Parasitology

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Parasite infections at the Roman fort of Vindolanda by Hadrian's Wall, UK

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Research Article

Cite this article: Ledger ML, Flammer PG, Smith AL, Birley A, Mitchell PD (2025) Parasite infections at the Roman fort of Vindolanda by Hadrian's Wall, UK. *Parasitology*, 1–9. https://doi.org/10.1017/S0031182025101327

Received: 12 September 2025
Revised: 14 November 2025
Accepted: 24 November 2025

Keywords:
archaeoparasitology; *Ascaris*; *Giardia duodenalis*; palaeoparasitology; soil-transmitted helminths; *Trichuris*

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Abstract

Archaeological sediments can be used to retrieve evidence for parasites that infected past populations, giving evidence for disease, diet, sanitation, and migration in the past. To increase our understanding of parasite infections in Roman Britain and determine which parasites may have infected people living at Vindolanda, sediment samples were collected from a drain connected to a latrine at the bath complex of Vindolanda. These samples were used to look for preserved parasite eggs and cysts deposited in the drain with the faeces of people who used the latrine. Microscopic analysis was used to identify eggs of helminths, and enzyme-linked immunosorbent assay (ELISA) was used to look for protozoan parasites that can cause severe diarrhoea. Eggs of *Ascaris* sp. (roundworm) and *Trichuris* sp. (whipworm) were found by microscopy and *Giardia duodenalis* was detected using ELISA. All of these parasites are transmitted by the faecal-oral route, usually through contaminated food and water. This is the first evidence for *G. duodenalis* in Roman Britain. A range of zoonotic and faecal-oral parasites have been found at other sites in Roman Britain, yet the drain studied from Vindolanda only contained faecal-oral parasites that can be transmitted directly between humans. This predominance of faecal-oral parasites is similar to a pattern found in large urban sites in the Roman Mediterranean and other military sites in the empire. In contrast, sites from larger urban cities in Roman Britain, such as London and York, appear to have a more diverse range of parasites.

Introduction

Palaeoparasitology, the study of parasites in past human and animal populations, provides important data for the range of parasites that have been sustained in human populations before the modern era (Mitchell, 2024). This evidence exemplifies the successes of modern public health measures and allows us to explore drivers of parasite transmission within Britain throughout history. As we continue to study more historical sites, patterns in parasite transmission throughout specific regions arise and allow for more nuanced study into the palaeoepidemiology of parasite infections to truly understand when and how parasites have been controlled throughout human history (Mitchell, 2025). Here, we present evidence for parasite transmission at the Roman fort of Vindolanda and compare this to other sites within Roman Britain and the Roman Empire more broadly, to explore gastrointestinal parasite infection in Roman military settlements.

Vindolanda is a Roman military fort located just south of Hadrian's Wall between Carlisle and Corbridge in modern-day Northumberland, Britain. Hadrian's Wall was built by the Romans in the early 2nd century. CE as a defensive fortification, running east-west from the North Sea to the Irish Sea (Breeze, 2019). Excavations at Vindolanda have provided some of the most important evidence for life in Roman Britain, particularly military settlements along Hadrian's Wall. In-depth insights into daily life have been gained through the analysis of exceptionally well-preserved organic objects, such as wood and leather, which are normally lost to archaeologists. Of particular value are more than 1000 thin wooden tablets, written with ink, that provide documentation of activities at the Roman site, including acquisition of materials, military communications, and personal communications (Bowman et al. 2010).

The site was occupied by the Romans between the 1st and 4th century CE. Throughout that time there were various infantry and cavalry units stationed at the fort, including the First Cohort of Tungrians from modern-day Belgium, the Ninth Cohort of Batavians from modern-day Netherlands, the Second Cohort Nervian from modern-day France/Belgium, the Fourth

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Cohort Gauls from France, and the Vardulli cavalry from Spain (Birley, 2009). There were multiple construction phases at Vindolanda with the initial, primarily timber-constructed fort, rebuilt as the garrison troops stationed there fluctuated as they responded to conflicts in the Empire. In the 3rd century, there was extensive construction at the site that included a village-like settlement (*vicus*) outside the walls of the fort (Blake, 2014). Archaeological evidence shows that the site was not only inhabited by military personnel, but also women and children and others who supported the needs of the community, as was the case at many Roman military sites (Driel-Murray, 1999; Greene, 2014). Of relevance to our study of health and disease, and specifically parasite infections at Vindolanda, is the infrastructure that was built to manage human waste. The fort hosted two Roman bath houses, the pre-Hadrianic baths and later 3rd century baths (Birley, 2001). The 3rd c. baths had water supplied from an aqueduct that channelled water from a spring located northwest of the *vicus* (Blake, 2014). The natural springs located northwest of the site were also used to bring water into other areas of the site, as evidenced by ditches, stone aqueducts and timber pipes (Blake, 2014). Managing drainage was equally important, especially with the high water table at Vindolanda, thus a number of ditches and drains are located around the site to remove water and waste (Birley and Blake, 2005; Blake, 2014).

Aside from providing exceptional archaeological evidence for life in Roman Britain, Vindolanda also provides us the opportunity to further understand health and disease on the northern frontiers of the empire. The work of palaeoparasitologists in Britain has been relatively extensive compared to other regions (Ryan et al. 2022; Ledger et al. 2024). This allows us to move away from broadscale analysis of parasite infections in past populations to a more nuanced analysis of how parasite infections varied within and between communities. Climate and ecology are major determinants of parasite endemicity regionally. However, there are a myriad of important social, cultural, political, and environmental factors that contribute to transmission on a finer scale which may result in variation in parasite infections at Vindolanda compared to other Roman sites in Britain.

Palaeoparasitological analysis of faecal material from Vindolanda can provide important evidence for parasite infections amongst the Roman military and associated community. The majority of existing palaeoparasitology data from Roman Britain comes from urban sites, particularly from London and York (Wilson and Rackham, 1976; Rouffignac, 1985; de Moulins, 1990; Ryan et al. 2022; Ledger et al. 2024). The only other site along Hadrian's Wall where palaeoparasitological analysis has been undertaken is Carlisle (Jones and Hutchinson, 1991). The exceptional preservation at Vindolanda offers an important opportunity to deepen our understanding of parasite transmission and gastrointestinal disease amongst the Roman military living in the northern frontiers of the empire. Thus, the aim of this study was to understand parasite infections at Vindolanda using samples collected from the length of a drain and fort ditches.

Materials

During the 2019 excavation season the main drain carrying latrine waste from the 3rd century bath house latrine down to the stream and valley to the north of Vindolanda was excavated (Figure 1). Excavations started at the remains of a 17th–19th century farmhouse (Smith's Chesters). Below the farmhouse and its associated cobbled yard, the sealed deposits from the 3rd century bath house drain were uncovered (Collins, 2020). Artefacts recovered from the drain included Roman beads, pottery and animal bones. The western edge of the drain had been cut into a combination of natural and re-deposited clay that had been brought in to cover the remains of much earlier fort defensive ditches, before the construction of the 3rd century latrines took place. The eastern side was backed onto the sandstone foundations of a *vicus* building. This was constructed with large slabs of packed sandstone and boulder clay packing the joints, creating an effective barrier to water loss.

The depth of the drain varied from 1.3 m at its southern end where it exited the latrine, to 18 cm deep at its termination. The main drain split into two channels around 9 m to the north of the latrine, with the main channel continuing directly to the north-west, maintaining a slight slope of only 2–3 degrees, and a steeper extension or branch channel cut to the northeast. The northeastern channel followed the steeper slope of the hill and therefore gained a much greater 10–14 degree angle, enabling the more rapid removal of water through this side channel.

The drain had three primary fills. An upper fill consisting of deposits of dark brown soil, masonry, and lime mortar which formed after the drain was no longer in use, likely associated with the abandonment of the latrine and baths towards the end of the 3rd century (context V19-2). Below this were the two primary occupational deposits. Context V19-11 was contemporary with the final use of the latrine and baths, and it contained a soil/silt mixture that had a large volume of fine ash and soot in it, staining the soil black. The primary fill of the drain was in a shallow channel about 30 cm wide and 20 cm deep, cut into the base of the drain, and this contained a finer grey silty soil (context V19-26).

Fifty-eight sediment samples were collected along the length of the drain from the two primary occupational contexts. Fifty samples came from the primary fill (see Figure 2, V19-26) and eight samples came from the final use of the latrine (V19-11). In addition, one sample was also collected from the nearby Period I Fort Ditch. The Period I Fort at Vindolanda was constructed in 85 CE and occupied until 91/92 CE. Its northern ditch was filled with 2.3 m of organically preserved anaerobic material, sealed below 2 m of clay and rampart material from the later builds. The artefacts from these deposits included finely preserved leather shoes, leather bags and tent panels, some woven textiles, and a matt of yellow hair on the jawbone from a small dog.

The samples were split between two labs for analysis. Samples V19-26 41–50 and seven samples from V19-11 were processed in the Ancient Parasites Lab at the University of Cambridge. Samples from V19-26 1–40, and one sample each from V19-11 and from the northern Period I Fort ditch were processed at the University of Oxford.

Methods

All samples were disaggregated and microsieved to concentrate material within the size range of helminth eggs. This material was viewed with a compound light microscope at 200x and 400x magnification to detect preserved helminth eggs.

As the samples were processed in two separate laboratories there were slight variations to the methods used. At the University of Oxford (V19-26 samples 1–40, V19-11 and Period I Fort ditch), 5–7 g of sediment was rehydrated in ultrapure water with gentle agitation (Titertek shaker setting 3) then filtered using sieves with 1030 and 500 μm mesh. Material less than 500 μm was collected and concentrated by centrifugation (400 g, 10 min). The remaining

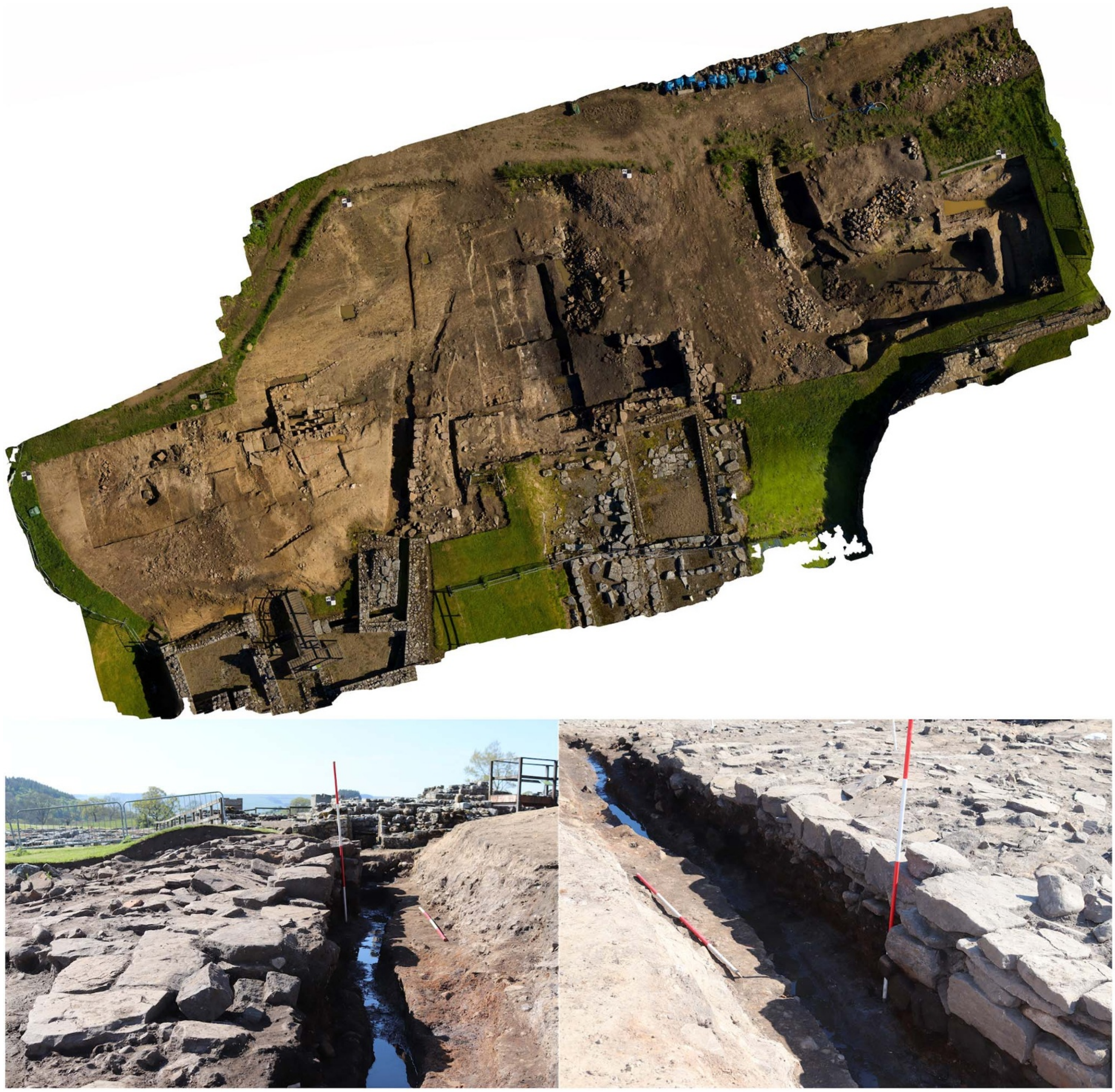

Figure 1. Aerial view of the latrine drain (top). Photos of the latrine drain during excavation (bottom).

pellet was resuspended in ultrapure water and microscopy was performed (Anastasiou and Mitchell, 2013; Ryan et al. 2022). For samples processed at the University of Cambridge (V19-26 samples 41–50 and V19-11), 0.2 g of sediment was rehydrated in 0.5% trisodium phosphate with intermittent vortexing until all material was disaggregated. Samples were then microsieved using sieves with 300, 160, and 20 μm mesh. Material between 20 and 160 μm was collected and concentrated by centrifugation (3000 g, 5 min). The pellet was resuspended in glycerol and microscopy was performed (Ledger et al. 2021).

In addition, one sample with preserved helminth eggs (V19-26 sample 47) was tested using commercial ELISA kits to detect preserved antigens from *Cryptosporidium* spp., *Entamoeba histolytica*, and *Giardia duodenalis*. The ELISA kits used were *Entamoeba histolytica* II, *Giardia* II, and *Cryptosporidium* II produced by TECHLAB (Blacksburg, Virginia, USA). A 1 g subsample was disaggregated in 0.5% trisodium phosphate, microsieved to collect material less than 20 μm, and centrifuged to concentrate material. The remainder of the test procedure followed the manufacturer's test protocol. A total of 6 technical replicates and one biological replicate on a separate day were tested. A sample was considered positive if biological replicates were both positive (i.e. a positive result was obtained on 2 separate days, with 2 separate ELISA kits, using 2 separate subsamples). Absorbance values were obtained using an ELISA plate reader at 450 nm and positive results were called using the interpretive criteria in the manufacturer's test protocol. Appropriate colour changes in each well were also visually confirmed.

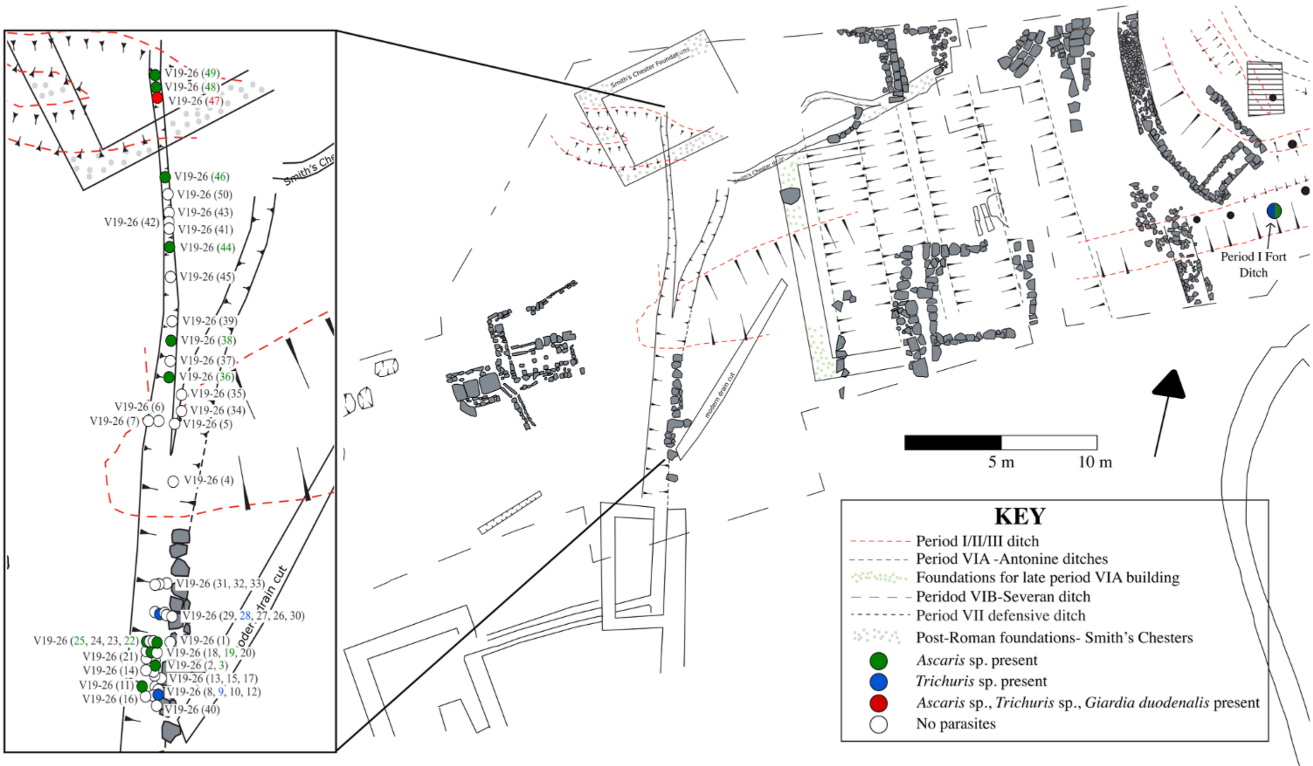

Figure 2. Excavation plan from Vindolanda showing the drain that was sampled for palaeoparasitological analysis and the location of samples from the primary fill (V19-26). The inset shows the location of parasite samples along the length of the drain with coloured circles indicating the parasite taxa found.

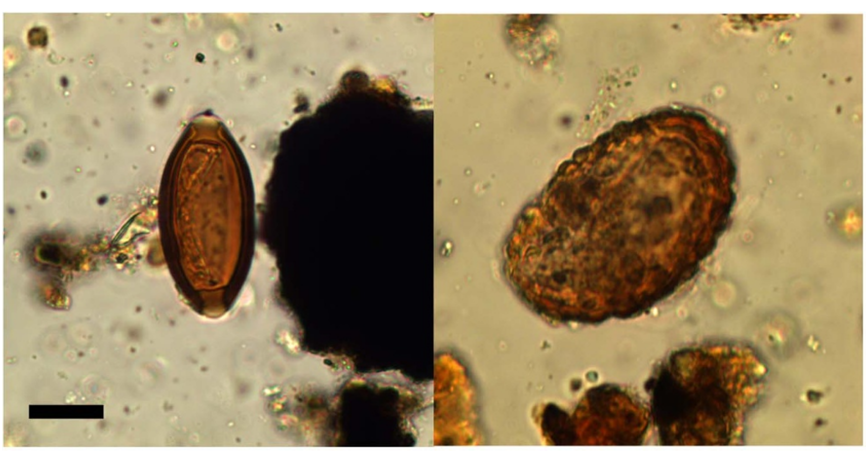

Figure 3. *Trichuris* sp. (left) and *Ascaris* sp. (right) eggs recovered from Vindolanda. Scale bar is 20 μm.

Results

Helminth eggs were found in 28% (14/50) of samples collected from the primary fill (V19-26) along the length of the 3rd century CE drain (Figure 2). The helminth taxa recovered from the primary fill of the drain were *Ascaris* sp. (roundworm) and *Trichuris* sp. (whipworm) (Figure 3). *G. duodenalis* was also detected using ELISA in the sample tested (V19-26 sample 47) (Table 1). This was also the only sample that contained both *Ascaris* sp. and *Trichuris* sp. eggs together. *Ascaris* sp. was found alone in 22% (11/50) of samples, while *Trichuris* sp. was found alone in 4% (2/50) of samples. In comparison, 25% (2/8) of the samples from the final fill of the drain (V19-11) contained helminth eggs, one had both *Ascaris* sp. and *Trichuris* sp. eggs and one had only *Ascaris* sp. eggs.

Finally, the sample collected from the Period I Fort ditch (1st century CE) contained *Ascaris* sp. and *Trichuris* sp. eggs.

The mean size of *Trichuris* sp. eggs was 53.1 μm long (standard deviation 5.9) and 26.7 μm wide (standard deviation 2.0, $N = 10$) (Table 2). For only those with preserved polar plugs the mean length was 57.3 μm long (standard deviation 0.4) and 27.3 μm wide (standard deviation 2.3, $N = 6$). The typical size range of *Trichuris trichiura* (human-infecting whipworm) is 50–60 μm long and 20–30 μm wide (Garcia, 2016; Ryoo et al. 2023). The mean size of *Ascaris* sp. eggs recovered were 60.5 μm long (standard deviation 4.6) and 42.7 μm wide (standard deviation 3.3, $N = 10$). Approximate egg concentrations were calculated and ranged from 5 to 84.7 eggs per gram (epg) for *Ascaris* and 35 to 79.9 epg for

Table 1. ELISA results from Vindolanda drain sample V19-26 sample 47. The ELISA kit used with number of positive wells on both days of testing is presented with the absorbance values from positive wells and cut-off value for determining positivity

ELISA kit	No. of positive wells Day 1	Absorbance values	No. of positive wells Day 2	Absorbance values	Final interpretation
Cryptosporidium II	0/6	–	0/6	–	**Negative**
E. histolytica II	0/6	–	0/6	–	**Negative**
Giardia II	**1**/6	0.18 (positive $\geq$ 0.15)	**1**/6	0.51 (positive $\geq$ 0.15)	**Positive**

Table 2. Number of positive samples for each parasite taxa with size ranges and mean dimensions for each parasite taxa

Parasite	Positive samples (%)	Length (μm)*	Mean length ± SD (μm)	Width (μm)*	Mean width ± SD (μm)
Ascaris sp.	15 (25)	53.47–68.88	60.5 ± 4.6	36.84–47.18	42.7 ± 3.3
Trichuris sp.	5 (8)	41.51–57.87	53.1 ± 5.9	24.99–31.84	26.7 ± 2.0

*10 eggs of each taxa were measured. SD, standard deviation.

Trichuris in the drain samples from the primary fill (V19-26). The egg concentrations in one V19-11 subsample were 10 epg for both *Ascaris* and *Trichuris* and in the other subsample were 61.7 epg of *Ascaris* with no *Trichuris*, while remaining samples contained no eggs. Egg concentrations in the Period I Fort Ditch were higher at 648.1 epg for *Ascaris* and 787.8 epg for *Trichuris*.

Discussion

Sampling along the length of a drain at the Roman Fort of Vindolanda has provided evidence for parasite presence at the site. Parasites were recovered from 28% of samples from the primary fill (3rd century CE) collected along the length of the drain. All parasites recovered are spread by ineffective sanitation. *Ascaris* sp. (roundworm) and *Trichuris* sp. (whipworm) are both soil-transmitted helminths (worms). Eggs were identified to the genus-level given the inability to differentiate between closely related species based on morphology. *Ascaris lumbricoides* and *Ascaris suum* are indistinguishable under the microscope and while the size of different *Trichuris* sp. eggs is variable, the typical size range of *T. trichiura* overlaps that of *T. suis* (pig-infecting whipworm) (Beer, 1976) precluding differentiation of the eggs identified in our samples. The large size range of the *Trichuris* eggs recovered from the drain samples is partially attributed to variation in preservation of the polar plugs. However, for the minority of eggs that were the largest, we cannot rule out that some may be from other animal species whose faeces may have contaminated the drain such as *Trichuris muris* from mice. *Ascaris* sp. and *Trichuris* sp. can cause co-infections and are often found within the same populations today (Howard et al. 2001; Lepper et al. 2018). Similarly, they are commonly detected together in communal deposits from Roman period sites, including those in Britain (Ledger et al. 2024, 2025). Interestingly, however, one study analysing pelvic soil samples from Roman period Britain did not detect any co-infections of *Ascaris* sp. and *Trichuris trichiura* in Roman period individuals (Ryan et al. 2022). Thus far, only one study from Roman Britain has shown evidence for co-infection of *Ascaris* sp. and *Trichuris* sp. in one individual (Jones, 1987). *G. duodenalis*, which was also identified in the drain, is a unicellular flagellate that is often transmitted through contaminated drinking water or food (Minetti et al. 2016). The presence of these three parasites is suggestive of faecal contamination of drinking water and/or food sources at the Roman fort in the 3rd century CE. Additionally, the sample collected from the earlier Period I Fort ditch (1st century CE) also contained *Ascaris* sp. and *Trichuris* sp. indicating that these parasites were persistently present through time at the site.

Ascaris sp. was present in 15 samples while *Trichuris* sp. was present in only five. This may indicate a predominance of *Ascaris* sp. infection in the community. However, the reproductive potential and worm burdens of these two parasites should be kept in mind. Female *A. lumbricoides* worms can release up to 200 000 eggs per day (Phuphisut et al. 2022) while *Trichuris trichiura* worms only release 18 000 (Hansen et al. 2016). For this reason the definition of a heavy worm burden for *Ascaris* and *Trichuris* are different, with heavy *Ascaris* infection defined as ≥50 000 eggs per gram of stool and *Trichuris* ≥10 000 eggs per gram (Montresor et al. 1998). However, the total number of worms that an individual can carry from the two species also varies. The absolute number of *Trichuris* worms that an individual can carry being higher than that of *Ascaris* (Brooker, 2010). Despite the variation in fecundity of these two worms, the much larger proportion of samples that contain *Ascaris* sp. eggs may suggest that *Ascaris* sp. was more common within the community.

Transmission of both *Ascaris* sp. and *Trichuris* sp. within one community is expected based on the similarities in their faecal-oral transmission route (Else et al. 2020). Both are endemic in many tropical or subtropical low and lower middle income countries (Holland et al. 2022). However, it is clear that these infections were common in past European populations (e.g. Roche et al. 2019; Flammer et al. 2020; Ryan et al. 2022; Mitchell, 2023; Ledger et al. 2024).

One other possibility to keep in mind is the zoonotic potential of *Ascaris*. While *Ascaris* presence in archaeological sites is commonly linked to human-to-human transmission as a result of poor sanitation in the past, epidemiological data in modern populations points to the zoonotic potential of *A. suum* infecting humans (Anderson, 1995; Nejsum et al. 2012; da Silva et al. 2021). This is particularly relevant to the Roman period when there is a distinct reliance on pigs, especially in the Mediterranean region (King, 1999). However, zooarchaeological studies in Britain have highlighted the variation in foodways across the Empire and shown that in Roman Britain cattle were the dominant domesticate followed by sheep and pigs to a lesser extent (Rizzetto et al. 2017). These broad comparisons by region, however, do not consider site type. For example, studies have shown that even within a single region animal husbandry varied between urban, rural and military sites (Valenzuela-Lamas and Albarella, 2017). At Vindolanda, the exceptional preservation of the Vindolanda tablets give us particular insight into meat preferences, with pig being a popular source of meat as documented in written records from the site (Pearce, 2002). *A. lumbricoides* is classically considered the human-infecting species of roundworm while *A. suum* is the pig-infecting species. However, a multitude of experimental and clinical cases exist of human infection with *A. suum* (Bendall et al. 2011; Nejsum et al. 2012; Betson et al. 2014). For example, multiple infections were documented in schoolchildren in Denmark after the school garden was fertilized with pig manure (Roepstorff et al. 2011). The use of pig faeces as fertilizer or pig faeces contaminating crops and water sources could additionally lead to human infections in the Roman period. Unfortunately, it is not possible to distinguish between the two species using morphological appearance, thus we have identified the eggs as *Ascaris* sp. Similarly *T. suis* (pig whipworm) has been shown to establish infections in humans, however, it is expected that reproductive capacity is limited in these cases (Nejsum et al. 2012). Thus, while the *Trichuris* eggs recovered from Vindolanda could be from either species, if the drain primarily contained human faecal material from the bath complex it seems more likely that the *Trichuris* eggs are from *T. trichiura*, the transmission of which would be more easily maintained within the population. Finally, we need to consider that if pigs were reared or butchered within the vicinity of this drain, the faecal material and intestinal contents of pigs could have been washed into the drain leaving behind *T. suis* eggs that may have infected pigs at the site.

G. duodenalis was also detected using ELISA. Studies suggest that the Giardia II ELISA kits we used, which target the *Giardia* Cyst Wall Protein 1, have a high sensitivity and specificity for *G. duodenalis* in fresh faecal samples, ranging from 91% to 100% sensitivity and 97.8% to 100% specificity (Boone et al. 1999; Silva et al. 2016). However, sensitivity is expected to be lower in archaeological samples. The presence of *G. duodenalis* further exemplifies the transmission of faecal-oral diseases at the site. This is the first evidence for *G. duodenalis* in archaeological contexts in Britain. *G. duodenalis* has also been detected in latrines from Iron Age Jerusalem (Mitchell et al. 2023), Roman period Italy and Turkey (Williams et al. 2017; Ledger et al. 2021) and later time periods in Belgium, the Czech Republic, France, Germany, Israel/Palestine, and the Netherlands (Gonçalves et al. 2002; Le Bailly et al. 2008; Mitchell et al. 2008; Bartošová et al. 2011; Yeh et al. 2015; Eskew et al. 2020; Graff et al. 2020; Rabinow et al. 2024). We cannot confirm that the detection of *G. duodenalis* indicates human infection as many other animals can also be infected with *G. duodenalis*, and the drain could have been contaminated with run-off from other areas of the site contaminated by animal faeces. However, the suite of parasites found, which all have common transmission routes and are often co-endemic in human populations, in a drain primarily carrying latrine contents, lends weight to them originating from infected people living at Vindolanda.

Parasite evidence from Roman Britain has recently been reviewed (Ledger et al. 2024). Across Roman Britain, *Ascaris* and *Trichuris* are the most common parasites found, with at least one of these taxa being found at every site studied (Ledger et al. 2024). However, *Dibothriocephalus* sp. (fish tapeworm), *Taenia* sp. (beef or pork tapeworm), *Fasciola* sp. (common liver fluke), and *Dicrocoelium* sp. have also been recovered (Pike, 1968; Rouffignac, 1985; de Moulins, 1990; Jones and Hutchinson, 1991; Boyer, 1999; Ryan et al. 2022). Of particular relevance to the current study is the palaeoparasitological investigation undertaken on occupation layer sediments dating from the 1st–4th century CE from Carlisle, another site along Hadrian's Wall, only 40 km from Vindolanda. In these sediment samples eggs of *Ascaris, Trichuris* and *Fasciola* sp. were recovered (Jones and Hutchinson, 1991). Given the sample type studied, it may well be that the *Fasciola* eggs recovered represent infection of animals kept near the site. Regardless, this study confirms that *Fasciola* was present in the region at this time though we find no evidence for infections at Vindolanda. Elsewhere in the Empire we also have similar evidence for transmission of *Ascaris* and *Trichuris* in military settlements in the absence of other helminths including at Carnuntum in Austria (Aspöck et al. 2011), Valkenburg on Rhine in the Netherlands (Jansen and Over, 1966), Bearsden in Scotland (Knights et al. 1983) and Viminacium in Serbia (Ledger et al. 2020; Marković et al. 2024). Whether this is reflective of the overall predominance of *Ascaris* and *Trichuris* in the Roman period as a whole, or a particular pattern seen in military settlements will likely be further elucidated as we gain more evidence from palaeoparasitological studies.

The sampling approach undertaken in this study highlights the value of collecting samples from multiple locations along archaeological drainage features to increase chances of recovering biological remains in faecal material. As to be expected in archaeological settings, not all samples collected from the same drain were positive for parasites. However, by collecting multiple samples, we can increase our ability to more accurately reconstruct parasite presence in archaeological contexts. In addition, collecting samples along the course of drains (as done in this study) may provide information on drainage design and use. The drain sampled in this study consisted of two channels fed from one larger channel that was connected to the latrine (see Figures 1 and 2). The samples that were collected from the northeastern channel did not contain any parasite eggs, while multiple samples collected from the northwestern channel and the wider portion that fed these two channels did contain parasite eggs. This may indicate that the northwestern channel was carrying the bulk of the latrine run-off, or that the slower rate of flow in this channel allowed for more deposition of faecal material, while the steeper northeastern channel carried this material away on a stronger current. However, fewer samples were collected from the eastern channel, thus it is possible that this channel did originally contain faecal material but we did not have adequate samples to detect this. One limitation of studying drain samples is that run-off from the town can also be carried within the drain, thus recovered parasite eggs may also represent general environmental contamination. In this study, while we expect the bulk of the fill of the drain to have come from the latrine it was connected to, there is a possibility for material from other areas of the settlement to be washed into the drain.

While latrines and cesspit fill are very common sample types for palaeoparasitological analysis, drain samples have also proven to be a useful sample type for recovering parasite eggs. This has been undertaken in other archaeological sites, particularly in the Roman period where the architectural remains of drains have been preserved. *Ascaris* and/or *Trichuris* have been recovered from Roman period drains from the sites of Vagnari and Vacone, Italy and Sardis, Türkiye (Ledger et al. 2020, 2021). From Roman Britain, eggs from *Ascaris* and *Trichuris* were recovered from a sewer system in York (Wilson and Rackham, 1976). Samples collected from both latrines and latrine drains in the Hellenistic City of Delos, Greece contained *Ascaris, Trichuris* and Strongyle-type eggs (Roche et al. 2025). While these findings were useful in confirming the use of drain structures as possible structures for carrying faecal waste, samples were not collected along the length of these drain structures precluding further analysis of drain function.

The impact that these parasites would have had on the community of Vindolanda is likely to be similar to what was experienced elsewhere in the Roman Empire. Palaeoparasitological studies undertaken in various regions of the Roman Empire suggest that gastrointestinal parasite infections, especially with *Ascaris* and *Trichuris*, were likely quite common (Mitchell, 2017; Ledger et al. 2025). This was no different for Roman military troops stationed at Vindolanda. Palaeoparasitological studies on other Roman sites have shown that environmental contamination with eggs from *Ascaris* and *Trichuris* was occurring and likely contributed to ongoing transmission of these parasites (Van Geel et al. 2003; Roche et al. 2020; Gaillot et al. 2024). The presence of parasites transmitted by the faecal-oral route indicates that other pathogens transmitted by the same route could have been supported in the community and some of these pathogens may have contributed to disease outbreaks (e.g. *Salmonella, Shigella, Campylobacter*, norovirus, adenovirus, rotavirus, enterovirus). There is written evidence for conjunctivitis spreading at the fort when the First Cohort of the Tungrians were stationed there (Jackson, 1990; Birley, 2009:68). A letter recording the strength of the unit states that 10 men were unfit for duty as they were suffering from conjunctivitis. One must wonder if the cause of conjunctivitis was one of these common gastrointestinal viruses that are also common causes conjunctivitis such as adenovirus and enterovirus.

Conclusion

Palaeoparasitological analysis of samples from the length of a latrine drain and ditches at the Roman site of Vindolanda along Hadrian's Wall reveal evidence for the presence of *Ascaris, Trichuris*, and *Giardia duodenalis* at the site. These results provide further evidence for the types of gastrointestinal diseases that Roman military units likely experienced and are remarkably similar to those found in other regions of the Empire. The sole presence of parasites related to sanitation conditions exemplifies the risk for infections transmitted by the faecal-oral route in Roman military settlements. This study also highlights the value of sampling multiple locations along archaeological drains to increase detection of ancient parasites as well as investigate drainage patterns within a site.

Acknowledgements. We would like to thank the Vindolanda Trust and excavation teams and TechLab, Blacksburg, Virginia, USA for donating ELISA kits used in this study.

Author contributions. M.L.L., P.F., A.S., A.B., P.D.M. conceptualized the study. M.L.L. and P.F. performed laboratory analysis. AB contributed to excavation and sample collection. M.L.L. was responsible for writing original manuscript draft. M.L.L., P.F., A.S., A.B., P.D.M. were responsible for writing and editing the final manuscript.

Financial support. This work was supported by a Social Sciences and Humanities Research Council of Canada Doctoral Award to M.L.L. A Cambridge Commonwealth, European and Internal Trust and Trinity Hall College Award to M.L.L.

Competing interests. The authors declare there are no conflicts of interest.

Ethical standards. Not applicable.

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