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Fascicolo 17. Marzo 2024

Storia Militare Antica

a cura di
Marco Bettalli ed Elena Franchi

Società Italiana di Storia Militare

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The Camp at Pooh Corner. Ancient Environmental Warfare

by Mike Dobson[1]

Abstract. Environmental concerns are relatively recent. Ancient armies would have little or no concept that they caused environmental damage. Such armies were 'eco-warriors' nevertheless, but in the sense of against the ecosystem, not for it. An army's success may result from marching on its stomach, but what those stomachs produced could also conduct environmental warfare. Surprisingly little has been published about ancient armies' daily bodily waste – urine and faeces – or the environmental impact where they encamped. An encamping army would cause rapid local and increasingly extending environmental change and devastation. Woodland would be steadily consumed, water security a constant concern, disease from pollution a threat. Food supplies would be sucked into camps from nearby and increasingly further afield. As for a camp's growing smell, an enemy's nose would have been more than adequate to find their foe. Using the example of Roman armies in the succession of camps mainly associated with the 2nd century BC campaigns against the Celtiberian city of Numantia, Spain, eye-watering sewage statistics emerge for when an army encamped, and its general environmental impact.

Keywords. Environment – Sewage – Deforestation – Water security – Roman Republican armies – Roman camps – Numantia, Spain

Today, environment and sustainability are hot topics. This is relatively recent. It is hard to imagine such concerns worrying people in the ancient world, especially for those in armies, where mere survival and victory (probably in that order for the ordinary soldier in most periods[2]) were only what mattered, rather than preserving the landscape. Yes, ancient armies were eco-warriors, but against the ecosystem, not for it.

An army's success may result from marching on its stomach, but what came out of it could maim an army and also conduct environmental warfare. Ancient

1 Dr Mike Dobson, Honorary Senior Research Fellow, Department of Classics and Ancient History, University of Exeter, email: m.j.dobson@exeter.ac.uk.

2 John Keegan, *The Face of Battle*, London, Jonathan Cape, 1976.

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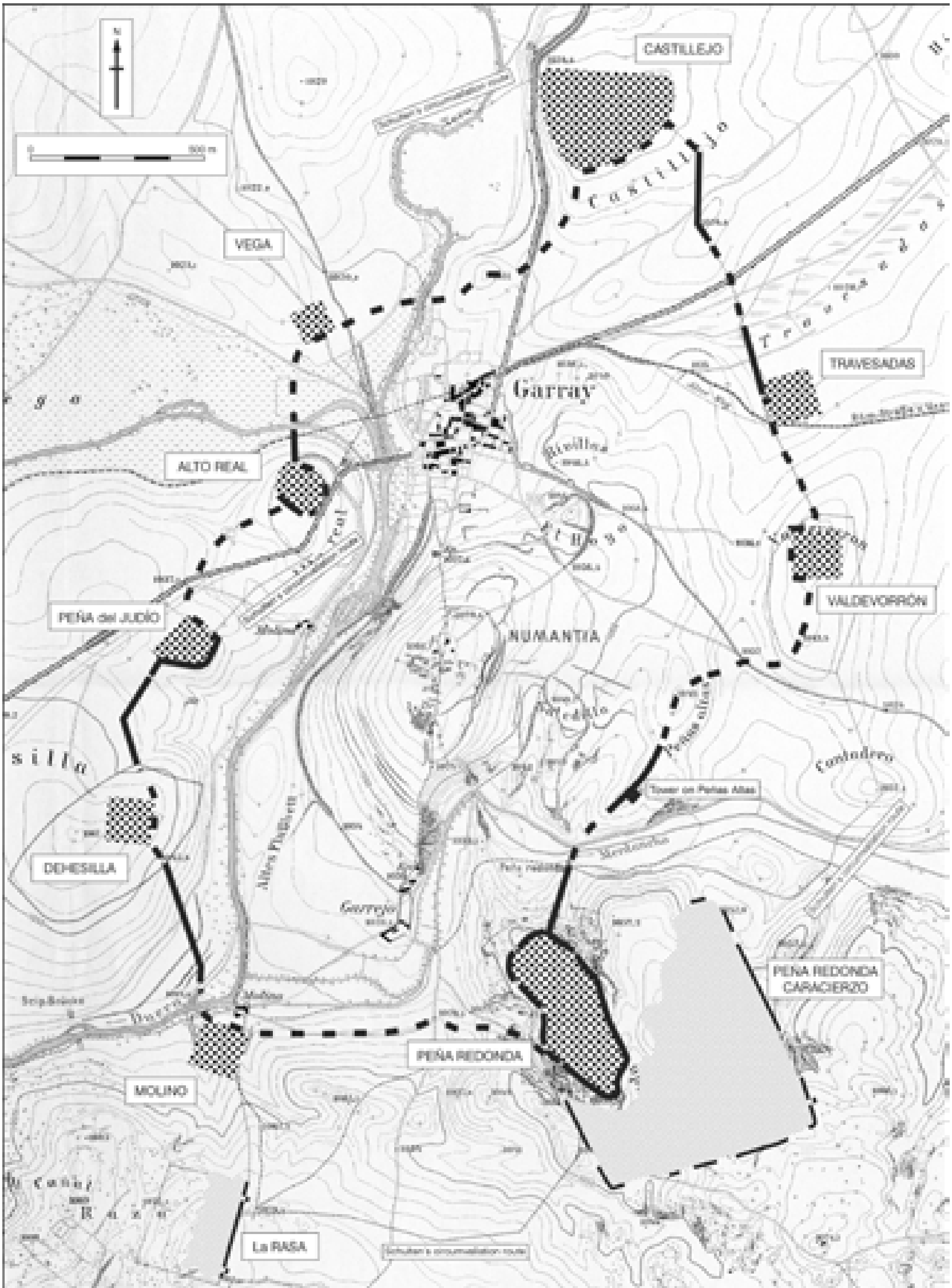
Marzo 2024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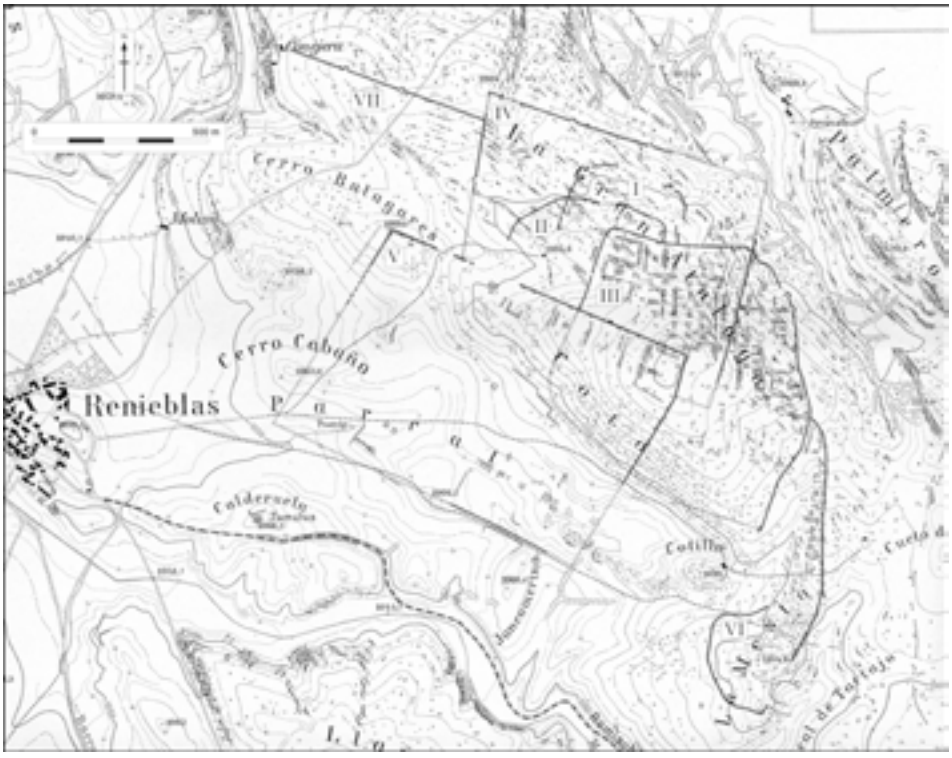
ALTO REAL
PEÑA del JUDÍO
VALDEVORRÓN
NUMANTIA
Tower on Peñas Altas
DEHESILLA
PEÑA REDONDA
CARACIERZO
PEÑA REDONDA
MOLINO
La RASA
Schulten's circumvallation route

armies seem to have been well aware of this. Using the example of Roman armies in the succession of camps near Soria, Spain, created mainly for campaigns of the second century BC against the Celtiberian city of Numantia, culminating in the infamous siege with the inhabitants committing suicide rather than being captured (Figs 1 and 2), some eye-watering sewage statistics emerge for when an army encamped, and the general environmental impact on the local area is astonishing. The conclusions can be applied to other ancient armies – sewage and 'harvesting' the locality for everyday things were as much part of all their everyday lives, as eating, drinking and sleeping.

◄ Fig. 1 Numantia and the Roman camps, with alternative Scipionic siegeworks (heavy dashed line and dot-filled camps) to those proposed by Schulten (based on Schulten 1927 cit., plan I; Dobson 2008 cit., fig. 269. Peña Redonda-Caracierzo plotted by Dobson from LiDAR image in Hesse, Costa-García cit., fig. 3 and fieldwalking of Morales Hernández and Dobson).

▼ Fig. 2 Camps at Renieblas, with VI and VII proposed as separate camps, differing from Schulten's interpretation (after Schulten 1929 cit., plan I; Dobson 2008 cit., fig. 39).



Sewage

Much has been written about the Roman army. This is frequently about its development, organisation, arms and equipment, fortifications, tactics etc. In contrast, relatively little has been published about the minutiae of soldiers' daily life. One particular aspect of this is what was done about bodily waste products – urine and excrement. Indeed, the whole subject of toilets and latrines in Roman civilian life, let alone the military, was largely ignored until the late 1980s, when Jansen and Koloski-Ostrow realised from their work at especially Pompeii and Herculaneum that this was an overlooked theme that needed studying[3]. Since then, more researchers have started looking at this 'down-to-earth' aspect of Roman life, and also extending into looking at waste, filth and pollution[4]. A result of such interest was the first conference on Roman toilets and sanitation in 2007[5], looking at the Mediterranean area, followed by one looking at the north-western Roman Empire in 2009, stimulated by Hoss's research[6].

There are many known examples of toilets, latrines and cesspits in Roman civil contexts[7]. In Roman military contexts, there are also buildings identified as latrines. The published evidence for fort latrines in Britain is particularly indic-

3 Gemma Jansen, «Systems for the disposal of waste and excreta in Roman cities. The situation in Pompeii, Herculaneum and Ostia», in Xavier Dupré Raventós, Josep-Anton Remolà (Eds.), *Sordes Urbis, La liminación de residuos en la ciudad romana: actas de la Reunión de Roma, 1996*, Bibliotheca Italica, Monografías de la Escuela Española de Historia y Arqueología en Roma 24, Rome, «L'Erma» di Bretschneider, 2000, pp. 38–49; Gemma Jansen, Ann Olga Koloski-Ostrow, Eric Moormann (Eds.), *Roman Toilets. Their Archaeology and Cultural History*, Bulletin Antieke Beschaving (BABESCH), Leiden, Peeters, 2011; Ann Olga Koloski-Ostrow, *The Archaeology of Sanitation in Roman Italy: Toilets, Sewers, and Water Systems*, Chapel Hill, University of North Carolina Press, 2015; Stefanie Hoss (Ed.), *Latrinae. Roman Toilets in the Northwestern Provinces of the Roman Empire*, Archaeopress Roman Archaeology 31, Oxford, Archaeopress Publishing, 2018, p. 3.

4 E.g. Xavier Dupré Raventós, Josep-Anton Remolà cit.; Alain Bouet, *Les latrines dans les provinces gauloises, germaniques et alpines*, Gallia Supplément 59, Paris, CNRS Éditions, 2009; Barry Hobson, *Latrinae et Foricae: Toilets in the Roman World*, London, Duckworth, 2009; Mark Bradley (Ed.), *Rome, Pollution and Propriety. Dirt, Disease and Hygiene in the Eternal City from Antiquity to Modernity*, Cambridge, Cambridge University Press, 2012; Jodi Magness, «What's the Poop on Ancient Toilets and Toilet Habits?», *Near Eastern Archaeology* 75, 2012, pp. 80–7.

5 Jansen *et al.* cit.

6 Hoss cit.

7 Hobson cit.; Jansen et al. cit.; Koloski-Ostrow cit.; Hoss cit.

ative of how common such structures must have been on military sites, as 40% of them (137 examples) have yielded latrines or latrine-related features[8]. Perhaps the best-known of these is the well-preserved and relatively technically elaborate communal stone ones at Housesteads, Hadrian's Wall[9], but there are also well-preserved communal examples at Bearsden, Caerleon, Castlecary, South Shields and Vindolanda[10]. Military latrines or associated features are also known outside Britain, e.g. Künzing[11], Oberaden[12], Trier-Petrisberg[13] and several in the Netherlands[14]. Such structures are often of some size, accommodating a number of sitters at one time. They are frequently found close to fort perimeters and at the lower end of sloping sites, which makes good practical sense regarding drainage, and smell and hygiene, with them away from accommodation areas. A number of smaller latrines are also known from barrack blocks, particularly in officers' areas, and the size of some suggests they were not just for his personal use but shared with his unit[15]. There are also latrines that seemed to have served only the *contubernium* ("tent-group", the smallest unit of men), where they were located in the front room (*arma*)[16]. In addition, and reflecting developments in the social hierarchy and segregation of toilet usage (below), there are individual latrines for

8 Adam Goldwater, Ann Olga Koloski-Ostrow, Richard Neudecker, «Users of the toilets: Social differences», in Jansen *et al.* cit., p. 136; Hobson cit., pp. 33–41; Koloski-Ostrow cit., 58–59.

9 Anne Johnson, *Roman Forts of the 1st and 2nd Centuries AD in Britain and the German Provinces*, London, Adam and Charles Black, 1983, pp. 211 ff.; Hobson cit., 34–35.

10 Hobson cit., pp. 33–41; Goldwater *et al.* cit., p. 136 with detailed refs; David Breeze, *Bearsden. A Roman Fort on the Antonine Wall*, Edinburgh, Society of Antiquaries of Scotland, 2016; Hoss cit.

11 Hans Schönberger, *Kastell Künzing-Quintana: die Grabungen von 1958 bis 1966*, Limesforschungen Römisch-Germanische Kommission des Deutschen Archäologischen Instituts 13, Berlin, Gebr. Mann, 1975, p. 88.

12 Bouet cit., pp. 373–83.

13 Thomas Fischer, *Army of the Roman Emperors. Archaeology and History*, Oxford, Oxbow, 2019, p. 244.

14 Monica Dütting, Frits Laarman, Wim Wouters, Wim Van Neer, «Spanish mackerels and other faunal remains from two Augustan latrines at the Kops Plateau (Nijmegen, the Netherlands)», in Jos Bazelmans, Eelco Beukers, Otto Brinkkemper, Inge van der Jagt, Eelco Rensink, Bjørn Smit, Marja Walrecht (Eds.), *Tot op het bot onderzocht. Essays ter ere van archeozoöloog*, Nederlandse Archeologische Rapporten 70, Amersfoort, Rijksdienst voor het Cultureel Erfgoed, 2020, pp. 73–86.

15 Goldwater *et al.* cit., p. 137; Koloski-Ostrow cit., p. 59.

16 Goldwater *et al.* cit., p. 138; Koloski-Ostrow cit., p. 59.

commanding officers[17].

These are structures or features in 'permanent' forts rather than temporary camps, or, as in the case at Numantia, in siege installations. The creation of human (and also animal) waste and its disposal, must have been of equal requirement, be the troops in temporary or permanent installations. How was this material dealt with in camps? For a 'marching camp' occupied for merely one night, it was perhaps less of an issue (though still important), but for longer-occupied camps it would have been no trivial matter, since such installations could have been occupied for weeks, if not months, especially in the case of sieges, and so quantities of waste would have been significant.

To assess the scale of what modern attitudes would regard as a problem, estimates of the overall quantity of waste produced can be attempted. It is obviously difficult to calculate such figures, as the amount of human excrement and urine generated daily, depends on many and varying factors, including diet, health, climate, lifestyle, body mass, ethnicity and age. A modern study of faeces and urine showed that the main factor in the amount of faeces produced is the quantity of fibre consumed, with the median daily production per person in high-income, low-fibre countries being 126 g of faeces, of which 28 g was dry mass and the rest water, and in low-income, high-fibre countries it was 250 g, of which 38 g were dry mass[18]. For both faeces and urine, it was found that the dietary composition of food and liquids is the major influence in variation of quantity and composition[19]. Another influence on faeces is that hot conditions reduce the proportion of water, becoming very small in desert heat[20]. The data also showed that people produced faeces at least once a day; a median of 1.1 motions in a 24-hour period, but more frequently with a higher fibre diet, and the UK data showed that most were relatively early in the morning[21]. The daily amount of urine produced aver-

17 Goldwater *et al.* cit., p. 137; Koloski-Ostrow cit., p. 62.

18 Christopher Rose, Alison Parker, Bruce Jefferson, Elise Cartmell, «The characterization of feces and urine: A review of the literature to inform advanced treatment technology», *Critical Reviews in Environmental Science and Technology* 45, Issue 17, 2015, pp. 1827–79.

19 Rose *et al.* cit., pp. 1827 ff.

20 Gabriel Moss, *Watering the Roman Legion*, unpubl. MA Diss., Chapel Hill, University of North Carolina, 2015, p. 3.

21 Rose *et al.* cit., p. 1838.

aged 1.42 litres per person, of which 59 g were dry solid content. The volume and composition of urine varies, though, depending on especially the amount of fluid and particularly water drunk, the amount of physical exertion and perspiration, environmental conditions and the quantity of salt and high protein consumed[22]. For lower volumes, extreme heat or desert conditions can reduce daily urine to below 0.5 litres a day[23]. Data on the number of times people urinate is limited, but may be of limited value anyway, as frequency is greatly affected by the amount of fluid intake, hydration levels and general health, but five or six urinations per 24-hour period may be typical[24], though becoming less frequent as ambient temperature rises and quantity of urine reduces. A modern experimental march in full Roman army equipment in hot conditions (21° C and above) observed that despite drinking hourly about 0.25 litres, urination occurred rarely or not at all[25].

These figures are for modern societies. It is unknown how they relate to ancient ones. The data from low-income, high-fibre areas are presumably more indicative in this respect, as they are likely to avoid refined modern western diets and lifestyles etc., and be closer to past practices.

To estimate the amount of sewage produced by the Roman army at Numantia, the data from low-income, modern areas could consequently be used as a guide, since Roman military diets (and ancient diets in general) would probably have been high in fibre, and largely unrefined and unprocessed. The Roman military food ration had 60–75% of its weight made up of wheat and is estimated to have been a daily personal ration of approximately 850 g[26]; wheat was one of the main human fuels in the ancient Mediterranean world[27]. The military wheat ration pro-

22 Dick Parker, S. Gallagher, «Distribution of human waste samples in relation to sizing waste processing in space», in Wendell Mendell (Ed.), *The Second Conference on Lunar Bases and Space Activities of the 21st Century*, NASA Conference Publication 3166.2, Houston, NASA, 1992, pp. 563–8; John Garrow, W. Philip James, Ann Ralph, *Human nutrition and dietetics* (10th ed.), Edinburgh, Churchill Livingstone, 2000; Rose *et al.* cit., pp. 1850 ff.

23 Moss cit., p. 3.

24 Rose *et al.* cit., p. 1851.

25 David Atkinson, Len Morgan, «The Wellingborough and Nijmegen Marches», in Michael Dawson (Ed.), *Roman Military Equipment: The Accoutrements of War,* British Archaeological Reports International Series 336, Oxford, BAR Publishing, 1987, p. 102.

26 Jonathan Roth, *The Logistics of the Roman Army at War (264 BC–AD 235)*, Leiden–Boston–Cologne, Brill, 1999, p. 24.

27 Geoffrey Rickman, «The Grain Trade under the Roman Empire», *The Seaborne Com-*

vided the same proportion of daily calories as its weight[28]. When the wheat was ground, it could yield about 760 g of actual flour[29], and would presumably have resulted in our modern equivalent of wholemeal flour, since it would have been both wasteful and time-consuming to remove the nutritional bran. Wholemeal flour is high in fibre; modern wholemeal flour has approximately 11 g of fibre per 100 g. The current recommended daily intake of fibre is at least 30 g[30]. Consequently the Roman allowance of 850 g of wheat would have been more than adequate to provide a very good healthy fibre diet, with potentially more than twice the modern recommended amount.

Using the low-income, high-fibre data, a single Roman soldier would consequently have daily produced about 250 g of faeces and 1.42 litres of urine (assuming 'average' European conditions and not extreme heat). That means that the smallest units of the Roman army, a *contubernium* of 8 infantry, would produce 2 kg of faeces and 11.36 litres of urine, and a *contubernium* of 3 cavalry troopers would produce 0.75 kg and 4.26 litres each day. In terms of cubic volume, which is more the problem being faced as regards disposal, and easier for us to visualise, this equates to a cube with sides of about 12 cm for the faeces of each infantry and 9 cm for each cavalry *contubernium*. Such quantities are significant, as this is the daily amount needing disposal. If they are scaled up to a legion with its associated cavalry, which for the period of Numantia was a 'paper strength' of about 4,200 infantry and 300 cavalry[31], the quantities start to become concerning: 1.125 tonnes of faeces and 6,390 litres of urine every day. This equates to about 1 m^3 of faeces and 6.4 m^3 of urine.

merce of Ancient Rome: Studies in Archaeology and History. Memoirs of the American Academy in Rome 36, 1980, p. 262.

28 Roth cit., p. 18.

29 It has been calculated that a kilogram of ancient wheat could yield about 900 g of flour (J.K. Evans, «Wheat production and its social consequences in the Roman world», *The Classical Quarterly* 31, 1981, p. 432, n. 24). Modern conversion rates, to be expected, are higher, at about 950 g.

30 British Nutrition Foundation, «Fibre», *https://www.nutrition.org.uk/healthy-sustainable-diets/starchy-foods-sugar-and-fibre/fibre/* [accessed November 2023].

31 Mike Dobson, *The Army of the Roman Republic. The Second Century BC, Polybius and the Camps at Numantia, Spain*, Oxford, Oxbow, 2008, pp. 47 ff.

Size of armies at Numantia and their sewage

To scale the figures up for the size of armies at Numantia is unfortunately not straightforward as their actual size is uncertain. The best source of troop numbers is Appian *Hisp.* 45 ff., but his accuracy and reliability are questionable[32]. There is also little in the way of detail, with, for example, no indication of whether the infantry was organised as maniples or cohorts, or about the internal organisation of the non-citizen forces[33]. Similarly, the nature or size of the garrisons in each installation are never indicated[34]. The scale of the sewage problems at Numantia, and specifically at each site, is consequently uncertain. The available information suggests that the armies associated with the Numantine campaigns mostly comprised about 30,000 men[35]; Appian's claim that Scipio's siege army numbered 60,000 is questionable, and it was probably also in fact about 30,000[36]. These armies tie in with the theoretical strength of the typical consular armies at the time, with two legions, allied forces and foreign troops[37].

The potential daily sewage generated by such armies is astonishing:

Faeces: 7.5 tonnes (approx. 7.5 m^3 = a cube with sides of 1.96 m)

Urine: 42,600 litres (42.6 m^3 = a cube with sides of 3.49 m)

Putting this into meaningful perspective, in just under a month, a football pitch would be covered with 3 cm of faeces and the urine would fill an Olympic-sized swimming pool one metre deep.

32 Dobson cit., pp. 41–42.

33 Dobson cit., p. 42.

34 Dobson cit., p. 42.

35 App. *Hisp.* 45 ff.; Dobson cit., pp. 43–44.

36 Mike Dobson, «A green and pleasant land. Not once the Romans arrived!», in Toni Ñaco del Hoyo, Jordi Principal, Mike Dobson (Eds.), *Rome and the North-Western Mediterranean. Integration and Connectivity* c. *150–70 BC*, Oxford, Oxbow, 2022, p. 70.

37 Polyb. 6.19.1 ff.; Dobson 2008 cit., pp. 56 ff. The calculation is: legion (I) 4,200 + legion (II) 4,200 + legionary cavalry (I) 300 + legionary cavalry (II) 300 + allied infantry (I) 4,200 + allied infantry (II) 4,200 + allied cavalry (I) 900 + allied cavalry (II) 900 = 19,200. Plus senior officers, their staff, non-combatants. Plus unspecified number of foreign troops. Could reasonably round up to about 30,000.

Manure

To these figures should be added the dung and urine produced by the cavalry horses, transport mules and any other animals (e.g. cattle on the hoof for food) accompanying the army.

The amount of dung and urine a horse produces will vary depending on diet, climate, working conditions, breed and size, etc. As regards the size of cavalry horses in the Roman army, skeletal remains suggest they varied between 10 and 15 hands (102–152 cm)[38], possibly sometimes larger[39]. Some scholars interpret the evidence to form an average and say that all cavalry used horses of about 14 hands (142 cm), but as Dixon and Southern warn, this could distort discussions and a wider picture should be retained; also size may have varied during the Roman period[40]. Noting their warning, it is useful for the purposes of calculating the amount of waste generated by the cavalry, if an average of 14 hands is used.

A modern horse of 14 hands typically weighs 350–420 kg[41]. Cavalry horses of the Roman army may have differed from this, but it seems reasonable to take the mid-point in this range for the purposes of the following calculations, and perhaps lower it a little as nutrition, feed quality and conditions may have been poorer in the past; so resulting in an average weight of about 380 kg.

Modern horses typically produce 4 to 13 piles of manure a day. On average, a horse daily produces 31 g of faeces and 19.7 ml of urine per kilogramme of body weight. A typical 380 kg, 14-hand horse hands would thus daily produce about 19.25 kg of wet manure (60% solids and 40% urine, with a density of about 954 kg per cubic metre), equating to 11.7 kg of faeces (0.012 m^3) and 7.6 litres of urine (0.0071 m^3), resulting in the overall wet manure of 19.25 kg being 0.019 m^3. To that can be added the straw/grass/etc bedding, which requires regular changing. In modern calculations, the volume of bedding is about twice the amount of manure. It is uncertain how frequently Roman soldiers cleaned their stables,

38 Hands are measured from ground to top of withers, the ridge between shoulder bones above the front legs.

39 Karen Dixon, Pat Southern, *The Roman Cavalry. From the First to the Third Century AD*, London, Batsford, 1992, pp. 165 ff.

40 Dixon, Southern cit., pp. 167 ff.

41 Equine World UK, «Horse Body Weight», *https://equine-world.co.uk/info/horse-care/horse-body-weight* [accessed November 2020].

but daily would have been advisable to maintain horse health, especially their hooves, which become soft and weak in wet conditions[42]. That results in a daily amount of material of 23–27 kg (0.057 m^3, a cube of about 39 cm), but clearly less if the cavalry were on manoeuvres outside the camp. That may not seem much, but it would result in a single horse filling a 3.5 x 3.5 m stall to a depth of 1.83 m after a year if it were not cleaned out![43] It is unclear which buildings were occupied by cavalry at Numantia, but for this period it can be suggested that combined stable/barrack accommodation blocks existed, probably similar in form to how the horses and men were arranged in the stable/barrack blocks being increasingly suggested in Imperial forts[44]. Such blocks at Numantia can be reconstructed with each stable room holding three horses. The rooms' internal dimensions are difficult to assess, due to the nature of the surviving remains and the uncertainties about reconstruction, but rectangular areas between 3 to 5 m across are possible[45]. Using the above figures, three horses in such areas would have daily generated a depth of about 12 cm of combined manure and bedding (a staggering 4.48 m a year). The requirement for daily cleaning would have been imperative, not just to maintain horse health, but after a day, the accumulated debris would have been over ankle-deep for the soldiers.

Removing the daily 75 kg of stable material must have been very arduous in the high Numantine summer heat, especially as it must have required being taken outside of the camp since it would soon have blocked streets and hindered troop movement. Collectively, a camp which included cavalry would have generated huge quantities of manure each day. In terms of the cavalry at Numantia, exact numbers are uncertain (above) and would have varied between the armies. Consular armies at the time would theoretically have had 600 legionary and 1800

42 Ann Hyland, *Equus: The Horse in the Roman World*, London, Batsford, 1990, p. 124.

43 Data from various sources, especially Eileen Fabian, Jennifer Zajaczkowski, «Horse stable manure management», 2019, *https://extension.psu.edu/horse-stable-manure-management* [accessed October 2020].

44 C. Sebastian Sommer, «Where did they put the horses?" Überlegungen zu Aufbau und Stärke römischer Auxiliartruppen und deren Unterbringung in den Kastellen», in Wolfgang Czysz, Claus-Michael Hüssen, Hans-Peter Kuhnen, C. Sebastian Sommer, Gerhard Weber (Eds.), *Provinzialrömische Forschungen. Festschrift für Günter Ulbert zum 65. Geburtstag*, Espelkamp, Marie Leidorf, 1995, pp. 149–68; Nicholas Hodgson and Paul Bidwell, «Auxiliary Barracks in a New Light: Recent Discoveries on Hadrian's Wall», *Britannia* 35, 2004, pp. 121–57; Dobson 2008 cit.

45 Dobson 2008 cit.

allied cavalry[46]. Armies at Numantia could have exceeded this, from the extras that Appian notes (above). The cavalry would also have needed remounts to cover injured or sick animals[47]. The number of these is uncertain, but even if it was only one per ten-man squadron (*turma*), a sensible minimum number, it means that the total number of cavalry horses becomes 2,640 in a consular army. The daily amount of combined manure and bedding consequently produced could have been approximately 66 tonnes, 150 m^3. To that would be added horses for the senior officers etc., but also less an (uncertain) amount for while the horses were out of camp, e.g. on active duties, watering or grazing[48].

A significant amount of material would also be produced by the pack animals, with one or possibly two mules per *contubernium*[49]. Associated officers (centurions and decurions) may also have had their own mule for transporting their tents etc. This produces a total of 3,220 mules for the troops of a consular army[50], but this should be seen as a minimum figure, as it is based on only one mule per *contubernium* and does not include pack animals for senior officers, their staff, non-combatants etc.

The mules probably generated similar quantities of manure and bedding to the cavalry horses, i.e. about 80 tonnes, 180 m^3 a day. A staggering combined horse and mule daily total is 146 tonnes, 333 m^3 (less an amount while the animals were out of camp). To repeat the football pitch analogy, one would be covered to a depth of 1 metre every three weeks. It may have been even quicker, as there would also be manure from the oxen probably used for drawing wagons[51]. And not to forget the elephants in some of the armies!

46 Dobson 2008 cit., pp. 50 ff.

47 Dixon, Southern cit., pp. 156 ff.

48 Veg. *Mil.* 3.8 refers to horses grazing outside the camp.

49 App. *Hisp.* 85–86; Roth cit., pp. 77 ff.

50 The calculation is: legion (I) 525 *contubernia* + 60 centurions + legion (II) 525 *contubernia* + 60 centurions + legionary cavalry (I) 100 *contubernia* + 10 decurions + legionary cavalry (II) 100 *contubernia* + 10 decurions + allied infantry (I) 525 *contubernia* + 60 centurion + allied infantry (II) 525 *contubernia* + 60 centurion + allied cavalry (I) 300 *contubernia* + 30 decurions + allied cavalry (II) 300 *contubernia* + 30 decurions = 3,220.

51 App. *Hisp.* 85; Roth cit., p. 83.

Camp cleanliness – location of toilets

Although it seems obvious that the debris produced by the horses must have been regularly taken out of the camp, for the sake of simple practicalities would the same have applied to the human-produced waste?

There is very limited literary evidence about Roman toilet habits[52]. The few examples are usually crude or derisory observations made about activities in public toilets, e.g. by Martial. The impression, though, is that they were social places; Martial even mocks someone for spending so much time in them hoping to gain a dinner invitation[53]. The archaeological evidence of toilets with several seats indicates the social aspect of this basic human activity. The presence of gaming boards scratched between seats also implies that people would spend some time sitting in these areas. Going to the toilet can consequently be regarded as a social thing by Romans[54]. This is not only unexpected with our modern Western notions wanting privacy for such activities, but also surprising that anyone would want to spend time in what must have been exceedingly smelly environments, as attested at the time[55].

Private toilet facilities inside houses generally ranged from chamber pots, which could be specifically made vessels or recycled ones,[56] to individual seats over a cesspit[57]. These, however, often lacked a sense of privacy, with a frequent arrangement being a seated cesspit next to the kitchen stove or in the kitchen area. Such cesspits also functioned as rubbish pits for kitchen waste[58]. A totally unimaginable configuration and practice to our modern sensibilities. There were also latrines away from the kitchen, frequently in a room next to the street (drain-

52 Hobson cit., pp. 133–47.

53 Mart. 11.77.

54 Jansen *et al.* cit.; Magness cit.

55 E.g. Cic. *Nat. D.* 2.56.141; Columella *Rust.* 1.6.11, 9.5.1; Jérôme Carcopino, *Daily Life in Ancient Rome*, Harmondsworth, Penguin Books, 1956, p. 54; Hobson cit., pp. 106–108 with a very graphic description of his own experiences of extreme smells while emptying a Pompeii latrine used by tourists.

56 E.g. Varro *Sat. Men.* 192.104 refers to *amphorae* being reused.

57 Hobson cit., 46–60; Beatrix Petznek, Silvia Radbauer, Roman Sauer, Andrew Wilson, «Urination and defecation Roman-style», in Jansen *et al.* 2011, pp. 95–111; Magness cit., p. 81; Koloski-Ostrow cit.; Beatrix Petznek, «Roman chamber pots», in Hoss 2018 cit., pp. 127–35.

58 Magness cit., p. 82; Koloski-Ostrow cit.

ing into a cesspit under the pavement to allow easy emptying), but probably not for the slaves or servants, whose latrines remained in their work areas[59]. Such segregation and social hierarchy of usage increased from the late Republic and especially into the second century AD[60].

Consequently, we need to distance ourselves from modern Western practices of a separate and potentially secluded location for performing toilet activities; the sense of 'privacy' is very culturally determined and complex[61]. Indeed, the evidence of Roman graffiti and wall signs suggest that Romans would potentially simply urinate and defecate anywhere, not only outside but also even inside a building, as the texts request refrain from doing this[62]. Related to this, is that Roman culture lacked the modern obsession with toilet privacy, general cleanliness and hygiene, all of which change between cultures and over time, with also variable definitions of pollution and dirt[63]. Indeed, Roman streets may have been more alike to open sewers and rubbish dumps, of unimaginable smell for our noses[64], than to the clean, uncluttered streets that can nowadays be walked down in Pompeii and Herculaneum, for example, though street cleaning in Rome and presumably other cities was meant to have occurred, but often ignored[65]. No longer does the modern visitor have to face the threat, according to Juvenal, of falling rubbish or a soaking from a chamber pot being emptied onto the street from a

59 Hobson cit., 79 ff., p. 168; Goldwater *et al.* cit.; Jesus Pérez, Miko Flohr, Barry Hobson, Jens Koehler, Ann Olga Koloski-Ostrow, Silvia Radbauer, Jeroen van Vaerenbergh, «Location and contexts of toilets», in Jansen *et al.* 2011, pp. 113–30; Koloski-Ostrow cit., p. 6.

60 Goldwater *et al.* cit., p. 141; Koloski-Ostrow cit., p. 6.

61 Alexander Kira, «Privacy and the bathroom», in Harold Proshansky, William Ittelson, Leanne Rivlin (Eds.), *Environmental Psychology: Man and his Physical Setting*, New York, Holt, Rinehart and Winston, 1970, pp. 269–75.

62 Hobson cit., p. 142 ff.; Magness cit., p. 82.

63 Kira cit.; Louise Martin, Nerissa Russell, «Trashing rubbish», in Ian Hodder (Ed.), *Towards Reflexive Method in Archaeology: The Example at Çatalhöyük*, British Institute of Archaeology at Ankara Monograph 28, 2000, pp. 57–69; Hobson cit., pp. 79–87; Bradley cit.; Magness cit., p. 80; Koloski-Ostrow cit.; *Die übelriechende Metropole? Olfaktorische Perspektiven auf die Großstadt der Vormoderne*, International Conference, Universität Regensburg, November 2023.

64 Though arguably "smell is in the nose of the smeller, but also in the culture of the smeller"; Anthony Synnott, *The Body Social: Symbolism, Self and Society*, London, Routledge, 1993, 193.

65 Juv. 3.248; Hobson cit., pp. 92 ff.

window above[66]; this could well be Juvenal's satirical exaggeration, but there was presumably some truth behind it[67]. But the 'problem' as we would see it today, was likely to have been the norm in all the ancient world, not just the Roman. In ancient Palestine it was even necessary to prevent the reciting of religious texts in alleyways soiled with excrement, it must have been that common, though some Jewish sects were very particular about privacy, isolation and cleanliness when defecating, including making sure the faeces were properly covered by soil in a pit in a remote spot[68]. So, a Roman soldier walking through the Celtiberian streets of Numantia would probably have felt 'just as at home' as in his own home city, wherever that was, with perhaps only just different culinary smells.

Such uncleanliness would clearly have been perilous as a source of disease and health conditions, though perhaps not fully appreciated in the ancient world[69]. Diseases associated with inadequate sanitation account for 10% of modern disease problems[70]. Poor sanitation and management of waste also affect the environment through contaminating water sources, soils and food sources[71].

Our modern views of cleanliness need to be dispelled when considering the appearance of Roman camps. There is probably a tendency to think of these like modern army camps and barracks, with clean and ordered streets. Such a view would also be fuelled by modern reconstructions of Roman forts; the streets and building interiors are pristine (and rightly so to maintain visitor health). We should think perhaps not of the 'clinical' Saalburg, Germany (Fig. 3), but the shanty towns and slums in parts of the Third World, to more accurately appreciate the appearance and atmosphere of Roman military installations. Archaeological evidence to support this comes from excavations in the fort at Carlisle, Britain. It was noted that although the interior of buildings was relatively clean, there was what would now be called 'litter' in all the streets and large quantities of butch-

66 Juv. 3.269–277; Carcopino cit., pp. 54–55.

67 Laura Nissin, «Smellscape of a Pompeian neighborhood», *Journal of Roman Archaeology* 35, 2022, pp. 625, 641; Übelriechende Metropole cit.

68 Albert Baumgarten, «The Temple Scroll, Toilet Practices, and the Essenes», *Jewish History*, 10.1, 1996, 9–20; Magness cit., pp. 82 ff.

69 Hobson, cit., pp. 147–154

70 Annette Prüss-Üstün, Robert Bos, Fiona Gore, Jamie Bartram, *Safer water, better health: Costs, benefits and sustainability of interventions to protect and promote health*, Geneva, World Health Organisation, 2008.

71 Rose *et al.* cit., 1828.

ery and industrial waste were allowed to accumulate along especially the minor streets (though this may represent the final dumps in a sequence of dumping and regular clearance), and make-up layers and dumps associated with clearance and rebuilding contained industrial and other debris from elsewhere, suggesting the clearance and moving of middens inside the fort[72]. Some pits accumulated human and/or animal sewage "on a fairly casual basis"[73]. Another toilet-link for these pits is that they also contained moss. Moss was commonly used for bottom-cleaning in the West before toilet paper became readily available in modern times, and is being found increasingly in Roman military installations[74]. Moss is very suitable as it is highly absorbent and coincidentally its high iodine content makes it naturally anti-bacterial. The widespread distribution and location of bones suggests that butchery could have taken place along street edges; perhaps carcasses were issued to units and then butchered by or for each *contubernium*. It is consequently no surprise that the environmental evidence indicates large numbers of flies and other insects were breeding in what are seemingly puddles of rotting waste in areas of Carlisle fort. Some of the identified insect species are known to carry pathogens and eggs of human parasites (e.g. *Trichuris* worms) into housing, the two commonest being the house fly (*Musca domestica*) and stable fly (*Stomoxys calcitrans*), which can spread salmonella, typhoid, diarrhoea and possibly even poliomyelitis, and so would have directly impacted on human health[75]. Evidence of both roundworm (*Ascaris*) and whipworm (*Trichuris*) was found in human-sewage deposits at Bearsden fort, Scotland[76]. This fort also yielded similar evidence of what would now be regarded as squalor, indicated by beetles which

72 Christine Howard-Davis, *The Carlisle Millennium Project. Excavations in Carlisle, 1998–2001*, Lancaster Imprints 15, Lancaster, Oxford Archaeology North, 2009, p. 520.

73 Howard-Davis cit., p. 527; presumably meaning they were used as toilets or for receiving such waste as required.

74 Elizabeth Huckerby, Frances Graham, «Waterlogged and Charred Plant Remains», in Howard-Davis cit., p. 929; Breeze cit., pp. 327–330, 384; Camilla Dickson, James Dickson, «Plant remains», in Breeze cit., p. 234; for other methods see Petznek *et al.* cit., 102–104.

75 Harry Kenward, Allan Hall, «Biological evidence from Anglo-Scandinavian deposits at 16–22 Coppergate», *The Archaeology of York* 14.7, York, Council for British Archaeology, 1995, p. 762; Howard-Davis cit., p. 527; David Smith, Emma Tetlow, «Insect Remains», in Howard-Davis cit., pp. 925–6.

76 Andrew Jones, Jef Maytom, «Parasitological investigations of the east annexe ditch», in Breeze cit., pp. 301–303.

Fig. 3 The pristine reconstructed Saalburg fort, being visited by its main initial financial patron, Kaiser Wilhelm II
(copyright Römerkastell Saalburg; reproduced by permission).

fed on rotting hay, perhaps bedding, and on the dung of large herbivores, either horses or cows[77]. Both sites also had evidence of human fleas[78].

It should therefore be no surprise that a large number of Pompeius' troops suffered from and even died of dysentery in winter camp at Numantia in 141/42 BC[79]. Appian also comments that some of Nobilior's troops died "inside the camp from the shortage of space and from the cold" in their winter camp in 151/52 BC[80], which presumably relates to health-impacting living conditions.

In a Roman military context, contemporary practice meant there would have been little notion of the soldiers wanting privacy or to be distant from their col-

77 Breeze cit., p. 371.

78 Howard-Davis cit., p. 527; Breeze cit., p. 371.

79 App. *Hisp.* 78.

80 *Hisp.* 47; trans. John Richardson, *Appian. Wars of the Romans in Iberia*, Warminster, Aris and Phillips, 2000.

leagues for toilet purposes (Fig. 4). This institutional practice would also have the beneficial effect of reinforcing the relative unimportance and anonymity of the individual[81], making the ordinary soldier simply part of a slave-like military team (just like the latrines for slaves being in their work areas in houses; above). So where and how far away did they go? There is no obvious literary evidence for the Roman army in this respect. There is some for the Spartan army[82]. This indicates that since sentries were to be constantly ready for action, they were forbidden to go further from their weapons and comrades for toilet purposes than to avoid giving offence[83]; this would have been a very sensible regulation from the military aspect[84]. But in general, the Spartans seemed to have allowed soldiers to go outside the camp in the morning for toilet purposes, as a Spartan-trained Greek army is recorded as suffering defeat by a calculated surprise attack while the troops were dispersed in this way[85]. For the ancient Middle East, a Dead Sea Scroll, the War Scroll, specifies that the toilets for camps occupied by the army of the Sons of Light (Qumran Jewish sect) should be placed 2,000 cubits (about 900 m) from camps[86]. There is an interesting detail in Old Testament law, which specifies that soldiers have a specified area outside the camp for going to the toilet, and they should have a trowel as part of their equipment to dig a hole and bury the excrement[87]. Similarly, Josephus comments that new members of the Essene Jewish sect were given a pick to dig a small trench in the ground for toilet purposes[88]. Such toilet cleanliness and desire for privacy was, however, unusual to Jewish religious practice (though probably derived from excellent practical commonsense) and very different from the Roman world. But even Jewish practice seems at times to have had a very practical approach to the matter, and required going some distance for toilet purposes only during the day, for one Talmud text advises going to the toilet early in the morning or in the evening so that a cleared

81 Kira cit.

82 John Anderson, *Military Theory and Practice in the Age of Xenophon*, Berkeley, University of California Press, 1970, p. 61.

83 Xen. *Lac.* 12.4.

84 Anderson, though, seems to view this regulation as a general requirement rather than just for the sentries (cit., p. 61).

85 Xen. *Hell*. 2.4.6; Anderson cit., p. 66.

86 Magness cit., p. 83.

87 *Deuteronomy* 23.9–14.

88 *BJ* 2.137; 2.147–149; Baumgarten cit., 11–12.

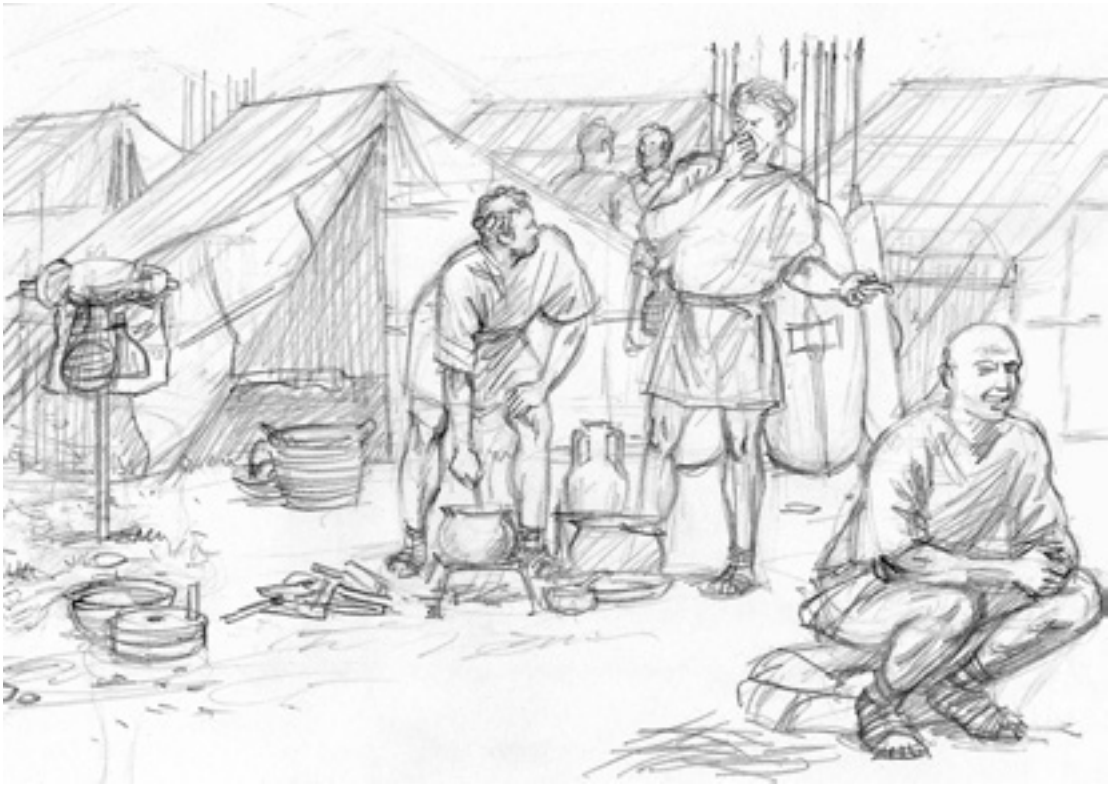


Fig. 4 Sketch reconstruction of the area in front of an infantry tent, with latrine/rubbish pit amusingly in use (artist and copyright: William Webb; reproduced with permission).

spot in the nearby street or behind a building could be used and so avoid having to go some distance for such needs[89].

The existence of latrines in so many Roman forts (above) obviously shows that there was provision for the soldiers to go to the toilet within the confines of a fort, and this may have been normal practice. Though this does not mean that soldiers used only this facility; they are arguably rather small to have accommodated the daily requirements of a garrison. There remains the possibility of soldiers going outside the fort (though walking distance and security probably rendered that impractical), or perhaps using other receptacles (e.g. refuse pits/cesspits or chamber pots) within the fort. Presumably the soldiers were not allowed simply to follow civilian practice and use the streets as open toilets; certainly, modern notions of

89 Magness cit., p. 86.

military discipline and cleanliness could never countenance this (below).

Since the layout of forts and camps was closely related, and the former was simply the physical 'permanent' transposition of the 'temporary' former in both essence and layout[90], perhaps there were designated latrine areas within them, as in the forts. Soldiers could have followed the Greek and Jewish practice mentioned above, and gone out of the camp, perhaps even some distance from it. This made good hygiene sense, but as the successful attack on the Greek troops shows, it would have been a very risky thing to do in hostile territory. From a practical and military point of view, it also made little sense and would undermine security of the whole camp, as it would have meant a very large proportion of the troops being out of camp in the early morning, when most men are prone to require to defecate; modern figures indicate 61% of men between 6 and 10 a.m. and 20% of those between 7 and 8 a.m.[91] Hence, a likely scenario is that the toilets were closer to accommodation. In that sense, it would have mirrored civilian practice and that found in forts.

Presumably, total freedom in the camp to follow civilian practice and urinate and defecate anywhere and in the streets would not have been encouraged and may even have been forbidden. If the streets were like those in towns, and covered in sewage (and rubbish) they would become both slippery and slow to traverse by troops. This would hinder troop deployment, a vital requirement and one to be performed as quickly as possible. Polybius, in his digression on the Roman camp[92], actually indicates that importance was given to such requirements, since he says that two maniples (about 240 men) were required to keep the ground in front of the tribunes' tents swept clean and watered with great care, as this was the general resort of the troops during the day[93]. What Polybius does not specify is that this area was actually the main street through the camp[94] and so logistically vital to be kept clear; and hence also the labour requirement of that many men to keep such a long and wide street clean.

If the evidence from forts is used, a toilet model for camps can be suggested.

90 Dobson 2008 cit.
91 Rose *et al.* cit., p. 1838.
92 Polyb. 6.26–42.
93 Polyb. 6.33.3–4.
94 Dobson 2008 cit., pp. 68 ff.

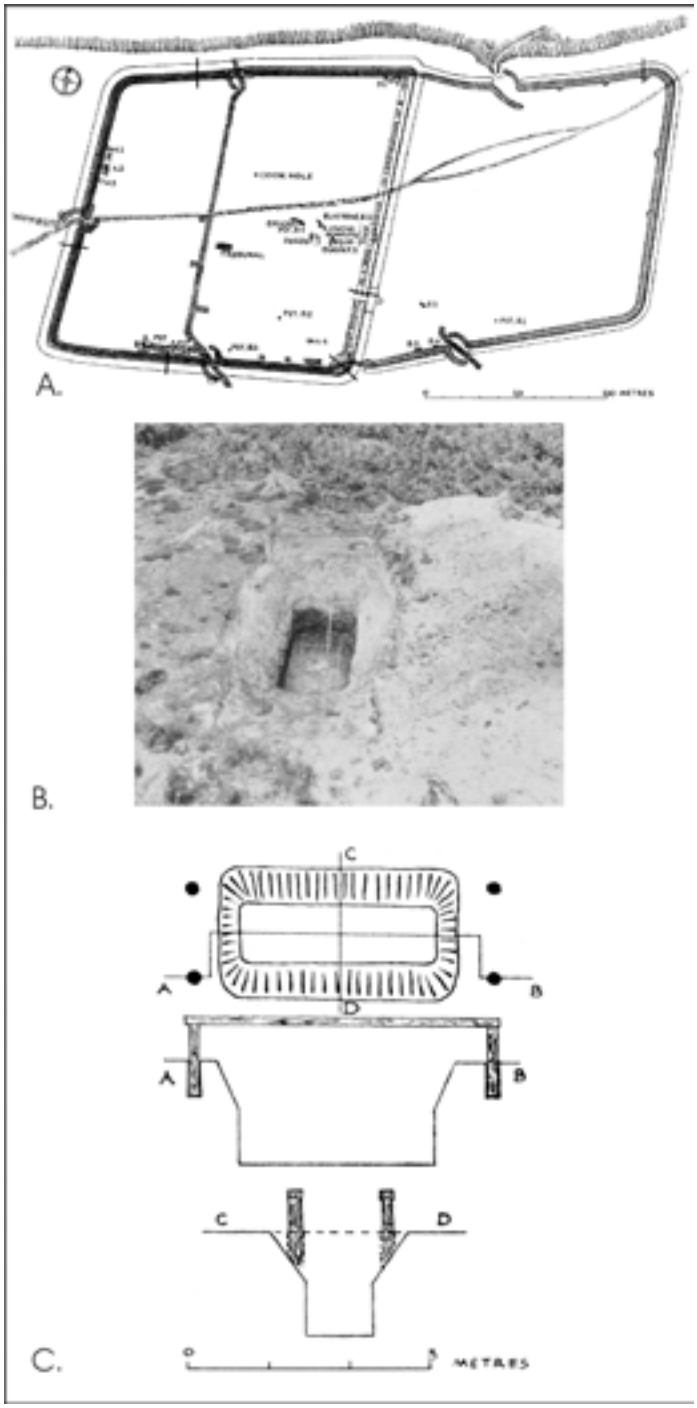


Fig. 5 Cawthorn, Britain. A) camps A and B with numerous pits inside. B) and C) photograph and drawing of possible latrine trench B5 of camp B (after RICHMOND cit., plates XX, XVII, fig. 18).

The camp *intervallum*, like the fort one, would have been a very convenient and practical location for the communal latrine facilities as found in forts. In the camps at Cawthorn, Britain, for example, several pits were interpreted as latrines, in part as they were very close behind the ramparts[95] (Fig. 5). Perhaps these were similar to the communal latrine trenches dug by armies in World War One, with a long horizontal pole as a seat over the trenches, seen in photographs of the period and with frequent horror stories when the poles broke! (Fig. 6). Such facili-

95 Ian RICHMOND, «The Four Roman Camps at Cawthorn, in the North Riding of Yorkshire», *Archaeological Journal (for 1932)* 89, 1933, pp. 17–78.

Fig. 6 German soldiers using a pole latrine during World War One (source: https://www.vintag.es/2019/03/wwi-latrines.html; accessed November 2023).

ties are described in detail, including specifying the pole, and illustrated in a 1911 British army manual[96] (Fig. 7). One pit at Cawthorn (though about 25 m distant from the rampart), interestingly resembled the shape and form of a British army trench latrine, complete with post-holes near either end for supporting a seat along the trench, as the excavator noted, "the type corresponds closely to that dug by the modern army in the field"[97], though it is significantly bigger than those specified in the manual (below). Consequently, some Roman camp latrines could have consisted of a series of open trenches in the *intervallum*, with users squatting along the sides, or on some form of timber pole or seating (Fig. 8).

96 *Manual of Field Engineering. 1911*, London, His Majesty's Stationery Office, 1911, pp. 57–58, plate 38.

97 Richmond cit., pp. 68–69.

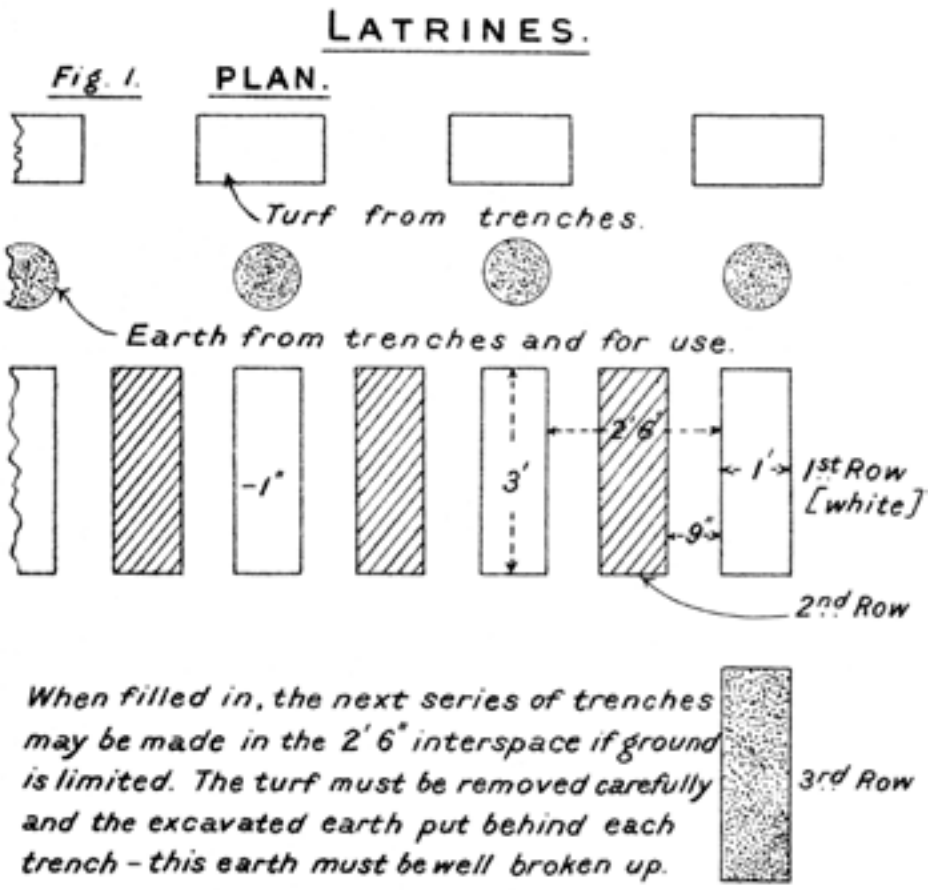


Fig. 7 British army field manual diagram of how to construct latrines (Manual 1911 cit., plate 38).

It is interesting to note the high importance the British army placed on the timing of latrine construction: "Latrines should be dug as soon as possible after the troops reach their camp or bivouac"[98]. The Roman army may have felt the same, but the great care and precision described by the British is probably more a hallmark of modern, disciplined and cleanliness-driven armies.

The British specified five trenches, 3 by 1 feet and at least 1 feet deep (0.9 x 0.3 x 0.3 m), to be provided for 100 men for one day, and ideally new trenches

98 Manual cit., p. 57.

dug each day, with the previous day's trenches backfilled; if any remained in use beyond a day, it was recommended that 2 inches (5 cm) of dry earth were used to cover smell and reduce flies[99]. If the Roman army adopted this for the armies at Numantia, it would have required hundreds of trenches. There is no known evidence for such trenches at Numantia, however. This may be due to the excavation techniques at the time of Schulten's excavations in the early 1900s[100] or because the ground is generally rocky[101] and so digging trenches would have been impractical. As an alternative, perhaps the latrines here consisted simply of designated areas in the *intervallum*, perhaps with the material confined within a ring of stones or earth etc. Fortunately, nearly all the installations at Numantia were on raised ground, with slopes leading away from the defences on most sides. Consequently, latrines near the defences would easily allow liquids to drain out of the camp. The siege forts at La Vega and Molino were unusual exceptions, being on level ground, but they were so close to rivers that liquids would soon find their way into those (though river pollution would be a potential hazard; below). The solid material in such 'surface' latrines would require removal, if only for the practicality of retaining capacity in these areas. Even if the latrines were trenches, there would have been insufficient space in the longer-occupied sites to be able to have a sequence of British-army-style new and back-filled trenches along the *intervallum*. It has often been stated that a first century AD duty roster of Legio III Cyrenaica in Egypt shows the soldier M. Longinus being on latrine cleaning duty[102], and it is reasonable to suppose that such duties may have long been in place. But, as Juntunen convincingly argues, in this case, it is more likely that *ad stercus* means Longinus is working at the dung heap by the stables or at a general waste dump outside the fort[103].

As well as latrines in the camp *intervallum*, the practice in forts of smaller latrines within barrack complexes (above) could well have had equivalent within

99 Manual cit., pp. 57–58.

100 Dobson 2008 cit., pp. 28–29.

101 At Renieblas, for example, today the bedrock is very close to the surface and often even forms the surface; it can be seen in the right-hand part of Fig. 12.

102 Robert Fink, «papyrus 9, 32g», in *Roman Military Records on Papyrus*, Cleveland, American Philological Association, 1971, pp. 110–111; Johnson cit., p. 214; Goldwater *et al.* cit., p. 138.

103 Kai Juntunen, «The meaning of *stercus* in Roman military papyri – dung or human faeces? Or: who is supposed to clean *this* shit up?», in Hoss 2018 cit., pp. 143–51.

Fig. 8 Reconstruction of a Roman pole-seat trench latrine in the *intervallum*. A timber-stake, *chevaux-de-frise* can be seen on top of the low stone/earth rampart behind the sitters (artist: William Webb; copyright: William Webb and Karwansaray Publishers; reproduced with permission).

and at the end of the rows of tents in camps. Numerous pits are usually found in camps and some could potentially have functioned both as rubbish and cesspits (e.g. as at Carlisle, above). Perhaps each *contubernium* had its own receptacle, placed in front of each tent, like the small latrines found in the *arma* of forts (above; Fig. 4). They would then have been convenient from a practical point of view. Although cooking would have been performed in these areas in front of the tents[104], a toilet in the same area would have simply mirrored the situation found in civilian Roman kitchens (above), would consequently have seemed normal to the troops and provided a similar very convenient combined rubbish and cesspit. As with the absence of latrine trenches in the *intervallum* of camps at Numantia, no such pits have been found inside these camps, for the same reasons. As an alternative, perhaps the debris just formed a pile on the ground, or more sensibly confined within a circle of stones or shallow depression in the ground. Large pots, recycled or intended for that purpose, or recycled *amphorae* (many sherds were found at Numantia) could also have been used as containers. An example of a 'toilet/rubbish pot' could be the large Iberian *dolium* found upright in the ground against a wall at Travesadas (Fig. 9)[105], though clearly this could have been a storage vessel for anything.

As with the *intervallum* latrines, whatever was used near the tents to contain the sewage and rubbish would have needed periodic emptying. Some of the contents may have been useful. Urine was used at the time in some manufacturing process (though possibly not as extensively as often claimed[106]) and general cleaning. Appropriate to Numantia, the Celtiberians were known to use urine for teeth cleaning:

> "Egnatius, who has shiny, white teeth, grins forever everywhere […] Now you're a Celtiberian: and in the Celtiberian land early in the morning they piss and scrub their teeth and pinky gums with it, so that the higher the polish on your teeth, the more it proclaims that you have drunk your piss."[107]

104 Roth cit., p. 59.

105 Adolf Schulten, *Numantia. Die Ergebnisse der Ausgrabungen 1905–1912. Band III. Die Lager des Scipio*, Munich, Bruckmann, 1927, p. 224, fig. 29.1; Dobson 2008 cit., p. 302.

106 Andrew Wilson, «The economy of ordure. The uses and value of excrement», in Jansen *et al.* 2011, pp. 147–8.

107 *Catull. 39; trans.* Perseus, «C. Valerius Catullus, *Carmina*», *Perseus digital library translation, based on Leonard* Smithers and Richard Burton, *The Carmina of Gaius Valerius Catullus*, 1894, *http://data.perseus.org/citations/urn:cts:latinLit:phi0472.phi001.*

Fig. 9 Iberian *dolium* set in the ground by a wall of a building in Travesadas camp, Numantia (Schulten 1927 cit., plate 29.1).

Consequently, urine may have been collected separately in a pot, convenient for subsequent use[108]. As for the faeces, these could have retained their physical form for some time[109], despite 75% of their contents being water rather than solid matter[110]. They would have dried to a greater or lesser extent over those days, depending on the climate, but this would have been relatively quick in the case of the very hot Numantia summer, when temperatures frequently reach the high 30s Celsius. In a dry state, the amount of organic material, including undigested plant matter, means that dried faeces have between 44% and 55% of their dry mass as carbon[111]. They could consequently have provided very convenient fuel. Human faeces were used as cooking-fuel in some areas of the ancient world, as indicated in the Old Testament: "I will let you have cow's dung instead of human dung on which you may prepare your bread"[112]. The Roman army at Numantia may have done the same, but there is no actual literary evidence to indicate that human faeces were used as fuel in the Roman world[113]. Also, the faeces may have been mixed up with rubbish in the pits

perseus-eng2:39 [accessed November 2023].

108 This practice is often cited happening in Roman towns, with collecting pots placed along streets, but this is actually probaby unlikely (Nissen cit., p. 634, n. 82).

109 Rose *et al.* cit., pp. 1859–1860.

110 Rose *et al.* cit., p. 1839.

111 Rose *et al.* cit., pp. 1840 ff.

112 *Ezekiel* 4.12–15; Magness cit., p. 85.

113 Wilson cit., p. 147.

(e.g. as at Carlisle), so extracting them for fuel may not have been viable. There is, however, evidence of a Roman army using cow-dung as fuel[114], so armies at Numantia may have used their dung heaps for the same purpose.

Environmental impact of sewage and manure

The environmental impact on the locality outside camps would have been significant, as huge manure and rubbish dumps probably near the defences can be envisaged; it would have been impractical to carry the material any distance. The smell must have travelled far. It is tempting to suggest that scouts in ancient armies could compensate for the lack of modern technology to find their enemy by simply putting their noses into the air. The runoff caused by rain and natural decomposition would be significant. It was probably too concentrated to act as fertiliser for nearby vegetation and may even have killed it. If it flowed into water courses, it would have polluted those, killing fish and probably rendering the water undrinkable. Once the army had left, though, and the area was peaceful, it can be imagined that local farmers relished the dumps as a welcome source of manure; the use of excrement as fertilizer was widely practiced in the ancient world[115]. If, however, what they used included human sewage, it was likely to have spread eggs from human intestinal parasites and active disease bacteria onto the fields and then into the human food chain, as well as directly into the body when handling it[116]; the Romans would effectively have left behind them hidden germ warfare. It is now known that excrement is safe to handle only if it is fully composted, requiring at least six months, and it has become odourless[117]; but would this be known in antiquity?

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114 Army of Manlius Vulso in 189 BC (Livy 38.18.4).

115 Nissen cit., pp. 643–644.

116 Hobson cit., pp. 150–151; Horst Aspöck, Ingrid Feuereis, Silvia Radbauer, «Detection of eggs of the intestinal parasite *ascaris lumbricoides* in samples from the Roman sewers of Carnuntum», in Jansen *et al.* cit., p. 163; Elly Heirbaut, Andrew Jones, Kathleen Wheeler, «Archeaeometry: Methods and Analysis», in Jansen cit., pp. 16–17; Koloski-Ostrow cit., 86; Piers Mitchell (Ed.), *Sanitation, Latrines and Intestinal Parasites in Past Populations*, Abingdon, Routledge, 2016.

117 Peter Mackie Jensen, Pham Phuc, Line Knudsen, Anders Dalsgaard, Flemming Konradsen, «Hygiene versus fertiliser: The use of human excreta in agriculture — A Vietnamese example», *International Journal of Hygiene and Environmental Health* 211, Issues 3–4, 2008, p. 437, *https://doi.org/10.1016/j.ijheh.2007.08.011* [accessed November 2023].

The internal area of camps would also have been polluted due to the leaching of the contents of the numerous cesspits/rubbish pits and latrines into their surroundings, even if frequent emptying occurred; and the army probably left most of these unemptied when they departed. The area potentially only became 'neutral' after a period of at least 6 to 12 months, when the contents of the pits would have naturally composted, aided if they contained carbon, such as from the remains of cooking fires which could have been periodically cleared into the pits during a camp's occupation to make space for a fresh fire, and if the contents were aerated by pottery sherds, bones etc., thrown in as rubbish, which would also help reduce smell[118].

Environment as provider

As well as dumping large quantities of waste in the area of Numantia, the Roman army also extracted many resources from it. All ancient armies depended on the local environment for the basic resources to keep them alive, dry at night, at times warm, at others cool, adequately fed and watered, protected and in as good a state of health as could be expected. The environment also had to provide raw materials to actually wage war by effective fieldworks. The consequence was the powerless environment fell to these armies of uncaring, but necessarily self-preserving eco-warriors, yielding its natural and often age-old treasures to be repaid by polluted and reeking desolation. Anything 'untimely ripped', but then unwanted, was simply dumped behind by the departing troops. But in turn, despite years to recover completely, the environment could at least smile to see such thoughtless rubbish soon become new valued resources to less hostile occupants.

The amount of environmental impact caused by a Roman army, indeed by armies of any period, would be especially intense during sieges. Clearly, the longer an army encamped in an area, the more degradation. As the stay lengthened, not only would the amount of rubbish, sewage and manure build up in the vicinity of each camp, since it would have been impractical to take it any significant distance away, it would also cause the area of impact to extend beyond the immediate locality as resources close by became exhausted and things had to be brought in from increasingly further away. Sadly, there would have been many examples of this happening.

118 Like modern gardeners' compost-heap practices.

Deforestation

Shakespeare warns Macbeth that his doom would come when Birnam woods moved. Inhabitants standing on the walls of ancient cities besieged by Rome must have felt the same foreboding, as they watched their adversaries steadily move the surrounding woodland into camps and construct siegeworks.

Relating this to Numantia, Appian refers to the area being dense woods[119], in stark contrast to today. Deforestation did not really occur until the early sixteenth century, with ship-building requirements[120]. Roman military activity in the area nevertheless would have had a very significant effect on the number of trees remaining by the end of the Numantine Wars. At the bare minimum, woodland within each camp area would have been mostly cleared to make space for tents and streets (though presumably larger tree stumps would have to remain and be inconvenient obstacles).

Camps were various sizes at Numantia, but several were between 50 and 60 hectares, resulting in a significant amount of clearance. This would have been achieved quickly, as indicated by a British army manual stating that a soldier could fell a tree up to 12 inches (30.5 cm) in diameter at one minute per inch (2.5 cm) of diameter, using hand saw and felling axe or two minutes per inch with just an axe[121]. The time increases over 12 inches; the manuals even specify a formula to calculate this: minutes = diameter in inches, cubed, divided by 144; doubled if only axes are used[122]. Roman troops had similar types of tools (below), so felling times could have been comparable. With so many men and horses/mules available, the Romans could also have soon cut up the woodland and removed any unusable material from the camp. Several such scenes are shown on Trajan's Column[123].

119 *Hisp.* 76.

120 John Richardson, *Hispaniae. Spain and the Development of Roman Imperialism, 218–82 BC.,* Cambridge, Cambridge University Press, 1986, pp. 12–13.

121 Manual 1911 cit., p. 106; E. John Solano (Ed.), *Field Entrenchments. Spadework for Riflemen. Hasty Fire-Cover, Fire-Trenches, Communications, Concealment, Obstruction, Shelters*, Imperial Army Series, London, John Murray, 1915, p. 210; *Manual of Field Engineering Vol. I (All Arms)*, London, His Majesty's Stationery Office, 1933, p. 111.

122 Manual 1911 cit., p. 106; Manual 1933 cit., p. 111.

123 Conrad Cichorius, *Die Reliefs der Traianssäule*, Berlin, Georg Reimer, 1896–1900.

Deforestation – Firewood

At the 'domestic' level, there was a daily need for firewood[124] for cooking and heating (very necessary with winter temperatures of potentially -10° C); Appian comments that some of Nobilior's soldiers were killed collecting firewood and dying from cold[125]. Consequently, it is not surprising that there is evidence in the camps for hearths in sleeping areas; such features are common in later Roman barracks.

The armies at Numantia could each have had about 3,000 tent groups, each cooking and eating as mess units and using fires for heating. Additionally, there were fires for officers and any non-combatants. That is a huge number of fires, each daily requiring wood. Estimating actual quantities is challenging, as it depends on the type and density of available woodland, burning conditions, duration of fire, etc. British army manuals[126] say that one soldier could clear a square yard (0.84 m^2) of brushwood and small trees (up to 12 inches (30.5 cm) in diameter) in 2.5 minutes using hand saws, axes and billhooks, and this would yield about 5 lbs (2.27 kg) of brushwood; a 1933 manual changes this to a square yard every 2.4 minutes, but more realistically for trees up to only 2.5 inches in diameter[127]. Weight and hence amount of firewood, its type and burning time clearly vary, but experiments by the current author showed that 5 lbs could be sufficient for one fire to cook one meal. Significantly more would be needed if the fires continued for heating at least at night. Roman troops had similar types of cutting and clearance equipment to the early twentieth-century British army (indicated by remains of tools found at Numantia and later Roman military sites) so the tent-groups at Numantia could very quickly have daily cleared about 3,000 square metres of light woodland for firewood; i.e. the area of a football pitch about every two days. The amount of area clearly varied, depending on density and type of woodland, so may have spread even wider if the area was poorly wooded.

124 Roth cit., pp. 59 ff.
125 *Hisp.* 47.
126 Manual 1911 cit., p. 106; Solano cit., p. 210.
127 Manual 1933 cit., p. 111.

Deforestation – Construction timber

Construction requirements would have consumed vast quantities of timber, as although tents were probably used for some of the Numantia camps (e.g. Renieblas Lager II, IV, VI and the new Peña Redonda-Caracierzo[128]; Figs 1 and 2), other, longer-occupied ones contained buildings or tents roofed over in some way, all requiring timber to a greater or lesser extent[129] (Fig. 10).

The exact nature of building construction in the Numantia camps is uncertain, but was probably adobe (mud and straw) walls placed on stone sill walls, with thatched roofs, rather like the ones reconstructed in the city of Numantia (Fig. 11), and many seem to have been well-appointed[130]. These would have required timber components. How much timber is uncertain, in part as the detailed overall plans of the camps are unknown, so the number and size of buildings are uncertain. Calculations for timber needed for Inchtuthil fort, Scotland, indicate that thousands of cubic metres were needed there[131], though the half-timbered form of construction compared to the adobe-walled buildings of the Numantia camps could have used different amounts, it nevertheless indicates a very sizeable quantity would have been used at Numantia, especially as so many camps were built in the area during the Numantine Wars, each steadily encroaching on available timber supplies and before much regrowth occurred (below).

128 Dobson 2008 cit.; Ralf Hesse, José Costa-García, «LiDAR-Daten als Grundlage archäologische Prospektionen in der *Hispania romana*», *Kleine Schriften aus dem Vorgeschichtlichen Seminar Marburg* 61, 2016, pp. 37–38.

129 Schulten cit.; Adolf Schulten, *Numantia. Die Ergebnisse der Ausgrabungen 1905–1912. Band IV. Die Lager bei Renieblas*, Munich, Bruckmann, 1929, especially fig. 3; Dobson 2008 cit., pp. 122–123; Mike Dobson, «Tents, huts or houses? Soldiers' accommodation at Numantia. The work of Adolf Schulten and beyond», in François Cadiou, Milagros Navarro Caballero (Eds.), *La guerre et ses traces. Conflits et société en Hispanie à l'époque de la conquête romaine (IIIe–Ier s. av. J.-C.), Colloque International, Institut Ausonius, Bordeaux, 2010*, Bordeaux, Ausonius, 2014, pp. 57–87.

130 Schulten 1927 cit.; 1929 cit.; Dobson 2014 cit., pp. 71 ff.

131 Elizabeth Shirley, *The Construction of the Roman Legionary Fortress at Inchtuthil*, British Archaeological Reports British Series 298, Oxford, BAR Publishing, 2000.

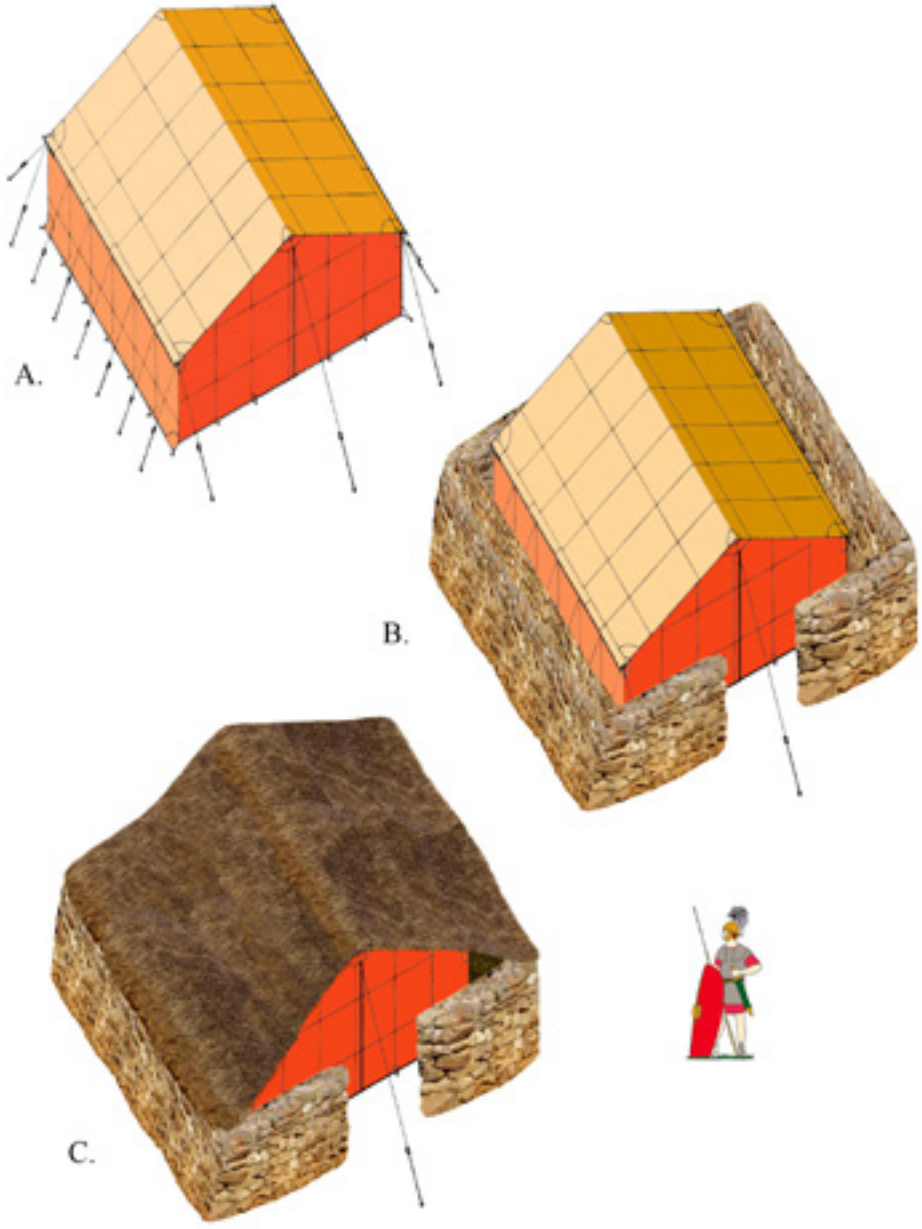

Fig. 10 Accommodation types at Numantia and Renieblas. A) Tent. B) Tent surrounded by low stone wall. C) Tent surrounded by low stone wall and thatched over (drawn: Dobson. Tent reconstruction after Carol van Driel-Murray, «A Roman army tent: Vindolanda I», in Valerie Maxfield and Mike Dobson (Eds.), *Roman Frontier Studies 1989*, University of Exeter Press, Exeter, 1991, fig. 70.4).

Deforestation and re-landscaping – Defences

All the camps are likely to have used some form of timber defensive palisade or *chevaux-de-frise* formed from stakes[132] on top of a low rampart of stone/earth/turf, according to local conditions, usually gained from digging a ditch in front of the rampart (Fig. 8).

Creating the ditch and rampart meant that a Roman army would have hand-dug and basket-carried thousands of tonnes of material in the construction of a

132 Veg. *Mil.* 3.8; C. (Kate) Gilliver, «Hedgehogs, caltrops and palisade stakes», *Journal of Roman Military Equipment Studies* 4, 1993, pp. 49–54; C. (Kate) Gilliver, *The Roman Art of War*, Stroud, Tempus, 1999, 77–78.

Fig. 11 Modern reconstruction of adobe thatched house on stone sill walls, Numantia city (photo: Dobson, 2017).

camp's defensive ditch and rampart. When on the march, new camps could be required each day, meaning that such huge earth-moving occurred daily. Arduous work, but the field operations of the Roman army were like ants achieving amazing structures relatively easily and quickly – each ant moves little, but collectively thousands of ants move a great deal. In the case of sieges, this defensive effort meant a truly mammoth manual undertaking, with the defensive circuit around the city also being required; at Numantia this was about 9 km long[133]. At least at Numantia, troops may have been spared digging the customary ditch, as the ground is generally too hard, but there would still have been the arduous collec-

133 48 *stades* – Appian *Hisp.* 90.

Fig. 12 Remains of stone rampart of Renieblas, camp III. Numantia lies to the top-right of the photograph (photo: Dobson, 2018).

tion and carrying of stones and loose surface material to form the rampart (Fig. 12). The result would have been a significant change to the visual appearance of the landscape.

Literary evidence indicates that the soldiers may each have carried one or two palisade stakes with them[134], but not always or there were insufficient and so would need to source them locally[135]. They would almost certainly not have had enough stakes to construct the initial palisade Scipio used for encircling Numantia and the one on the main defensive circuit. There was also all the other timberwork required in creating effective siegeworks, such as the towers built every 100 Hellenistic feet (35.5 m)[136].

134 Livy 33.6.1; Nicholas Fuentes, «The mule of a soldier», *Journal of Roman Military Equipment Studies* 2, 1991, pp. 65–99.

135 E.g. by Caesar's army; *BGall.* 5, 39.

136 App. *Hisp.* 90; Dobson 2008 cit., 46.

Deforestation – Extensive

It is consequently no surprise that Josephus claims the Roman four-month siege of Jerusalem used all the timber within a 15 km radius[137]. In the case of Numantia, the area affected could have been even larger, as numerous armies operated there every few years, at times annually, over a period of 20 years, which would have been insufficient for trees to have regrown adequately, and so resources would have to be brought in from increasingly further away. Similar effects of deforestation are attested elsewhere[138], so it is likely to have been a common problem[139].

Lucan brings out such destruction in very emotional terms in his account of Caesar's siege of Massilia (Marseille), almost taking the stance of a modern eco-warrior:

> "Now all the woods were felled and the forests stripped of their timber far and wide."
>
> "This grove was sentenced by Caesar to fall before the stroke of the axe; for it grew near his works. Spared in earlier warfare, it stood there covered with trees among hills already cleared. … Ash trees were felled, gnarled holm oaks overthrown; Dodona's oak, the alder that suits the sea, the cypress that bears witness to a monarch's grief, all lost their leaves for the first time; robbed of their foliage, they let in the daylight; and the toppling wood, when smitten, supported itself by the close growth of its timber. The peoples of Gaul groaned at the sight; but the besieged men rejoiced; for who could have supposed that the injury to the gods would go unpunished? But Fortune often guards the guilty, and the gods must reserve their wrath for the unlucky. When wood enough was felled, waggons were sought through the countryside to convey it; and the farmers, robbed of their oxen, mourned for the harvest of the soil left untouched by the crooked plough."[140]

The situation at Massilia was made even worse by deforestation also 'being reversed', as Caesar's opponents cut down "all of the trees far and wide" to deprive his army of timber[141].

The Numantines probably felt the same as they witnessed such wanton destruction around their city.

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137 *BJ* 5.263.

138 E.g. Caesar *BCiv.* 1.42; *BGall.* 5.39.

139 Roth cit., pp. 60–61.

140 Luc. *BCiv.* 3.395, 3.426 ff., Loeb trans.

141 Caes. *BCiv.* 2.15.

Food, fodder, hay, etc

Similar strain on local resources must have existed for straw and grass, or similar, for bedding of both animals and men, as well as for thatching buildings and tents[142] (Fig. 10). A minor, but important requirement for grass in hot and dry areas where moss was unavailable (which includes the Numantia area in summer), would be for toilet-cleaning purposes (above); the Palestinian / Yerushalmi Talmud mentions using grass for this[143].

Morales Hernández convincingly argues that Scipio deliberately timed the start of his campaign to coincide with harvest-time so that his army had sufficient food and fodder[144], though action and foraging a little distant from Numantia seems to have been slightly earlier, as Appian reports him foraging in fields and cutting 'still unripe grain'[145]. The necessity and logistics for adequate provisions have been well-discussed by Erdkamp[146] and Roth[147]. In short, the army would have sucked in almost as much food and fodder as it could acquire from the surrounding areas, amicably or otherwise (in Scipio's case seemingly the latter more than once[148]) and with increasing distances beyond, with any lengthened stay such as a siege. A vision of unfolding hectares of empty fields and orchards etc., comes to mind. Local inhabitants must have experienced significant resulting hardship.

Water consumption and security

The supply of water was vital. The 1984 experimental march in full Roman military equipment and hot summer temperatures of at least 21° C, caused significant water loss through profuse sweating[149]. One of the participants wore steel body armour, which allowed little bodily air circulation. He suffered from nausea

142 Schulten 1929 cit., p. 26; Dobson 2014 cit.

143 yT *Shabbat* 82a (11c 2–20); Stefanie Hoss, «Jewish and Christin texts on ancient latrines», in Jansen *et al.* 2011, p. 47.

144 Fernando Morales Hernández, «Comentarios en torno a las dos llegadas de Escipión a Numancia: deconstruyendo a Schulten», *Cuadernos de Arqueología de la Universidad de Navarra* 29, 2020, pp. 1–58.

145 *Hisp.* 87. Troops reaping is shown on Trajan's Column; Cichorius cit., scenes 291–292.

146 Paul Erdkamp, *Hunger and the Sword. Warfare and Food Supply in Roman Republican Wars*, Amsterdam, Gieben, 1998.

147 Roth cit.

148 App. *Hisp.* 87; 89.

149 Atkinson, Morgan, cit.

and dizziness after about three hours of marching. He also suffered excessive weight loss on one very hot day's 42 km march, losing just over 3 kg. Such weight loss was associated with dehydration and could be simply remedied by increased water consumption through small amounts frequently throughout the march rather than overloading the stomach with too much water before marching. An ideal was found to be about 0.28 litres per hour, i.e. 2.27 litres a day.

The effects of dehydration are serious[150]. They are measured in terms of the percentage loss of body mass, with a loss of 1 kg equating to a loss of 1 litre of fluids[151]. Dehydration up to 10% of body weight is unpleasant, will incapacitate, but is not fatal. 12% weight loss through dehydration requires medical intervention of fluids to recover. Between 15% and 25% loss is fatal, as the body cannot regulate its temperature through sweating and it overheats[152]. The weight of the adult experimenter is not given, but presumably the 3 kg loss would have been far less than 10% of his body mass, since it is unlikely he weighed merely 30 kg. He was probably more than the presumed weight of a typical Roman soldier, 55 kg[153], so the loss could in fact have been less than 5%, but it clearly demonstrates the incapacitating nature of dehydration at well below critical levels and hence the necessity to provision troops with sufficient water.

The experimenter's suffering was accompanied by temporary blindness and disorientation. This and the nausea were attributed to salt deficiency, associated with 10% dehydration[154]. Salt is vital to human (and animal) functioning, preventing potentially fatal hyponatremia; a daily intake of about 5 g is usually adequate[155]. Its importance is usually ignored or undervalued in Roman military studies, though Roth discusses it[156]. The Romans were well aware of its dietary importance, though lacked the underlying science, and that it should be frequent-

150 Carl Gisolfi, «Water Requirements During Exercise in the Heat», in Bernadette Marriott (Ed.), *Nutritional Needs in Hot Environments: Applications for Military Personnel in Field Operations*, Committee on Military Nutrition Research, Institute of Medicine, Washington, National Academies Press, 1993, p, 87; Melissa Beattie, *Just Deserts: Roman Military Operations in Arid Environments (108 BC–AD 400)*, unpub. MPhil thesis, Cardiff University, 2011, p. 35; Moss cit., p. 4.

151 Moss cit., p. 4.

152 Moss cit., p. 4.

153 Beattie cit., p. 30.

154 Atkinson, Morgan cit.; Moss cit., p. 4, n. 7.

155 Moss cit., pp. 24–25; Roth cit., p. 41.

156 Roth cit., pp. 25, 40–41.

ly issued to soldiers[157]. Vegetius includes it as a necessity for army provisions[158]. Caesar regarded good, local salt provision as making a location especially suitable for encampment[159]. Relating to the Celtiberian wars in Spain, Appian lists the absence of salt for Lucullus' soldiers in 153 BC as serious and contributary to causing dysentery[160]. Salt could even form an environmental weapon, as a Gallic tribe in the Val d'Aosta had to surrender when Octavian's forces blocked their salt supply in 35 BC[161].

The huge numbers of men and animals daily required a huge amount of water. Calculating the quantity is challenging, with understandably no ancient sources about this, so estimates have to be based on modern practices. The experimental Roman march (above) concluded there was a minimum daily requirement of 2.27 litres. Engels and Roth similarly estimated 2 litres per day for ancient armies, rising according to circumstances[162], but their methodology and sources for arriving at that are questionable[163]. The essentially 'pre-modern', early twentieth-century British army allowed 4.5 litres per man for daily drinking and cooking purposes[164]. Modern US army guidelines say that typical drinking requirements are between 4 and 6 litres a day, with more in higher temperatures and activity levels[165]. The most recent British military guidance states "that daily water requirements can increase from 2–4 litres to as much as 8–12 litres in extreme conditions, depending on physical activity levels"[166], but also that hydration must not exceed more than 1.25 litres per hour when undertaking very heavy work or more than

157 Roth cit., pp. 25, 41.

158 *Mil.* 3.3.

159 *BCiv.* 2.37.5.

160 *Hisp.* 9.54.

161 App. *Ill.* 4.17.

162 Donald Engels, *Alexander the Great and the Logistics of the Macedonian Army*, Berkeley, University of California Press, 1978, p. 125; Roth cit., pp. 35–40.

163 Moss cit., p. 5.

164 Manual 1911 cit., p. 53.

165 US Army, *Nutrition Standards and Education*, Washington, Departments of the Army, Navy, and Air Force, 2001, p. 5; Moss cit., p. 7.

166 Ministry of Defence, «Heat illness prevention, Annex F, Hydration guidance. Water requirements for working and exercising in the heat», *Management of health and safety in defence*, Joint Service Publication 375, Vol. 1, Chapter 41, 2022, p. 2, *https://www.gov.uk/government/publications/jsp-375-health-and-safety-handbook-volume-1* [accessed November 2023].

12 litres a day, since over-hydration can also be dangerous[167]. Junkelmann's reconstructed legionary march in 1985 concluded that a daily requirement was 4.5 litres and increased to 8.5 litres in hot temperatures, with suggestions of 2 litres only being appropriate for inactive soldiers[168]. Junkelmann's amounts overlap with the British and US army's allowances, and so his 4.5 litres per day can reasonably be taken as a minimum for Roman troop consumption at Numantia, but his findings and available military guidance suggest it could range up to at least 8 litres, especially with the hot summer temperatures there.

Water requirements for horses were significantly more than for the men. The early twentieth-century British army manuals vary in their daily water allowances for horses. The army's veterinary department allows 22.7 to 68.2 litres a day, according to the temperature and work being done, with an average being 36.4 litres, but "hot weather and hard work or both combined, will nearly double ordinary requirements"[169]. Slightly later army guidelines daily allow 45.5 litres per horse when in camp[170]. These amounts may have been generous, as modern experience shows that in normal circumstances, horses drink 23 litres, but it is variable, drinking considerably more in hot conditions and more according to whether the feed is dried grain or hay, or they are getting some water via grazing[171]; Dixon and Southern give a range of 27–36 litres[172], but some modern horse authorities state as much as 38–45 litres daily[173].

Whatever the amount, the Roman army had to provide significant quantities, especially as horses are capable of drinking large quantities per session (potentially almost 7 litres[174]). Water would also have to be provided several times a day,

167 Ministry of Defence cit., p. 2.

168 Marcus Junkelmann, *Die Legionen des Augustus*, Mainz, Philipp von Zabern, 1986; Marcus Junkelmann, *Panis Militaris*, Mainz, Philipp von Zabern, 1997, pp. 172–175; Moss cit., p. 6.

169 *Animal Management*, Army Veterinary Department, London, His Majesty's Stationery Office, 1908, 129.

170 Manual 1911 cit., p. 53)

171 Hyland cit., p. 96.

172 Cit., p. 206.

173 E.g. UMT, «Managing and composting horse manure», University of Minnesota Extension, *https://extension.umn.edu/horse-care-and-management/managing-and-composting-horse-manure* [accessed November 2020].

174 Manual 1911 cit., p. 53.

though the intervals could be infrequent. Three waterings are a daily average, two for cool weather or the horses were not working, but when working and especially in warm conditions, potentially four waterings would be needed[175]. Thankfully, the effects and treatment of heat-exhaustion and dehydration in animals were known in antiquity[176].

The Roman army's pack animals would also require water. The mule was probably the normally used pack animal. They generally drink less than horses, on average 18–35 litres a day, but could drink the same amount per session as horses (above). They tolerate thirst well as they can store water longer than horses, potentially for a few days in hot conditions[177].

The oxen used as draught animals would also have required water, between about 21 and 28 litres a day, and needed watering at least three times daily in summer, twice in winter[178].

Scipio learnt to his cost being unable to find sufficient water while in action before the siege at Numantia, as several of his horses and pack animals died from thirst on one occasion[179]. Other similar events are attested for Roman armies: thirst affecting military action; suffering from lack of water; battle occurring to secure water; battle delayed until water supply secured[180]. And the famous 'rain miracle' that saved the Romans during Marcus Aurelius' wars against the Sarmatians when surrounded without water[181].

The recognised importance of water for ensuring the effectiveness of ancient

175 Manual 1908 cit., 129.

176 Varro *Rust.* 2.1.22–23; Moss cit., p. 11.

177 Manual 1908 cit., pp. 270, 273; Manual 1911 cit., p. 53; Roth cit., pp. 62, 65–66; Brooke, «Horses, donkeys and mules vital in providing water», Brooke Action for Working Horses and Donkeys, *https://www.thebrooke.org/our-work/water-provision* [accessed October 2023]; Chesapeake, «*Caring for mules*», Chesapeake & Ohio Canal National Historical Park, 2023, *https://www.nps.gov/choh/learn/historyculture/mule-care.htm* [accessed October 2023]; Moss cit., pp. 10, 22.

178 Manual 1908 cit., p. 296; Abdou Fall, R. Anne Pearson, P.R. Laurence, Salvador Fernández-Rivera, *Feeding and Working Strategies for Oxen used for Draft Purposes in Semi-arid West Africa*. Nairobi, International Livestock Research Institute, 1997, p. 25; Roth cit., pp. 62, 66–67.

179 App. *Hisp.* 89.

180 E.g. Amm. 16.12.11; Caes. *BCiv.* 1.84; *BAfr.* 18, 41; Tac. *Ann.* 4.49; Dio Cass. 37.3.6 and 49.6.1; App. *BCiv*. 2.7.45 and 5.12.114; Plut. *Vit. Crass.* 23; Sall. *Iug.* 48.

181 Depicted on Marcus' Column; Dio Cass. 72.2.

armies is well illustrated by Vegetius' military treatise. He emphasises the important relationship between good water and soldiers' health: an army, "must not use bad or marsh water, for bad drinking water, like poison, causes disease in the drinkers"[182]. Similarly, *De Metatione Castrorum*[183] says there must be a river or spring by the camp. Vegetius also notes that local water supplies may be insufficient for very large armies[184]. Hence, limited water at a settlement could simply protect it from being attacked[185]. Persian armies suffered similar water problems, with Xerxes' large army drinking at least seven rivers dry[186]; this may not have been unusual, as Herodotus was not at all surprised about rivers running dry, but tellingly, he was surprised that the food supplies were sufficient despite the huge size of Xerxes' armies[187]. This all suggests that the threat of water-related problems was a constant concern for Roman and indeed all ancient armies.

These water consumption figures scale up to significant quantities for the armies at Numantia. The 30,000 men could daily consume 135,000 litres[188] and the horses and pack animals about 200,000 litres[189]. This total of 335,000 litres should probably be regarded as a minimum, as it does not take account of the senior officers etc., as mentioned in previous calculations. This equates to 165 m^3. In more meaningful terms, a two-metre deep Olympic swimming pool would be consumed almost weekly.

In the hot summer months there, when rainfall is low, the quantity may have put a strain on rivers and springs. In such Mediterranean areas, springs can even dry up in summer[190] and when running, springs have limited supplies[191]. During

182 *Mil.* 3.2.

183 57. This tract about laying out a camp is often referred to as 'Hyginus' or 'Pseudo-Hyginus'. The authorship is uncertain, however, so Grillone's title for his 1977 Teubner edition is used here; Dobson 2008 cit., p. 5 n. 3.

184 *Mil.* 3.1.

185 E.g. Singara (Mesopotamia), Thysdra (Tunisia) and Ursao (Spain); Amm. Marc. 20.6.8–9; *BAfr.* 76; *BHisp.* 41; Moss cit., pp. 26–27.

186 Hdt 7.21.1, 43.1, 58.3, 108.2, 127.2, 196.

187 7.187.

188 30,000 men x 4.5 litres = 135,000 litres

189 5,860 horses and mules x 34 litres = 199,240 litres, using the suggested average consumption in the range of 23 to 45 litres.

190 Caes. *BCiv.* 3.49; Veg. *Mil.* 3.8.

191 A spring was exhausted in Thrace by a barbarian army, causing casualties; Tac. *Ann.* 49.

Scipio's siege at Numantia though, it seems at least the river Duero remained at good levels, as Appian says it had a current and the Numantines used boats on it to bring in provisions, requiring Scipio to block it[192]. Not all the camps at Numantia were close to rivers, or those as large as the Duero, and the rocky ground probably prevented digging wells in the camps if there were no convenient springs; only one well was found, in the low-lying, less rocky area of Renieblas, Lager V[193]. Consequently, there could have been a daily arduous requirement to bring water up to some camps, most of which were on hills. Hopefully, the troops fared differently to those during the siege of Jerusalem, where the seriousness of water security caused significant suffering from thirst and water-carriers being attacked[194].

Stresses on the water systems could also have come from pollution. Since horses and pack animals were probably taken at least twice daily to rivers for watering, as the only practical way of providing sufficient (above)[195], this would inevitably have led to river fouling. Over time, this could have impacted on water quality and animal health if the same watering spots were used regularly, as they would probably have to be. Even if the men drew water upstream from the animals, dictated by common sense and so was probably ancient practice, men and animals in siege camps downstream would have suffered. Significantly, British army manuals are very precise about watering practice in rivers; perhaps a disciplined ancient army such as the Roman was also:

> "When a stream is the source, the watering place will be below the men's drinking water […]; have a sound bank and bottom; wide approaches and exits; be capable of watering as many horses as possible, and not liable to be fouled by upstream drainage […] If the bank and bottom are muddy, stones and gravel should be liberally used to make a firm, clean standing. Watering should always commence at the lowest part of the allotted length of water, so that each succeeding batch may procure a clean supply by entering a pace or two higher up. In watering, horses should be walked in single file across the river till its whole width is occupied, their

192 *Hisp.* 91.

193 Schulten cit., p. 171. The Romans seemed generally unwilling to dig wells. This is understandable, as the effort involved creating them is immense, they could not be guaranteed to actually find water and if they did, it may be poor quality and was usually low in volume (Moss cit., pp. 32–34).

194 Cass. Dio 65.4.5.

195 Dixon, Southern cit., pp. 206–207.

> heads turned up stream to give them a clean drink, and when satisfied, they should turn about and leave at the lowest part for the reason given above.
>
> Watering from ponds or other stagnant pools may be necessary, but it is to be avoided if another source is obtainable, for it is not possible to prevent such a supply being greatly fouled."[196]

The comment about needing to create firm and clean positions at watering points may be paralleled by the Roman army, with Trajan's column twice showing a soldier collecting water at a river bank, crouching on a firm surface (possibly planks), so that mud is not stirred up in the water[197].

The problem of water-fouling was known in antiquity, since Vegetius notes:

> "If a large number of soldiers stays too long in autumn or summer in the same place, then drinking-water contaminated by a polluted water-supply and air tainted by the general foul smell give rise to a most deadly disease."[198]

– meaning probably cholera or typhoid. Vegetius' solution recommended frequent changes of camp; unfortunately not an option for besieging armies. It may surprise us that Vegetius reveals there was an awareness in antiquity of foul-smelling camps, as we tend to believe that people in the past must have been 'nose blind' to their dirty surroundings, but other ancient authors also comment on the smell of camps: Sallust says that one Roman army in the war against Jugurtha only moved camp "when the stench or need for fodder" compelled it[199]; and Onasander comments that the smell from especially summer camps occupied for any length of time will taint the surrounding air[200].

Camp-followers

The environmental impact of a Roman army and probably most ancient armies was not limited to the camps. There would doubtless have been camp followers in the form of traders, merchants and 'entertainment providers' etc., eager to profit from the presence of the army, and are often referred to, including at Numantia[201].

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196 Manual 1908 cit., pp. 141–142. Similar in Manual 1911 cit., p. 53, but with characteristic modern military precision, it specifies 5 minutes should be allowed per horse to drink.

197 Cichorius cit., scenes 36, 285.

198 *Mil.* 3.8.

199 *Jug.* 44.4.

200 *Onas.* 9.1.

201 E.g. App. *Hisp.* 85; *BAfr.* 75; Frontin. *Str.* 2.4.8 and 4.1.1; Sall. *Iug.* 45.2; non-Roman ar-

The numbers of such people are uncertain and probably varied during a camp's occupation, but may have been numerous[202]. Their quarters, effectively the *vicus* and *canabae* settlements by Imperial forts, must have had environmental consequences and similar to those of camps, but on a scale depending on numbers. If the camp-followers moved on with the army after hostilities, they too would have left behind a potentially polluted and despoiled landscape.

Rubbish or resources?

It is tempting to see the state of areas vacated by the army and camp followers in totally negative terms today, but what is regarded as pollution etc., is culturally influenced and changeable[203]. Yes, the environmental nature of the landscape had been changed. It was also changed physically by the associated military defences, which were not all levelled when the army departed, as remains of many survive (Fig. 12). The occupants probably also left behind large quantities of material impractical to transport or no longer wanted (e.g. pottery, broken items, faulty equipment), or simply dropped and lost during occupation (hence now found archaeologically). We might see the areas as rubbish-strewn, despoiled, but for local inhabitants they could have been regarded as rich in easily obtained valuable recyclable and upcyclable resources, e.g. metal for re-smelting, ready-cut timber, building materials, cloth and leather pieces; just like the practice of modern rubbish-heap pickers in India and Egypt etc[204]. Consequently, the locals may even have regarded the deserted camps as a good thing, almost 'shopping centres'.

The recovery of such material may have gone on long after the army left. Stones were being extracted around Numantia into modern times, e.g. many of the older buildings in the local villages are thought to have been built from the stones, and sheep pens and bird-shooting hides have been constructed from them (Fig. 13)[205].

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my – Hdt. 7.187; Roth cit., pp. 91 ff.

202 Roth cit., pp. 113–114.

203 Bradley cit.

204 William Rathje, Cullen Murphy, *Rubbish! The Archaeology of Garbage*, New York, University of Arizona Press, 1992; Hobson cit., p. 89.

205 Schulten 1927 cit.; 1929 cit.; Adolf Schulten, *Numantia. Die Ergebnisse der Ausgrabungen 1905–1912. Band II. Die Stadt Numantia*, Munich, Bruckmann, 1931; Morales Hernandez pers. comm.

Fig. 13 Modern bird-shooting hide constructed at Renieblas from the stones of camp V (photo: Dobson, 2016).

Dust and ashes

Environmentally, an increasingly barren land can be imagined in and around the Numantia camps, continuing in such a poor state once the armies departed. The amount of destruction would have been more concentrated and perhaps consequently longer lasting at the camps occupied by whole armies, such as at Renieblas and the huge camp at Peña Redonda-Caracierzo (Fig. 1). But perhaps worse, it would have been spread over a much bigger area by the numerous siege installations placed by Scipio around Numantia itself. The inhabitants of the city would have literally watched their natural surroundings disappear or die off.

The devastation caused by an encamping army was well-known in the ancient world. The Spartans may have moved camp frequently simply because the ground became too foul for themselves, but also it was used as a weapon to destroy enemy territory, though could limit localised damage in friendly areas by not being in each place for long[206]. One Spartan commander even moved camp

206 Anderson cit., p. 61.

several times a day to force his allied contingent to ravage the ground and destroy as many trees as possible in areas they were loath to[207].

Near the end of Cervantes' play about the siege of Numantia, Marius says: "Of this dead city, turned to dust and ashes, with all its fruits and flowers turned to thorns!"[208]. He could have said similar about the areas in and around the camps. Sadly, such environmental devastation would have been repeated wherever the Roman army spread its locust-like wings.

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Saint Maurice (wearing mail-suit and coat-of-plates) in the Cathedral of Magdeburg, next to the grave of Otto I, Holy Roman Emperor. The sculpture was created around 1250, and is considered to be the first realistic depiction of an ethnic African in Europe. Unfortunately, the figure is no longer complete and misses the lower legs and an item in the right hand, presumably a lance. (Photo Acoma, GNU Free Documentation License, Wikipedia Commons) Among the martyr saints venerated by the Christian Churches there are many military men, such as Saint Marcellus of Tangier, Saint Sebastian and Saint Maurice, commander of the Theban Legion which, according to the *Passio Acaunensium martyrum* by Eucherius bishop of Lyon, was composed of Christian Egyptians. After taking part of the Gallic campaigns of general Maximian, the legion would have been repeatedly decimated at Agaunum (now Saint-Maurice, Switzerland) for having refused to exterminate the Christian populations of Valais.

So called Missorium of Kerch, 4th century Found: Bosporan Necropolis, vault on the Gordikov estate. Near Kerch, the Crypt in the North-Eastern Slope of Mount Mithridates, 1891 This silver dish was a diplomatic gift from the Byzantine Emperor to a representative of the Bosporan government. In this fine example of the early Byzantine art traditional Classical themes are combined with a new artistic style. The vessel shows a composition typical of Roman coins: the Emperor on horseback is piercing the enemy with a spear. The rider was usually accompanied by one or several warriors and Nike crowning the winner. In contrast to the Classical composition showing the final scene of a battle, here we see the scene of triumph: Emperor Constantius II sits on a horse, triumphantly raising his spear. To emphasize the Emperor's highest rank and divine power, the artist used special pictorial devices including, for example, the distortion of proportions. The images were produced by a chisel. Part of the ornamentation is nielloed. The outer surface is gilded and a loop is soldered onto it. Hermitage Museum. Saint Petersburg.

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