of an area being pestilent and abundant with germs, diseases, unsanitary conditions, overcrowded spaces, and flora and fauna that could be harmful to someone's health.
[29] Cillers and Retief 2004: 128.
[30] There is a fourth malarial fever, *P.o.*, a mild form of malaria, see fn. 11.

reoccur every 72 hours, were the most chronic, but death was rare unless a complication arose.[31] Fevers that correspond to these symptoms are frequently discussed in the sources of the period. Both Celsus and Galen devoted large sections of their works to fevers with these symptoms, periods of affliction and some treatments.[32] Similar illnesses are also noted in Hippocrates's *Airs, Waters and Places,* where it states that epidemics such as quartan fever are prolonged in the hot summer and result in death. This may be a reference specifically to *P.m.* or malarial fevers in general. [33] In his *Epidemics*, there are several cases of fever observed and recorded, some of which could be malarial fevers. There are, of course, no diagnoses to confirm that these were cases of malaria. Nikita, Lagia and Triantaphyllou argue that following Hippocrates' initial observations, those who studied or wrote on medicine in antiquity, continued to observe the symptoms even further, which allowed them to determine the type of fever present and what treatments could be used.[34] Researchers still lack sufficient evidence that could connect malaria with the fevers described by ancient authors and the terminology they use, which includes a lack of correspondence between the literary record and skeletal remains.[35] There is also a lack of evidence on the mortality rates per year in Rome, as researchers rely prominently on funerary inscriptions that record the age at death.[36] These inscriptions give us a sample of how many died per year and only some describe the manner in which they died. Scheidel's examination of the

[31] Cilliers and Retief 2004: 129. This paper's primary focus is *P.f.* and the affects it had on the people and the environment the mosquitos inhabited. Therein, *P.v.* and *P.m.* are only discussed in passing for the reader to distinguish the three types of fevers that were the main symptom.

[32] Cel. *De Med.* 3.3-4; Galen 7.435, 467-8; Burke Jr. 1996: 2257

[33] Nikita *et al.* 2014: 468; Hipp. *Aer*. 7; Hipp. *Ep.* 1. 24-26; *Epidemics I* also lists 14 cases of fevers that were observed, some of which could be malarial, but there are no diagnoses to clarify.

[34] Nikita *et al.* 2016: 467

[35] Nikita *et al.* 2016: 465; Burke Jr. 1996: 2257

[36] Scheidel 2003: 161. The ages were inscribed with how long the person lived in years, months, days and sometimes hours.

work of Paine and Storey on mortality rates through epitaph evidence, suggests that the demographic range for deaths was 5–25 years; however, this study falls short as we have to consider who was commemorated and who was not.[37] Due to this lack of evidence and precision diagnosis, it is difficult to attribute death to a specific epidemic, other than estimating them through the general mortality rates during each season of the year. However, scholars have made estimates using the available evidence. Scheidel points out that *P.f.*'s transmission rates peaked from July to September, due to the temperature reaching an average of 19 ºC.[38] In late Roman antiquity, mortality rates were close to 38% higher between August and October, therefore it can be suggested that the higher mortality could be connected to an outbreak of *P.f.*.[39] Scheidel's analysis suggests that the prominence of infections was typical during this season, which he correlates with annual *P.f.* spikes in nineteenth century Rome.[40] Further, seasonality played a role in the mortality patterns and their flux in the summer months, which is evident in the temperatures needed for the malarial parasite to develop and spread.

The developmental process of *P.f.* ranged anywhere between nine (at 30 ºC) to twenty-three days (at 20 ºC).[41] For the most part, the malarial parasite was dependent on the topography

[37] For Paine and Storey's study, see Scheidel 2003: 161 and 'Further Reading' below. Commemoration of the dead may have not taken place due to the wealth and social status of the family. In some instances, the departed individual's information is fully recorded on the funerary monument. However, in many cases, we lack the evidence for dates of birth or death, sometimes both. Depending on the cost, only the name and who erected the monument may be inscribed. This causes an issue with collecting viable evidence for morality rates over a specified period of time in the ancient world. In addition, due to preservation and naturalistic changes over time, some of the inscription may be fragmentary or missing, leaving researchers with little evidence on the person's identity. For further discussion on funerary monuments and commemoration, please see 'Further Reading' below.

[38] Sallares 1991: 272; In the nineteenth century there were few to no cases of *P.f.* in Rome, see Sallares 2002: 62; Scheidel 2003: 162; Hays 2005: 9.

[39] Scheidel 2003: 162; See the discussion on Lugnano, below, for further evidence on malaria in the late antique period.

[40] See, Scheidel 2003: 161-3 for further analysis on summer mortality rates in Rome.

[41] Sallares 2002: 102; Soren and Soren 1999: 635.

and altitudes of where it lived, as mosquitos preferred low-lying areas of land that were around five hundred meters above sea level.[42] The unhealthy low lands, according to an Italian physician, Guido Bacelli, always had damp top-soil that was not waterlogged.[43] As such, in these areas mosquitos were ubiquitous, though some areas did not carry the parasite, for example, Attinum, a town in Venetia, and both Ravenna and Aquileia, located in Northern Italy.[44] While, areas in Southern Italy such as the Pontine Marshes and Etruria were affected.[45] The landscape influenced the prevalence of malaria and as will be made clear, due to the low-lying areas and human interaction on the landscape, some locations were more prone to infestation and outbreaks of malaria.

Infectious Italy: malarial stricken landscapes

Malarial stricken landscapes developed throughout the regions of Italy, in both the countryside and city, which was problematic for both settlements and livelihoods. Marshlands, in particular, provided the perfect environment for *Anopheles* mosquitos to dwell and the elements needed for the parasite to develop.[46] In antiquity, the countryside was considered an aesthetically beautiful and culturally significant landscape. However, it was also thought to be a chaotic environment, especially in the marshlands with its pestilent insects and lack of water drainage.[47] As such, marshlands were deemed unhealthy areas that contained sources for disease, which made them unsuitable for settlements, yet archaeological and literary evidence suggests that

[42] Sallares 2002: 60; Hays 2005: 9.

[43] Sallares 2002: 214.

[44] Borca 2000: 78; Hays 2005: 9; Sallares 1991: 280; Crudeli 2015: 45; Most places that were pestilent during the summer months were healthier in winter, see Vitru. 1.4.4, 11-12; Strabo 5.1.7; Ravenna and Attinum were disease-free due to the salty waters around the landscape; Cilliers and Retief 2004: 132.

[45] Borca 2000: 78; Hays 2005: 9; Sallares 1991: 280; Vitru. 1.4.4; O'Sullivan *et al*. 2008: 758.

[46] See 'The City' below.

[47] Borca 2000: 74.

these areas, rife with disease, were essential to the people who lived in and near them. For example, the Pontine Marshes were agriculturally productive and vegetation flourished because of the decomposition of organic matter, providing ideal cultivation conditions for the people.[48] Research has proven that these areas started as settlements, especially for farmers and the poor, but came to be inhabitable places due to their conditions.[49] The majority of people that worked in the countryside may have not lived in that same area, but in towns at a higher elevation. As they descended from their towns to the fields each day, they ran the risk of coming into contact with pestilent mosquitos. In other words, none were safe from the disease.[50]

In the late 1800s, Professor Tommasi Crudeli used a processual line of thinking which led him to believe that the marsh areas were the sole cause for disease, blaming the air, not mosquitos for illness.[51] However, this speculation did not consider the inhabitants of the area and had no relevant evidence to support his claim. Various changes occurred in the physical environment, both naturalistic and humanistic, that affected the sustainability of the land over time. For example, events such as deforestation, erosion, runoff water, and human interaction, especially in marshy areas, altered the sustainability of the landscape and created a breeding ground for the *Anopheles* mosquitos.[52] Several ancient authors provide evidence that malaria affected both the inhabitants and the landscape. Columella advised his readers not to build around marshy areas and he commented that marshes are only pestilent during the summer.[53]

[48] Borca 2000: 74, 78.
[49] Borca 2000: 74; Nutton 2002: 33.
[50] Sallares 2002: 60.
[51] Crudeli 2015: 102.
[52] Sallares 1991: 280; Arist. *HA 569b.* 10-12.
[53] Col. 1.5.6; Sallares 2002: 61.

Further, according to Hippocrates, malaria was commonly connected with swamps and marshy areas of land.[54] The ancient writings suggest that the environment turned chaotic as mosquitos took over the marshy landscape, and to demonstrate this point, the Pontine Marshes, in Southern Italy, are used as an example.

The Pontine Marshes

The majority of modern research of the Pontine Marshes comes from Dutch and Italian archaeologists, especially Nicola Maria Nicolai, who wrote four books on detailed surveys of the area.[55] In antiquity, the Pontine Marshes were a low-lying area that would receive an average of nine hundred millimetres of water annually, creating the perfect breeding ground for the *Anopheles* mosquito.[56] Further, this area can be considered a marsh biotope as the combination of vegetation and water rendered the Pontine Marshes a liminal area.[57] Originally the area was called the Pontine territory, and according to Pliny the Elder it was made up of twenty-four cities.[58] This shows that the area was inhabited and cultivated before Rome seized it and split the area up for agricultural productions in the early Roman Republic.[59] All sorts of people, but especially the poor, were attracted to this area for cultivation even though it had a reputation for malaria and high mortality rates.[60] The human activity in this environment that altered the landscapes such as road building, deforestation, farming and cultivation, most likely encouraged the mosquito population to spread, since their habitat expanded due to these human interventions

[54] Hipp. *Aer.* 7, 24.
[55] Sallares 2002: 168, 185.
[56] Sallares 2002: 182.
[57] Borca 2000: 74-5.
[58] Plin. *NH* 3.5.59.
[59] Plin. *NH* 3.5.59; Sallares 2002: 177-9; Borca 2000: 79; Crudeli 2015: 100.
[60] Sallares 2002: 179-181; Arnott 2005: 15.

which exposed areas of land for water to settle.[61] For example, Appius Claudius built the Via Appia that ran from Rome to the Pontine Marshes (later extended to Capua). This altered the natural drainage system and caused more runoff water from rainfall, creating suitable conditions for the spread of malaria.[62] Horace recalled these conditions during a trip he took along Via Appia in 36 BCE, writing *hic ego propter aquam, quod erat deterrima, ventri indico bellum* ("here owning to the water, for it was villainous, I declare war against my stomach").[63] The scholar Giovanni Doni says something similar: "wherever anyone rests, disease arises."[64] In addition, during the summer the marshes gave off a foul stench and caused harm in other ways, such as effluvium of pestiferous vapours, noxious wildlife, and dampness that created rot.[65] The solution was often attempts to drain the area. Farmers, for example, would fill in some of the low-lying areas but their attempts failed to recede the brackish waters from their fields.[66] Perhaps due to the permanently flooded areas of land that provided conditions for the mosquitos to thrive, some rural areas in the Italian regions were abandoned.[67] Those who did not have the ability to escape the area, more than likely the lower class and poor, continued to be affected by the unhealthy conditions of the marshy plains.

By the first century BCE the Pontine Marshes were overrun by malaria, creating a very unhealthy environment in a densely populated landscape, in which people did not want to live

[61] Similar to Italy, Sallares mentions rice cultivation in Greece caused the interaction of mosquitos and humans, see Sallares 1991: 280; Sallares 2002: 72.
[62] Sallares 2002: 181; Lucan *De Bello Civilli* 3.35; Dio. Sic. 20.36.2.
[63] Hor. *Sat.* 1.5; Sallares 2002: 191.
[64] *ubi quis quieverit, morbus exsurgat*: Doni 1667: 155 in Sallares 2002: 191.
[65] Col. 1.5.6; Borca 2000: 75-6, 78; Vitru. 1.4.12.
[66] Sallares 2002: 183; Morley 2005: 198; Vitru. 3.5.3.
[67] Sallares 2001: 183; Burke Jr. 1996: 2278.

and be prone to infection.[68] It is likely that before the land was consumed by malaria the population thrived on the agricultural land, but when more people began to fall ill, we can assume fear and survival was a priority. Malaria may have spread quicker in this context, as the influx of people to the area may have included those who had not built up an immunity to the disease.[69] This is suggested by Vitruvius, who wrote "for when the morning breezes blow toward the town at sunrise, if they bring with them mists from marshes and, mingled with the mist, the poisonous breath of the creatures of the marshes [would] be wafted into the bodies of the inhabitants, they will make the site unhealthy."[70] Varro tells his readers that if they are farmers of pestilent land to *vendas, quot assibus possis, aut si nequeas, relinquas* ("sell it fast and for as much as you can get, and if you can't sell it, abandon it").[71] One major drainage program was initiated in 160 BCE by Marcus Cornelius Cethegus and following him Julius Caesar in 67 BCE; nevertheless, none were able to drain the marshes in an attempt to remove the *miasma* – the bad air – and the pestilence with it.[72] Mussolini finally achieved this feat in the twentieth century, demonstrating that prior failures to drain the Pontine Marshes were due to ineffective draining styles.[73]

[68] Certain places are better than others, see Borca, 2000: 75; Rome was not a healthy place either due to the city being overcrowded and unhygienic. This is discussed in the following section 'The City'. See Sallares 2002: 186, 269; Hays 2005: 10; Cruse 2011: 123-4.

[69] Sallares 1991: 273.

[70] Vitru. 1.4.1.

[71] Varro *Re Rus* 1.2.8, 1.12.2.

[72] Sallares 2002: 4-5, 75, 94, 185; Nutton 2002: 33; Suet. *Caes*. 44.

[73] Sallares 2002: 168, 180, 188; Plin. *NH* 26.9.19; O'Sullivan *et al.* 2008: 758.

The City

The countryside was not the only area of concern. The people of ancient Rome believed that the city was at risk because of the rural areas bringing disease into their city. However, the city was also the type of environment that allowed the disease to develop and thrive. Cities, too, were affected by population density as well as a lack of sanitation, hygiene and prevention skills.[74] It was thought that the bad air was entering the city from the country; Vitruvius mentions the air would waft into town, bringing creatures to the area and making it unhealthy.[75] However, in Rome, *Anopheles* mosquitos likely found a habitat in the small ponds (*piscinae*) that elites had in their yards and in the overflow of water from the public basins which resulted in permanent puddles.[76] This created ideal breeding grounds for mosquitos, similar to that of the countryside. Vitruvius noted that marshlands were reasonable areas for city walls; digging dykes around the walls would cause storm waters to overflow into the marshes and the sea salts prevented the birth of marshy creatures, i.e. mosquitos.[77] However, this notion is likely incorrect, as mosquitos infiltrated areas that had stagnant water both inside and outside the city's walls, causing the risk of malaria to diffuse into the city.

During Rome's expansion in the Late Republic, more timber was needed for construction, causing the deforestation of the hills and mountain slopes; therefore the increase in people caused an increase in watery areas surrounding cities and villages, and increased the spread of *P.f.* in urban and rural areas.[78] As Rome's population rose, further building and

[74] Hope 2007: 19; Scheidel 2003: 158-9, 169; Mattern 2013: 118.
[75] Vitru. 1.4.1
[76] Sallares 2002: 69-70; Hays 2005: 11; Plin. *NH* 19.58.180; Morley 2005: 198; Mattern 2013: 119.
[77] Vitru. 9.5-7
[78] Sallares 2002: 103, 108; For mortality rates see discussion: 'The Horseman of Malaria: *Plasmodium falciparum*' above; Hor. *Sat.* 2.6.19; Hays 2005: 12.

overcrowding created a higher exposure rate to disease and illness.[79] Similar to the rural landscape, inhabitants of the city lived in higher spaces, including two-story buildings, and when they descended to the ground level they risked exposing themselves to the unsanitary conditions of the streets. People lived among the watery streets and fountains surrounding the buildings, the prime breeding locations for mosquitos, and infection risk could be very high, as just one mosquito could be a vector for the malarial parasite and it could infect a small community.[80]

According to literary sources, during the Republic and the Early Empire, malaria was understood and regarded as avoidable.[81] However, there is a lack of evidence for malarial epidemics between c. fifth century BCE and c. second century CE; the majority of scholarship that focused on cases of malaria are based solely on funerary inscriptions, as mentioned above, and similar environmental settings in the sixteenth and seventeenth centuries CE.[82] Sources mention that the streets of Rome were constantly wet due to the overflow from basins and fountains.[83] Along with man-made structures for water, there was also the annual flooding of the Tiber River and runoff water from the hillsides.[84] According to Sidonius Apollinaris, malaria was active in Rome during late antiquity, as he tells his readers that he was infected by

[79] Sallares 2002: 98

[80] Sallares 2002: 97-8

[81] Col. 1.5.3; Varro *Re Rus.* 1.12.2.

[82] Sallares 2002: 37, 115; Funerary inscriptions are useful but only to an extent since funds to erect them were an issue for majority of the population that were not elite, see Scheidel 2003: 161; In 1623 the ratio of deaths in Rome was 43.1/1000, see Sallares 2002: 203.

[83] Sallares 2002: 211-217; Plin. *NH* 19.58.180.

[84] Scheidel 2003: 166, 169; Plin. *NH* 3.5.54; Mattern 2013: 119; O'Sullivan *et al.* 2008: 756-757.

something similar to it on his travels through the city.[85] Frontinus confirms this timeline, writing around the first century CE, that Rome had a bad reputation for miasmatic air.[86]

Crudeli openly admits that if it were not for malaria, Rome would have been the healthiest city in Italy, but he did not effectively consider the climate and environment in the Mediterranean that made it otherwise infested with disease.[87] Varro and Vitruvius both advise that a person should build their home in a remote area, suggesting in particular that they should avoid swampy areas because of the "miniature creatures that cannot be seen by the eye but float in the air."[88] Modern researchers thus suggest that people from antiquity did know about the unhealthiness of the city, however, they did not make any conclusions that it was *P.f.* Rather, they distinguished it as a type of fever.[89] We cannot prove how dangerous the city was compared to the country, but due to overcrowding in the city, it can be argued that it was just as difficult to avoid infection in the city as it was to avoid the abundance of mosquitos in the marshes.[90] All of these factors allowed for the infestations of malaria to rise and cause *miasma* to manipulate the daily lives of people in Roman society.

[85] Sidonius Apollinaris *Letter to Heronius* 1.5.8; Sallares 2002: 64; Plin. *NH* 18.6.27.

[86] Sallares 2002: 229.

[87] Crudeli 2015: 15.

[88] Vitru.1.4.1; Varro *Re Rus.* 1.12.2; Borca 2000: 75-7; In the 1600s, Doni believed that the infrastructure of how a structure was built was important and should face north or east away from the Tiber River, similar to Vitruvius's opinion on how to avoid pestilence, see Doni 1667: 8-9 in Sallares 2002: 209.

[89] See fn. 88.

[90] Scheidel 2003: 171.

Some Treatments for Malaria

The Romans had treatments for those who fell ill during the summer months, including cabbage, honeysuckle and amulets.[91] However, ancient authors, such as Celsus, believed that the treatment of malaria was a difficult undertaking for any physician.[92] Roman physicians did not know how to cure malaria precisely, but rather observed the symptoms and concluded that some symptoms such as fever, splenic issues, and chills were similar to other illnesses they had come across, and thus used similar treatments. Romans were well aware of the types of fevers: *quartana*, *tertiana*, and *quotidiana*, which were a symptom of malaria.[93] Treating malaria was difficult, according to our sources, because it presented similar symptoms to typhoid fever, chronic respiratory diseases (tuberculosis, pneumonia) and gastrointestinal infections.[94] Galen argued the intensity of these diseases, and others, matched the intensity of malaria:

> *Ἐφ᾽ ὧν γὰρ ὁ παροξυσμὸς εἷς ἀπ᾽ ἀρχῆς ἄχρι παντὸς διαμένων εἰς πολλὰς ἡμέρας ἐκτείνεται συνόχους ὀνομάζουσι τοὺς τοιούτους πυρετούς, …ἀλλ᾽ ὥσπερ ἰδέα μία τῶν τοιούτων ἐστὶ πυρετῶν, ἀφ᾽ ἧς ὀνομάζουσι συνόχους αὐτούς, οὕτως ἡ φύσις οὐκέθ᾽ ἁπλῆ καὶ μία.*
>
> [Doctors] term "continuous" those [fevers] in which there is a single paroxysm persisting throughout from the beginning and extending many days…But although there is one kind of such fevers, from which they name them continuous, even so, their nature is no longer simple and single.[95]

In this excerpt, Galen considered the reoccurring fever to be complicated, because it had the ability to continue for longer than 24 hours, as is the case with the fever associated with *P.f.*, and

[91] The examples given are just a sample of the numerous alleviators mentioned in the literary record. Please refer to 'References, Primary Sources' below for a list of authors, some of which discuss the ones mentioned along with other remedies for fever.

[92] Cel. *De Med.* 3.3; Lane 1999: 636.

[93] Soren and Soren 1999: 635.

[94] Scheidel 2003: 167-168; Retief and Cilliers 2004:132; Galen 7.468

[95] Galen 9.2.604

other diseases mentioned above. Without clearer indications of what the diagnosis was, medical practitioners from antiquity would remedy this fever with an all-purpose medicament.

Our knowledge of ancient ailments and treatments largely comes from Pliny's *Natural History,* which describes numerous herbal treatments – pharmacology – and other medical treatments that include animal products.[96] One of the major medicinal practices that was used by the Romans were amulets, which they frequently wore around their necks, often containing pieces of botanical, animal or mineral products, or a combination of them.[97] Amulets, in general, were used frequently by Romans because they were believed to bring luck, cure illness and avert disease.[98] Pliny mentions several remedies for quartan and quotidian fevers gathered from the Magi, but then contradicts himself by stating, "who could have made this discovery?"[99] He dedicated a chapter of Book 30 to quartan fevers, and states that, *in quartanis medicina clinice propemodum nihil pollet. quamobrem plura eorum remedia ponemus primumque ea quae adalligari iubent…* ("In quartans ordinary medicines are practically useless; for which reason I shall include several of the magicians' remedies, and in the first place the amulets they recommend…").[100] Pliny, relying on Magi sources, suggested an amulet be worn on the left arm for quartan fevers.[101] For victims of malaria, amulets were kept on their person for the entirety of their lives, and then with them to their graves.[102] According to Pliny, the most useful amulet was

[96] Laurence 2005: 92; Plin. *NH* 7.1, 20-32; Lane 1999: 634, 639.
[97] Sallares 2002: 51-2; Hays 2005: 13; Plin. *NH.* 24.1.
[98] Lane 1999: 642.
[99] Plin. *NH.* 28.66.228.
[100] Plin. *NH*. 30.30.98.
[101] Lane 1999: 642; Plin. *NH.* 30. 98-104.
[102] This was so that any 'evils' or disease that attached itself to the amulet remained with the wearer and did not transfer to others who would need the same remedy. Lane 1999: 642.

filled with frog claws or liver of a bramble-toad wrapped in cloth; some amulets even had a papyrus with ABRACADABRA written in a sequence.[103] This sequence came from the magical papyri for semitertian fever, and uses the same terminology that other ancient authors have used for malaria:[104]

> *Inscribes chartae quod dicitur abracadabra | saepius et subter repetes, sed detrahe summam | et magis atque magis desint elementa figuris | singula, quae semper rapies, et cetera †figes†, | donec in angustum redigatur littera conum: | his lino nexis collum redimire memento.*
>
> Write down on papyrus the word abracadabra | and repeat it many times, moving down the paper, but each time remove the final letter | from the line so that more and more of the letters of the word are missing, and mark the others, | until there is only one letter in the last line of the diagram at the apex of a cone. | Remember to tie it around one's neck with a linen thread.[105]

There are a few instances where Roman emperors would ban these amulets from being worn for fear of being overthrown with magic.[106] The Romans also used cabbage and *Artemisia abinsthum*, which is a Roman wormwood lethal to mosquitos.[107] These medicinal treatments, along with others listed in the sources, offer insight into the vast amount of medical knowledge that the Romans had, even if they were typically used for more than one ailment.

The Peculiar Case Study: Infants of the Lugnano Cemetery

The Lugnano child's cemetery allows us to observe the practices, including funerary rituals, used during malaria outbreaks. The site, discovered by Dr. David Soren, an archaeologist

[103] Plin. *NH* 32.38.114; Lane 1999: 643-644.
[104] Sallares 2002: 55 fn. 26.
[105] Quintus Serenus *liber medicinalis* 51.935-40.
[106] *HA Caracalla* 5.7.
[107] Hipp. *Aers.* 24; Sallares 2002: 17, 48; Laurence 2005: 92.

from the University of Arizona, is located in the town of Lugnano, Teverina (Umbria, Italy), roughly three kilometers from the Tiber River and sixty kilometers north of Rome, and dates to 450 CE.[108] Originally this site was a Roman villa, c. 15 BCE, which was later rendered useless due to its location on a shifting substratum, and was abandoned around the third century CE. By the fifth century CE the site was used as a short-term cemetery, as the stratigraphy and ceramic evidence (dated to c. fifth century CE) suggests that the cemetery had been installed in a short time frame.[109] Archaeologists were able to identify forty-seven children, ranging from pre-natal to two to three years of age, all of which were buried over a short period of time, perhaps several days to a month; moreover, the skeletal evidence suggests there was an epidemic that particularly affected pregnant women.[110] Soren states that an adult burial site was not located during excavations and he suggests that it may be located in a different part of the excavation site, perhaps to the south-west.[111] It was typical in late antiquity to have a separate burial plot for infants because of Christian beliefs; committing infanticide was banned in the fourth century, and baptisms and formal burials were the new norm.[112] The infant burials were located under several metres of soil which was loose and uncompacted, and contained roof tiles and large fragments of ceramics, suggesting that these graves were abruptly filled.[113] In addition, the lower

[108] This hill where this site was located is known as Poggio Gramignano, see Lane 1999: 635; Sallares 2002: 67. Excavation of the villa began in 1988 and excavation along the west side of the villa began in 1989 where they found the skeletal remains of animals and humans, see Lane 1995: 43; Mitchell 2003: 175.
[109] The major concern for this villa was that it was built on a hillside, which was on a shifting substratum causing the building to decay and fall apart, see Soren 2003: 193-4, 204.
[110] Sallares 2002: 67; Lane 1999: 633; Majority of the prenatal fetuses excavated were up to 5 or 6 months in age, and only one set of remains was dated to 2-3 years of age. For data see Soren 2003: 197; Nikita *et al*. 2016: 468; Soren *et al.* 1999: 516.
[111] Soren 2003: 197.
[112] Soren 2003: 197
[113] Soren 2003: 197.

level of the cemetery's stratigraphy contained single burials, while the upper half had multiple burials, which further suggests the presence of an epidemic that took place over a short span of time.[114] Inside the burials, excavators found the remains of the children, raven claws, puppies, burnt botanical remains, frog claws, amphorae, stones, and tiles; some of these items correspond with those used as medicinal remedies for fever, as described by Pliny in the *Natural History* Books 20-32.[115] The infant burials also contained a significant amount of honeysuckle, *periclymenon,* which Pliny identified as a useful plant for relieving quartan fever, a type of fever associated with malaria.[116] Pliny even mentioned the process for creating the honeysuckle lozenges used to remedy the spleen, a common symptom with *P.f.*:

> *nascitur in arvis ac saepibus circumvolvens se adminiculis quibuscumque…hi resoluti dantur in vini albi cyathis ternis tricenis diebus ad lienem, eumque urina cruentata aut per alvum absumit, quod intellegitur a decimo statim die.*
>
> The plant grows in cultivated fields and in hedges, climbing round supports of any kind. These [seeds], dissolved in three *cyathi* of white wine, are given for thirty days to cure splenic affections, the spleen being reduced either by blood in the urine or through the bowels, as is plain immediately from the tenth day.[117]

Honeysuckle was not a common offering at gravesites, and its presence in this site suggests its use as a healing agents for malarial fevers. It can be deduced that malaria was problematic in this rural area during the hot summer months, July to August, during the Dog Star, which is also when honeysuckle grows.[118] The other materials may have had a sacrificial purpose, suggesting a local practice of Pagan rituals during this devastating time.

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[114] Soren and Soren 1999: 633; Soren 2003: 197.
[115] Lane 1999: 633; Plin. *NH* 20-27; Sallares 2002: 232.
[116] Soren 2003: 202; Plin. *NH.* 27.94.120.
[117] Plin. *NH.* 27.94.120.
[118] Soren 1995: 48; Soren *et al.* 1999: 518; Hipp. *Ep.* 3.2

However, researchers have debated whether there is sufficient evidence for malaria as the cause for the burials in Lugnano during the fifth century CE. Forensic anthropologist Marshall Becker argued the cemetery did not contain any traces of malaria and that it was just a formal infant burial site. Other diseases, Becker suggests, could have been the cause for the mass burials of the infants and that further scientific proof is necessary. [119] Researchers Nikita, Lagia and Triantaphyllou argue that by considering the phylogenic relations among the various malarial strains, congenital blood disorders and the inference of the mosquito as a vector, it is possible to determine the malarial gene and its dissemination with the current biomolecular techniques.[120] Sallares offered to work with Soren to identify whether any of these children had the DNA sequence for malaria's *P.f.*.[121] After many DNA tests on modern skeletal evidence to compare them with the DNA from the bones at Lugnano, Sallares was able to determine that a specific burial, no. 36 containing a three-year-old female, carried the DNA sequence for *P.f.*.[122] Moreover, during the experiment, Sallares was able to gather PCR[123] (Polymerase Chain Reaction) products from two separate extractions, both of which were 98% positive for the *P.f.* sequence.[124] Mario Coluzzi, director of the Instituto di Parassitiologia at the University of Rome, who has been tracking the historical evolution of *P.f.,* concurs that malaria was the cause of the infants' deaths in Lugnano, particularly taking into account the cemetery's short span of use and

[119] Becker made the argument on a television special about the Lugnano site, see Soren 2003: 203.
[120] Nikita *et al*. 2016: 468.
[121] Sallares 2002: 233; Soren 2003: 203.
[122] Sallares 2002: 233; Sallares and Gomzi 2001: 203; Soren 2003: 203; Nikita *et al*. 2016: 468.
[123] PCR became a new scientific method in the late 1980s and allows small quantities of bone or tissue to be analyzed and the extraction of pathogens, such as *P.f.*. Cruse 2011: 174-5.
[124] Sallares and Gomzi 2001: 203; For DNA sequence data, see Sallares 2002: 67 fig. 11.

the way the infants were buried singular in the later strata and multiple in the earlier strata.[125] Further, the child's hands in burial no. 36 were placed under its pelvis, while her feet were covered with a large tile of limestone.[126] Researchers theorize the infant was weighed down to prevent demons (the malaria) from escaping and spreading further chaos among the people.[127] The Romans feared stillbirths and miscarriages, and purified themselves and the dead infants with ritualistic offerings to prevent further misfortunes.[128] The burial of Infant 36, and others at the site, with stones and offerings of honeysuckle, shows, then, that there was care put into the grave even though there is evidence of rushed filling.[129] This was an unusual practice at the time, as the formal burial indicates Christian practices and appears to be deliberate, while the materials buried with the child are components of Pagan practices. This suggests that the people of Lugnano hoped to stop the disease from leaving her body by some other means that diverged from their current religious beliefs. As such, this site suggests that the people inhabiting this area in the fifth century CE combined lavish Christian funerary rites with Pagan practices.[130]

Scholars have argued that the practice of magic or witchcraft at this site was meant to improve the bad air in the environment, in the hope this would protect the residents from further harm.[131] This is indicated by the artifacts discovered within the numerous burials, including: dismembered puppies, cooking-pots, a raven's claw and a doll.[132] The puppies, in particular, are

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[125] See Soren 2003: 198-9, 203.

[126] Soren 2003: 197; Soren *et al*. 1999: 508 *IB* 36; It is probable that *IB* 36 was part of same complex of burials to that of *IB* 39 and 40, see Soren *et al.* 1999: 508 (*IB* 36), 509 (*IB* 39), 509-10 (*IB* 40).

[127] Sallares 2002: 232-3, fn. 76.

[128] Soren, 2003: 203; Suet. *Nero* 34.4.

[129] Soren *et al.* 1999: 508 *IB* 36.

[130] Sallares 2002: 54, 233; Lane 1999: 633; Sallares 1999: 645; Sallares and Gomzi 2001: 202-203.

[131] Soren *et al.* 1999: 517-18.

[132] These items were also considered sacrificial to a chthonic deity, such as Hecate, see Lane 1999: 647.

of interest as they have ties to Pagan ritual and beliefs concerning illness. Dogs were believed to dispel or absorb evil, moreover the burials that included the dismembered puppies, thirteen in total, were notable because there was evidence that they were sacrificed for that purpose.[133] They were generally less than six months old, with only one approximately a year old, and the skeletal remains ranged from missing the crania to the mandibles, to the eldest puppy was missing its head.[134] Pliny mentions that puppies were commonly used for ritual practices as they would absorb the disease or evil lurking in the victim:

> *sed obrui tales religio est. hi quoque quos Melitaeos vocamus stomachi dolorem sedant adplicati saepius. Transire morbos aegritudine eorum intellegitur, plerumque et morte.*
>
> But the burial of an animal so used is an essential part of the ritual. Those puppies too that we call Melitaean relieve stomach-ache if laid frequently across the abdomen. That the disease is transferred to the puppy is seen by its sickening, usually even by its death.[135]

Additionally, archaeologists recovered a frog with one claw, which is a remedy that Pliny rendered useful as an amulet for treating malaria.[136] The combination of practices at the site offers researchers an idea of the typical practices carried out in rural areas and illustrates the Pagan practices, including the use of flora, fauna and daily materials, used for the treatment of malaria and formal burials.

Therefore, by connecting the deaths of the young children, the short-term use of the cemetery, the presence of Pagan practices, the ecology of the land, and the data analyses of DNA

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[133] Soren 2003: 199; Soren *et al.* 1999: 518, 530 Table 5; Plin. *NH.* 29.14.58, 30.20.64.

[134] Soren 1995: 44

[135] Plin. *NH.* 30.14.42-3; Pliny also discusses the age of puppies, two-days-old, used as another remedy for the spleen, see *NH.* 30.17.52.; Soren 1995: 45

[136] Lane 1999: 647; Plin. *NH.* 32.38.113-116

and PCR, it can be argued that malaria was the cause for disruption of this environment. The infants were buried in a ritualistic fashion that suggests the use of witchcraft in an attempt to rid the area of an epidemic. This suggests that the epidemic was deadly and the people living in the town of Lugnano feared for their lives and the lives of their children who were more vulnerable to malaria, especially those under the age of 5 and those still in the womb. As stated above, children and fetuses were more susceptible to malaria due to their lack of immunity to the pathogen, as they have not yet built up the antibodies to fight off the parasite, causing it to be fatal more often. The Lugnano child cemetery is peculiar in itself as the material evidence supports the theory that there was an epidemic affecting the area, and that people combined other practices with those of Christianity to rid themselves of it. This location had the necessary features for mosquitos to occupy the landscape, allowing the malarial agent to spread and cause chaos among the people and the environment they shared with this bad air.

Conclusion

The people of Rome were able to conquer the world, but they were unable to conquer this epidemic. Malaria played a destructive role in antiquity and as mentioned above, both the people and the environment were victim of this destruction. It was a contributor to the miasmatic air that played a role in people's lives culturally, socially and physically. The Pontine Marshes, the Lugnano cemetery, and the city of Rome itself were all affected by bad air (*miasma*) and the illnesses that came with it. Ancient authors and the people knew something contributed to the spread of fevers that peaked in the summer months, which we can suggest were often malarial fevers.

Malarial parasites migrated from the shores of North Africa to Italy and other parts of the Mediterranean. The environments where people resided were overrun with mosquitos that would breed in the stagnant wetlands and waterways. Rural land owners did not wish to remain in the area due to the stench of the air and waterlogged landscapes.[137] The Romans attempted to drain the water of the Pontine Marshes, developed various remedies for the fevers, and strove to build suitable structures, but nothing could stop the *Anopheles* mosquito's bite. The city of Rome was overcrowded and unhygienic, allowing the swift spread of malaria. The people built up immunities against the parasite, but there remained a few, including pregnant women and young children, who were susceptible to the deadly infection.

Lugnano's child cemetery was in use while Christianity was practiced, but out of fear from all the deaths, Pagan funerary practices were also used in the face of illness and death. Burial no. 36 allows archaeologists and researchers to deduce that the town was struck with malaria which spread quickly through infants and pregnant women. The people did not know that a tiny insect could be the cause of such destruction of the people and the environment, but they knew something was making the people sick and did their best to prevent further illness.

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[137] Sallares 2002: 25-34.

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