Roman sanitary engineering and its contribution to public health[1]

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The current COVID-19 pandemic clearly shows the importance of the study to public health, not only for the obvious reason to improve and save human lives but also for political, economic, and other sociological factors. By looking at public health during the Roman Empire we therefore not only investigate important lessons from the past but also learn more about Roman society as a whole. This essay will look at the effect of sanitary engineering on public health and thus will focus on archaeological evidence, and it is through this archaeological material that we can assess the effectiveness of sanitation policy and speculate about wider societal health issues. First, I will talk about Roman sanitary engineering before discussing the archaeological evidence for Roman urban health, especially on the basis of paleoparasitology. The question whether public health played a role in Roman politics is not relevant enough for us to discuss in this essay, but it is important to keep in mind that our understanding of public health is different from that of the Romans, and we must thus realise that the potential flaws of sanitary engineering regarding public health could be explained by the fact that it was not put in place for this reason. We should also be cautious with comparing Roman public health with that of modern society. It will be very unlikely that Roman sanitary engineering met our modern health standards, but that does not mean we cannot praise its benefits to Roman society. When writing about Roman water supply in 1986, Scobie took a modern standard that never existed in Roman times and looks for abuses of that standard.[2] Approaches like these will inevitably result in a negative view on Roman health policy, which might be undeserved. Indeed we will see that Roman sanitary engineering should be regarded as an admirable feat of Roman urban management.

One of the most important aspects of sanitary engineering is the sewage system. The Roman world, like the Greek, had a fair number of open sewers.[3] Pliny, in Trajan's reign, complained about the open sewer in the main street at Amastris (Turkey) and proposed to cover it over.[4] His uncle regarded the sewers of Rome as the most noteworthy achievements of that city.[5] Indeed according to Wilson, public drainage and sewerage infrastructure surely surpassed anything found after the end of the Roman Empire until the nineteenth century,[6] a fact made possible by the general concern exhibited for town planning and in particular by the assignment of specific responsibilities to magistrates.[7] New colonies and legionary fortresses could have underground drainage systems planned from the start like

[1] In this essay, 'public health' will refer to the average health of an urban community. With many thanks to Dr Dominik Maschek for whose tutorial this essay was written.
[2] Laurence, 1997, p. 11.
[3] Wilson, 2000 (a), p. 168.
[4] Pliny the Younger, *Epistles*, 10.99-100.
[5] Pliny the Elder, *Natural History*, 36.24.
[6] Wilson, 2000 (b), p. 307.
[7] Wilson, 2000 (a), p. 179.

Cologne or Timgad.[8] At Timgad (Algeria) the town planners, unhampered by the constraints of a pre-existing urban street plan, designed an orthogonal street grid with associated drainage system, with tributary drains under side streets feeding into collectors under the main thoroughfares.[9] The evidence from Carthago Nova (modern Cartagena in Spain) points to the conclusion that there must have been a ''system of administration, of management, of maintenance, and of municipal staff'' to undertake disposal of the town's liquid wastes, although, despite tantalising hints in the epigraphic record, the actual actors remain mostly unknown, as does the precise manner in which tasks for assuring the construction and maintenance of the sanitation infrastructure were parcelled out.[10] Herculaneum had an extensive system of sewers as well, consisting of at least two main sewers and a number of minor sewers, all of them discharging their waste into the sea. Latrines and waste pipes of private citizens were connected to the sewerage. The sewers were constantly being washed with the overflow of the three public fountains and rainwater could enter the sewerage only in a few places.[11] The military base at York also had excellent provision for drainage for effluent and run-off, and the ready availability of a good water supply, at least well into the fourth century A.D. A sewer served the very substantial military bath block and adjacent premises and was designed to take both fresh effluent, perhaps largely from the baths, and foul from various latrines.[12]

It is clear that sewage systems are attested throughout the Roman Empire. However, not all towns or urban districts possessed under-street drainage. At Berenice (near modern Benghazi in Libya) domestic waste discharged into soakaway pits in the street outside, a method found in more Roman places.[13] In Pompeii, only the Via dell'Abbondanza is equipped with under-street drainage: fountain overflow washed the street surfaces instead.[14] Sewage systems do indeed improve public health as experience and research shows, but it could also bring health problems. Periodic cleaning was required, as implied by the access manholes at Timgad. Maintenance was the responsibility of the *aediles* and was probably performed by condemned criminals and public slaves, although at Antioch, Libanius indicates that it was a civic duty of the shopkeepers (presumably in return for the right to trade).[15] The shopkeepers at Antioch complained about the danger of asphyxiation while performing their task, and sewer-workers must also have been exposed to health risks from faecal matter and to

[8] Wilson, 2000 (a), p. 169.
[9] Wilson, 2000 (b), p. 307.
[10] Koloski-Ostrow and Ostrow, 2014, p. 580.
[11] Jansen, 1991, p. 158.
[12] Addyman, 1989, p. 247.
[13] Wilson, 2000 (b), p. 308.
[14] Wilson, 2000 (a), p. 172.
[15] Libanius, *Orations*, 46.21.

conditions such as leptospiral jaundice transmitted by rats.[16]

Closely related to sewage systems but worthy to be discussed separately are latrines. Besides the famous multi-seated public latrines, the so-called *foricae*, which are found throughout the Roman Empire and were often part of public buildings such as *thermae*, private latrines are found as well. In Herculaneum nearly every excavated house or apartment, on the ground floor as well as on the upper floor, had latrines.[17] Such constructions required the provision of a piped water supply, and the majority of households in the Roman Empire made do with cesspits or lacked latrines entirely and used chamber pots. While cesspits can be adequately sanitary if periodically covered with earth, in houses at Pompeii they were frequently placed next to the kitchen, which may have been handy for disposing of kitchen waste, but was not hygienic.[18] At least in Herculaneum, cesspits were emptied regularly and people had to pay for this service according to an inscription.[19] Juvenal famously makes clear that in densely populated cities like Rome, emptying chamber pots from the upper storeys of apartment buildings into the street was a common practice, and thus likely a problem for hygiene.[20] Archaeological evidence confirms the use of chamber pots, for example the fragments found in Carnuntum, Austria, dating from the second and third centuries A.D.[21] Incrustations on these fragments were examined with X-ray diffraction analysis which showed that these pots were filled with urine.[22]

Public latrines also had potential problems. As papyrus and parchment were most certainly too expensive to be used as toilet paper,[23] the so-called *xylospongium* (sponge-on-stick) was probably used. There are some literary references, such as the one from Seneca who talks about a German committing suicide in public latrines by choking himself with a sponge stick.[24] In the fortress sewer in York, marine and freshwater sponges were found in substantial amounts,[25] and some holes in the front of toilets are too small to be entered by hands and may therefore have served as an entrance for the *xylospongium*.[26] Nevertheless, some scholars doubt the use of the *xylospongium*. I think the literary and archaeological evidence is convincing, but we must be cautious with assessing the impact on health by its use. I believe that our disgust for sharing a *xylospongium* with strangers is not a case of presentism but a natural human

[16] Wilson, 2000 (b), p. 307.
[17] Jansen, 1991, p. 155.
[18] Wilson, 2000 (a), p. 175.
[19] *CIL* IV suppl. 3.4.10606.
[20] Juvenal, *Satire* 3.
[21] Wilson, 2011, p. 97.
[22] Wilson, 2011, p. 99.
[23] Although P.Oxy. 67.4633, a third-century A.D. papyrus containing notes on Homer's *Iliad*, seems to have ended up as a piece of toilet paper.
[24] Seneca, *Epistles*, 70.20 (not 70.25 as Wilson states).
[25] Wilson, 2011, p. 104.
[26] Jansen, 1991, p. 157.

feeling. There could be various ways in which the *xylospongium* was cleaned, used and shared in order to alleviate this feeling, and thus various degrees of impact on public health.

The design of Roman public latrines reduced some hygienic issues. The slot in the front of the toilet seats was not only used for cleaning after use, but also prevented drops of urine being left in front of the seat. In the latrines by the forum at Timgad, drain slits in the floor in front of each seat, between the user's legs, seem intended for this purpose as well. In the latrines of the Baths of the Cyclops at Thugga (Tunisia) spillages were prevented from entering the gutter in front of the seats (which could have been used for washing hands, the anus or the *xylospongium*) by a raised border.[27] A washbasin was usually present as well. Water came either directly from the urban water supply or a cistern in the complex.[28] Whether flushing of latrines near bath complexes was continual or periodic will have depended on whether the baths were fed by continuous inflow and therefore overflowed constantly, or whether the pools were filled and emptied several times a day.[29] Of course, the provision of public latrines reduced the hygienic risks of urinating and defecating on the streets, which was certainly a problem in some cities.[30] But although the seat design avoided urine droplets at the front, sitting entailed contact with the seat and therefore some risk of germ contagion, and the use of the *xylospongium* would probably have been a major hygienic downside. Washbasins show indeed that the vital practice of handwashing was there, but there was no soap,[31] and we do not know to what extent handwashing was practised.

Instead of assessing the effectiveness of Roman sanitary engineering by looking at its design and functioning, I will turn to bioarchaeology and in particular parasite infections as these are often the result of poor sanitary engineering. I do this in order to look at actual firm evidence of the state of the health of Roman urban populations rather than speculating the impact of sanitary engineering on it. I think it is obvious that sanitary engineering will have had a positive rather than a negative impact, but assessing the exact 'lower-limit' (i.e. minimal) impact will be extremely difficult, especially without using modern preconceptions. Such an approach could therefore probably result in the conclusion that parasite infections must have dropped during Roman times, as the bioarchaeologists themselves expected, but as we shall see, paleoparasitology shows that this is not the case. However, a bioarchaeological approach on the other hand does not give evidence for the link between Roman health and a city's sanitary engineering. Nevertheless, we will be able to see what health risks Roman sanitary engineering did not prevent, and thus provide an 'upper-limit' impact of Roman sanitary engineering on public health.

[27] Wilson, 2011, p. 104.
[28] Wilson, 2011, p. 105.
[29] Wilson, 2000 (b), p. 309.
[30] Wilson, 2000 (b), p. 310.
[31] Wilson, 2011, p. 106.

Human faeces in archaeological contexts can be recovered from latrine soil, coprolites and the pelvic soil from burials, which can contain eggs of endoparasites. Ectoparasites can be detected by fine sieving of soil, and also by looking for them on hair combs, mummies or ancient textile. Mummies also have the potential to preserve the ancient DNA of endoparasites, the proteins secreted by these parasites when alive, and possibly the host antibodies made to fight the infection.[32] Some endoparasites have the potential to cause anaemia which can be seen in bones in the form of cribra orbitalia (lesions in the orbits), and Mitchell argues that anaemia was common in Imperial Roman Italy as 60–80% of children bones at certain sites showed cribra orbitalia.[33] However, I want to note that it was already established by Schutkowski in 2008 that these lesions are more likely the result of vascular activity in these areas and are therefore unlikely to be pathological (dietary deficiencies are the most probable cause).[34] I will therefore be looking at paleoparasitological research only, namely those from Sagalassos (2017) and Ephesus (2018) in particular, both in Asia Minor.

Five latrine sediment samples in Sagalassos were positive for roundworm (*Ascaris* sp.) eggs. The protozoan *Giardia duodenalis* was also found in human faeces.[35] Samples from the public latrine in Ephesus also contained eggs of roundworm, while human whipworm (*Trichuris trichiura*) eggs were found in the mineralised material from a private latrine. Samples from the harbour canal of Ephesus contained the eggs of both roundworm and whipworm.[36] Since only one species, roundworm, was found in the sewer drain of the public latrine, it is probable that the population of Ephesus was genuinely not infected by a broad range of parasites. This is confirmed by the fact that in the harbour sediment, where all the city drains and effluent eventually ended up, only whipworm and roundworm eggs were found. Currently 10 species of intestinal parasites have been identified in Roman-period sites across the empire. Of these species, whipworm and roundworm were indeed the most common.[37] In Roman Judea, two-sided combs of wood, bone or ivory have been excavated. On one side the teeth were placed very close together, in which both lice and their eggs have been noted on microscopy.[38]

If we look at archaeological excavations from York, we can note that the Roman habit of washing at the public baths does not seem to have decreased their risk of contracting ectoparasites compared with Vikings and medieval people who did not use public baths in the same way.[39] Ectoparasites are known to spread bacterial infectious diseases amongst humans and thus are a public health risk. Roman sanitary

[32] Mitchell, 2016, p. 2.
[33] Mitchell, 2016, p. 3.
[34] Schutkowski, 2008.
[35] Williams et al., 2017, p. 39.
[36] Ledger et al., 2018, p. 292.
[37] Ledger et al., 2018, p. 293.
[38] Mitchell, 2016, p. 8.
[39] Mitchell, 2016, p. 6.

engineering does not seem to have protected them from contracting intestinal parasites either. The parasites found in Ephesus and Sagalassos suggest that the way of life under the Romans may have facilitated the invasion of human tissues by these organisms more easily than do modern lifestyles. These are faecal-oral parasites, so their presence indicates that human faeces had contaminated food or water.[40] Modern research has shown that clean drinking water, latrine use and hand washing all decrease the prevalence of parasites such as whipworm and roundworm, but the prevalence of these helminths did not drop in Roman times when we compare them to older samples.[41] This could be explained by failing to wash hands after defecating or before cooking, the uncleanliness of Roman bathwater, the fact that few private homes were connected to the public sewers (and thus used unhygienic cesspits), the use of human excrement as fertiliser,[42] the fact that defecation still happened on the streets, the purpose of public fountains as a place to rinse hands while other collected drinking water from them,[43] or perhaps even the Roman enthusiasm for fish sauce *garum* which could contain fish tapeworm.[44]

As I mentioned above, paleoparasitology cannot show a direct link between the health of the Romans and their sanitary engineering, as there could also have been other reasons for the standard of public health. However, the bioarchaeologists concluded that the effect of sanitary engineering was not big enough to prevent parasite infections (which are reduced by a good sanitation system). This should not be a big surprise, as Roman sanitary engineering was probably not installed to improve public health anyway (as noted in the introduction), even though it was clearly advanced for its time and reduced the spread of germs in some ways. The failure to prevent parasite infections as well as the fact that the amount of parasite infections did not drop during Roman times despite the sanitation system, is explained by the bioarchaeologists by a number of possible reasons. However, I want to add that this does not mean that Roman sanitary engineering did not have a positive impact on public health. Roman cities were certainly better off with a sanitation system, but the extent to which it improved public health is extremely difficult to assess, but we can note that it was not enough to reduce parasite infections to pre-Roman nor modern levels.

[40] Williams et al., 2017, p. 40.
[41] Mitchell, 2016, p. 7.
[42] Williams et al., 2017, p. 40.
[43] Ledger et al., 2018, p. 293-294.
[44] Mitchell, 2016, p. 7.

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