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Koen Deforce

- Royal Belgian Institute of Natural Sciences, OD Earth and History of Life, Vautierstraat 29, 1000 Brussels, Belgium. koen.deforce@naturalsciences.be, ORCID: https://orcid.org/0000-0003-3075-2564
- Flanders Heritage Institute, Brussels, Belgium
- Ghent University, Department of Archaeology, Ghent, Belgium

Marissa L. Ledger

- Department of Archaeology, University of Cambridge, The Henry Wellcome Building, Fitzwilliam Street, Cambridge, CB2 1QH, UK. ORCID : 0000-0002-5501-6590

Marie Derreumaux

- Centre de Recherche Archéologique de la Vallée de l'Oise, 17 rue James de Rothschild, 60200, Compiègne, France. mariecarpo@free.fr
- UMR 7209 "Archéozoologie - Archéobotanique. Sociétés, pratiques et environnements"- Muséum National d'Histoire Naturelle

Quentin Goffette

- Royal Belgian Institute of Natural Sciences, OD Earth and History of Life, Vautierstraat 29, 1000 Brussels, Belgium. qgoffette@naturalsciences.be, ORCID: https://orcid.org/0000-0003-2845-1746

Denis Henrotay

- Agence Wallonne du Patrimoine-Direction opérationnelle de la zone Centre
- Institut archéologique du Luxembourg

Fabienne Pigière

- Royal Belgian Institute of Natural Sciences, OD Earth and History of Life, Vautierstraat 29, 1000 Brussels, Belgium. Current address: University College Dublin, School of Archaeology, Ardmore Annexe Belfield Dublin 4

Wim Wouters

- Royal Belgian Institute of Natural Sciences, OD Earth and History of Life, Vautierstraat 29, 1000 Brussels, Belgium

Piers D. Mitchell

- Department of Archaeology, University of Cambridge, The Henry Wellcome Building, Fitzwilliam Street, Cambridge, CB2 1QH, UK. ORCID: 0000-00002-1009-697X

Abstract

Botanical (macro remains and pollen) and animal remains, including intestinal parasites, from a latrine dated between c. 250 AD and 280 AD from the artisan quarter of the vicus *Orolaunum* (Arlon) have been studied. The results provide information on the diet and health of a non-elite and poorly understood part of the population in northern Gaul. The identified plant remains document a diet which include several Roman introductions to the region, but hardly any truly exotic imports. Also the remains of fish sauce have been identified, but this was a locally produced variety and possibly a cheaper version of the typical Mediterranean product. The results indicate that the diet of the household using the latrine was strongly influenced by romanisation and that the lack of exotic imports was most likely the result of a low economic status rather than a lack of interest for these products. The people using the latrine were also infected with both roundworm and whipworm, two intestinal parasites that were probably common in the population of northern Roman Gaul and which are spread when sanitation is ineffective.

Keywords: Roman period; diet; latrine; plant remains; animal remains; intestinal parasites

1. Introduction

Archaeological remains of cesspits and latrines are an important source of information on diet and health of past populations. The fill of these features largely contains human faecal remains and generally shows good preservation conditions for organic materials. Therefore, such finds are regularly studied for both botanical and animal remains, which largely reflect human diet, and for eggs of intestinal parasites which also provide information on sanitation and disease in the respective population. In addition, the fill of these features can often be linked to a single household, or the occupants of a single building or living quarter, and therefore provide information on diet and health of a specific subgroup of the population (e.g. Deforce, 2010; De Groote et al., 2018; Troubleyn et al., 2009).

In north-western Europe, large numbers of medieval and post-medieval cesspits and latrines have been found, mostly during excavations in historic city centres (Addyman, 1989; Greig, 1982; Sabine, 1934; van Oosten, 2015, 2017), and there are extensive archaeobotanical and archaeozoological (e.g. Brown et al., 2017; Clavel, 2001, Clavel et al., 2006; De Clercq et al., 2007; Deforce et al., 2019; Ervynck, 2016; Hellwig, 1997; Märkle, 2005; van Haaster, 2008; Troubleyn et al., 2009) and palaeoparasitological studies (e.g. Brinkkemper and van Haaster, 2012; da Rocha et al., 2006; Deforce, 2010; Fernandes et al., 2005; Flammer et al., 2018; Mitchell, 2015; Rácz et al., 2015; Søe et al., 2018) of these features. Far fewer archaeological remains of cesspits and latrines dating to the Roman period have been found in north-western Europe (Bouet, 2009; Hoss, 2018) and only a portion of those have been studied for biological remains (Gama et al., 2012; Goppelsröder and Sommer, 1996; Hänggi et al., 1989; Jauch, 1997; Kuijper and Turner 1992; Le Bailly et al., 2003; Petznek, 2018). In addition, many of these latrines were related to high status archaeological contexts and/or military sites with a potentially non-local population (e.g. Knörzer, 1970; 1981; Kučan, 1992; Kuijper and Turner, 1992; Schamuhn and Zerl, 2009). As a result, little is known about the diet and health of Roman period non-elite urban households in this part of the Roman empire.

The aim of this research is to improve our understanding of the life and health of the local, non-elite population in an urban centre in Roman Gaul. This is achieved through the detailed study of botanical (macro remains and pollen) and animal remains, including intestinal parasites, from a latrine dated between c. 250 AD and 280 AD from the artisan quarter of the vicus *Orolaunum* (Arlon).

2. The Site

Arlon is situated in the southernmost part of Belgium, at the border with Luxembourg (Fig. 1A). During Roman times, Arlon was a vicus (*Orolaunum*) situated at the intersection of the Reims-Trier and Metz-Tongeren roads, in the western territory of the *Treviri civitas*, northern Gallia (Henrotay, 2007). Previous finds of dromedary bones indicate it was probably a stopping point for long distance traffic (Pigière and Henrotay, 2012). Also, remains of Roman ceramics and especially amphorae excavated in Arlon indicate the import of goods from central and southern France, and also from Southern Spain, Italy and northern Africa (Hanut, 2009).

The Neu site at Arlon was excavated in 2003, 2004 and 2006 by the archaeological heritage agency of the Walloon region. This site was a residential and artisanal quarter of the vicus, bordering the Semois river during the early Roman period. It was destroyed in 275 or 276 AD and re-occupied in the second third of the 4th century AD (Colling et al., 2012; Hanut and Henrotay, 2006). During the excavations in this quarter, the remains of five Roman buildings have been found (Fig. 1B). The archaeological finds indicate that these buildings housed workshops for different artisanal activities such as smithing, wood turning, and glass and bronze production (Henrotay, 2009). Also the remains of several latrines associated with these buildings have been found (Henrotay, 2007, 2009). One of them, situated at the rear of a habitation plot and smithing workshop, is a former water well of 3 m depth which was reused as a latrine (F5 on Fig 1B).

3. **Material and methods**

Botanical and animal remains, including remains of intestinal parasites, recovered from the 1.5 m thick fill of the latrine have been studied (Fig. 1C). Two distinct archaeological layers were recognized during the excavation. Layer 01.051 is an organic layer that consists of mostly faecal material which accumulated during the use of the cesspit, while layer 01.050 corresponds to the backfill of the structure with rubble after its abandonment. The timespan of accumulation of the faecal material can be dated between 250 AD and 276 AD, based on the ceramics recovered from this layer and the covering layer of debris which corresponds with the destruction of the entire site in 275/276 AD (Hanut and Henrotay, 2006; Colling et al., 2012).

3.1. Botanical macro remains

The macro botanical remains come from a 5.25 L sample from layer 01.051. It was wet sieved, using mesh of 4, 2 and 0.5 mm. The macro botanical remains were identified with the aid of the reference collection of the Centre de Recherche Archéologique de la Vallée de l'Oise (CRAVO) and identification atlases (Bojňanský and Fargašová, 2007; Cappers et al. 2006). Botanical nomenclature as well as plant ecology are based on Lambinon et al. (2004). To calculate the Minimum Numbers of Individuals (MNI), seed fragments were counted as half an individual and entire seeds as one individual.

3.2. Pollen

Three subsamples of c. 1 cm³ from layer 01.051 were processed for palynological analysis using standard procedures (Moore et al., 1991), including the addition of *Lycopodium* spore tablets for the calculation of the pollen concentration (Stockmarr, 1971). Identifications of pollen and spores were based on Beug (2004) and Punt et al. (1976-2003) and a reference collection of modern pollen and spores, stored at the Royal Belgian Institute of Natural Sciences (RBINS). A minimum of 300 pollen grains were identified and counted from each sample. Percentages are based on the sum of all pollen types (ΣP). Spores are excluded from this sum.

3.3. Animal remains

Animal bones were recovered by hand during the excavation. In addition, the sediment from the entire structure was sieved in the field on sieves with a 1 mm mesh and one subsample of 4.5 L was screened on sieves of 4, 2 and 1 mm in the laboratory of the RBINS. The animal remains were studied using the reference collection of modern specimens of the RBINS and the Royal Museum for Central Africa. The results of the archaeozoological analysis of the other excavated archaeological features from the site can be found in Pigière and Wouters (2009a; b).

3.4. Intestinal parasites

A subsample of sediment from layer 01.051 from the fill of the cesspit was analysed in the University of Cambridge Ancient Parasites Laboratory for preserved parasite eggs following standard methods (Anastasiou and Mitchell, 2013). A 0.2 g subsample was rehydrated and disaggregated with 0.5% trisodium phosphate, and sieved with a set of microsieves (mesh sizes 300 µm, 160 µm, and 20 µm). All material with dimensions between 20–160 µm was collected on the 20 µm sieve, concentrated by centrifugation, then mixed with glycerol to be viewed under a digital light microscope. Helminth eggs were identified using standard reference manuals (Ash and Orihel, 2015; Garcia, 2016). Egg concentrations were calculated by counting all eggs in the 0.2 g subsample and multiplying this by five to get egg concentrations per gram.

4. Results and interpretation

4.1 Botanical macro remains

The results of the analysis of the macro botanical remains are listed in Table 1. A total of 2604 waterlogged and 10 charred seeds or fruits were recovered from the latrine sample. These included cereals, fruits and nuts, spices and vegetables, wild plants, and plants which both could have been cultivated or gathered in the wild. Cereals are scarce: only one grain of barley (*Hordeum vulgare*) was found. Nuts and fruit remains are much more diverse and include hazelnut (*Corylus avellana*), common walnut (*Juglans regia*), fig (*Ficus carica*), strawberry (*Fragaria vesca*), apple (*Malus* sp.) or pear (*Pyrus* sp.), cherry (*Prunus avium*), domesticated plums (*Prunus domestica*), sloe (*Prunus spinosa*), several bramble species (*Rubus caesius*, *R. idaeus* and *R. fructicosus*), blueberry (*Vaccinium myrtillus*) and grape (*Vitis vinifera*). Spices and vegetables discovered in the latrine are dill (*Anethum graveolens*), beetroot (*Beta vulgaris* subsp. *vulgaris*), poppy (*Papaver somniferum*), coriander (*Coriandrum sativum*), cucumber or melon (*Cucumis sativus*/*melo*) and savory (*Satureja hortensis*). Parsnip (*Pastinaca sativa* subsp. *sativa*) and carrot (*Daucus carota*) have also been found and could represent both the wild or the cultivated form. In both cases, the identified mericarps are more likely to represent weeds as these plants are generally harvested and consumed before fruit development. Patience dock (*Rumex patienta*) may have been cultivated as a vegetable for its leaves (André, 1981, Lambinon et al., 2004).

Celery (*Apium graveolens*), black mustard, bird rape or turnip (*Brassica nigra*/*rapa*), wallflower (*Raphanus raphanistrum*), and white or wild mustard (*Sinapis alba*/*arvensis*) were also found in the latrine, and these plants may have been cultivated or gathered in the wild to be used as spices or condiments. Celery is unlikely to have been collected in the wild however, as this species is very rare in the area around Arlon (Lambinon et al., 2004). Moreover, celery is regularly found in archaeological contexts in north-western Europe since the Roman period and generally interpreted as a cultivated plant (Livarda and van der Veen, 2008). Nowadays, the fleshy stem or the root of the *dulce* subspecies is used, resulting from horticultural work in the renaissance period, but celery fruits were used as a condiment during Antiquity (André, 1981). The remains of black mustard, rape or turnip, wallflower, and white or wild mustard could represent wild, seasoning or oleaginous plants as well as cultivated vegetables. All mustards seeds, as well as turnip and wallflower seeds have a pungent taste which can be used for flavouring food (Couplan, 1999). When found in medieval latrines, these are generally interpreted as condiments (Preiss, 2011).

The wild plants in the assemblage from the latrine fill belong to several plant communities: weeds including specific winter and summer crop weeds, ruderals, and taxa from grassland, woodland and hedges. The winter crop weeds are the more numerous wild plants (78.9% of the MNI of wild plants excepting ubiquitous ones = 293). This is due to the high numbers of two taxa: white lace flower (*Orlaya grandiflora*) and corncockle (*Agrostemma githago*). White lace flower‘s fruits are often present in spelt spikelet stocks as their size is similar to that of spelt spikelets, and sieving does not effectively remove it. Corncockle seeds are the same size as cereal grains and must be hand sorted before grinding or cooking the cereals. As most of the corncockle seeds are fragmented (RN = 129), they have probably been ground and incorporated in food with flour and ingested, or represent residues from flour sieving. Another winter crop weed worth mentioning is musk weed (*Myagrum perfoliatum*). This is a Mediterranean species, seeds of which have also been found in Roman archaeobotanical samples near Reims (northern France) and is an indication of the import of cereals, at some time, from southern Europe, probably via the Rhône and Saône distribution network (Toulemonde et al., 2017; Verloove and Vandenberghe, 1995). The presence of ball mustard (*Neslia paniculata*) is also remarkable as it is not naturally present in Belgium, however it does occur sporadically in the southern part of the nearby Champagne and Lorraine regions in France (Lambinon et al. 2004).

Black henbane (*Hyoscyamus niger*) was also found in the latrine. This is a toxic wild plant, but it has been used as a medicinal plant to ease pain and promote sleep since Antiquity (Fenwick and Omura, 2015). Archaeobotanical finds of this plant are therefore sometimes seen as indications for it medicinal use (Fenwick and Omura, 2015; Jedrusiak, 2016). Henbane is also a common weed however, with seeds that are difficult to remove from crops such as peas (Pitrat and Foury, 2013), and the henbane seeds in the latrine from Arlon might thus also result from its presence in harvested crops.

4.2 Pollen

The pollen assemblages of all three analysed samples are characterised by very low arboreal percentages (4.8%-9.2%) (Table 2). This is an indication that the contribution of the atmospheric pollen rain, both from local and regional vegetation and from long distance pollen transport, in the pollen assemblages of the cesspit samples is minimal (Deforce, 2017). Cerealia is the most abundant pollen type, which is another indication that most of the identified pollen types originate from faecal material. High percentages of Cerealia pollen are a common feature of cesspits which is generally explained by the consumption of cereal based food such as bread or porridge (Greig, 1981; Deforce, 2017). As most cereals are autogamous, a large number of pollen grains remain in the hulls and will end up in cereal based food products after cereal processing and food preparation (Jankovská and Kratochvílová, 1988; Joosten and Van den Brink, 1992; Robinson and Hubbard, 1977).

Other food plants from which pollen have been found are pea (*Pisum sativum*), beetroot or chard (*Beta vulgaris*), coriander (*Coriandrum sativum*) and anise (*Pimpinella anisum*). Only small numbers of pollen from these taxa have been found, but except for *Beta vulgaris*, these are all low pollen producers, and the consumption of their seeds (pea, coriander, anise), leaves (chard, coriander) or roots (beetroot) is not likely to result in the ingestion of large numbers of pollen.

The mustard family (Brassicaceae), which has percentages up to 12.8% in the samples, includes both wild plants and several potential food plants. The seeds of some of these food plants have been found in the latrine (cf. supra) (i.e. black mustard, wallflower and white or wild mustard), which indicates that these plants were used, and the Brassicaceae pollen might have the same origin. Another likely source for the Brassicaceae pollen is the consumption of honey. The consumption of honey has been shown to have an important influence on the pollen assemblages of coprolites (Hadorn, 1994; Moe and Oeggl, 2014), cesspits and latrines (Deforce, 2010; 2017; De Groote et al., 2004; 2009; Jankovská, 1987; Meurers-Balke et al., 2015), and north-western European honeys often contain high percentages of Brassicaceae pollen (Crane, 1975; Kruczek and Stacewics, 2015). Therefore it is not unlikely that at least part of the Brassicaceae pollen from the latrine originates from the use of honey. Also the high number of other typical honey plants such as the lettuce-subfamily (Asteraceae-Liguliflorae), common heather (*Calluna vulgaris*), ivy (*Hedera helix*), red clover (*Trifolium pratense*) and white clover (*Trifolium repens*) indicate that honey was consumed by the people that used the latrine. Sweet chestnut (*Castanea sativa*), also found in the latrine, produces edible seeds, but it is unlikely that consumption of it would result in the ingestion of its pollen, as both the spiny cupule and the nutshell have to be removed to access the edible nut. Therefore, the consumption of honey is also the most likely origin for the identified sweet chestnut pollen, as this is also a typical component of the pollen assemblage of honey.

Another likely origin for the pollen of many of the identified wild herbaceous plants are arable weeds that have been harvested and processed together with the Cerealia and thereby incorporated in cereal based food products (Deforce, 2017). This would explain the presence of pollen of white lace flower, an arable weed that is almost exclusively restricted to cereal fields (Lambinon et al., 1998), and of which many fruits (mericarps) have been found as well. Mugwort (*Artemisia* sp.), pink family (Caryophyllaceae), goosefoot family (Chenopodiaceae) and common knotgrass type (*Polygonum aviculare* type) are also pollen types that include typical arable weeds.

4.3. Animal Bones

The preservation of the faunal material is very good. The animal remains recovered by hand in layer 01.051 (Table 3), which accumulated during the use of the structure, total 1314 elements mainly from medium to large size domestic mammals such as cattle (*Bos primigenius* f. taurus), pig (*Sus scrofa* f. domestica), sheep (*Ovis ammon* f. aries), goat (*Capra aegagrus* f. hircus), dog (*Canis lupus* f. familiaris) and horse (*Equus ferus* f. caballus). A few bird bones belong to domestic fowl (*Gallus gallus* f. domestica), northern raven (*Corvus corax*) and an unidentified dove species (Columbidae). Smaller bones include 2 elements of chub (*Squalius cephalus*) and 9 bones of frogs (*Rana* sp.). Animal bones were scarcer in the backfill of the structure (layer 01.050), with 178 fragments, mostly from partial pig carcasses. Again, some bird bones were identified, most as domestic fowl but Western jackdaw (*Coloeus monedula*) and a dove were also recognized.

Layer 01.051 was also sieved and delivered a very diverse fish assemblage, which is believed to include the remains of a fish sauce. This salted product included at least 17 marine fish taxa, mostly plaice (*Pleuronectes platessa*), lesser weever (*Echiichthys vipera*) and clupeids, as well as small cyprinids, such as tench (*Tinca tinca*). All the marine taxa identified can be found in an estuarine environment, where they were likely caught. Given the species included, this fish sauce must have been produced locally, i.e. along the North Sea or the North Atlantic coasts and not in the Mediterranean region. A detailed inventory of these fish remains, shrimps and crab fragments, and their interpretation as fish sauce ingredients has been published by Van Neer et al. (2010) and Derreumaux et al. (2011). Other taxa, including fish, not considered as ingredients of the fish sauce, are presented in Table 4. These fish are represented by larger specimens such as the Atlantic salmon (*Salmo salar*) and cyprinids. Insects and some gastropod shells were also recovered. Amphibians include only frogs. Bird bones are present but could not be assigned to any species. Mammal remains in the sieved samples only include small species such as the bank vole (*Myodes glareolus*), field mouse (*Apodemus* sp.), shrew (Soricidae) and mole (*Talpa europaea*).

In both layers, most faunal remains represent consumption refuse. Among the domestic mammals, only dog and horse are not considered as part of the diet, as no cutmarks were found on their bones. However, the consumption of horse is not totally ruled out, as other Roman period archaeological contexts in Arlon-Neu yielded evidence that it was sometimes filleted (Pigière and Wouters, 2009a). The fish, domestic fowl and doves are most likely food items, while the insects, molluscs, frogs, micromammals are interpreted as intrusive, and the corvid bones as remains of carcasses (sensu Gautier, 1987), in the absence of cutmarks.

4.4. Intestinal Parasites

Four different taxa of helminths were found in the fill of the Arlon latrine. These were roundworm (*Ascaris* sp.) , whipworm (*Trichuris* sp.) , *Capillaria* sp., and lancet liver fluke (*Dicrocoelium* sp.) (Fig. 2). These eggs were well preserved, as indicated by the presence of a mamillated coat on most of the roundworm eggs and polar plugs on some of the whipworm eggs, features that are often lost in archaeological samples. The concentrations and mean dimensions of eggs recovered can be found in Table 5.

The concentration of roundworm and whipworm eggs in the sample was much higher than that of *Capillaria* sp. and lancet liver fluke. The concentration of roundworm eggs was 990 eggs/g and the concentration of whipworm was 1,795 eggs/g. The concentration of both *Capillaria* sp. and lancet liver fluke eggs was 10 eggs/g.

When the dimensions of all *Trichuris* sp. eggs are compared to mean recorded size ranges for different species (Beer, 1976), the majority of eggs fall in the size range for human whipworm (*T. trichiura*) with some falling into the overlapping range for pig whipworm (*T. suis*) and human whipworm (Fig. 3). This indicates that the eggs are most likely human whipworm, but we cannot rule out that some eggs are also from the species that infects pigs. *Capillaria* sp. eggs were differentiated from *Trichuris* sp. based on the characteristic pitted surface of *Capillaria* sp., while *Trichuris* sp. eggs have smooth egg shells.

5. Discussion

5.1. Taphonomy of the latrine fill

The results of the pollen analysis, with low percentages of trees and shrubs and high percentages of Cerealia pollen, indicate that the fill mostly consists of faecal material. Also the scarcity of charred macroscopic plant remains and numerous parasite eggs from human faeces indicates that little rubbish has been thrown in the latrine. Most of the identified seeds might have entered the latrine as faecal material as well. Except for one fragment of hazelnut shell and some fragments of walnut shell, all identified remains from fruits and nuts likely represent ingested remains. Several of the crop weeds, such as the high number of fragmented corncockle seeds, could also have been consumed together with food. The high number of whole mericarps from white lace flower, and the high overall number of identified taxa representing (potential) crop weeds, indicates that the latrine fill also includes the refuse from seed cleaning preceding food preparation and consumption. The presence of relatively large animal bones indicates that table leftovers and/or refuse from food processing and preparation have been deposited in the latrine as well.

5.2. Food

The high percentages of Cerealia pollen indicates that cereals were the main staple food. This is not directly reflected in the botanical macro remains, but uncharred cereal grains are rarely preserved, even in waterlogged conditions (Knörzer 1984; Jacomet and Kreuz, 1999), and charred material is largely missing in the latrine fill. The high number of macro remains of typical cereal crop weeds are another (indirect) indication for the importance of cereals as a staple food. Some of these weeds, such as white lace flower and musk weed show a largely southern European modern day distribution and are rare or even considered as non-native to the modern local flora (Lambinon et al., 1998). Therefore, their presence could be an indication for the import of cereals from southern Europe. The growing number of archaeobotanical finds of both species in Northern France (e.g. Zech-Matterne 2010; Wiethold and Zech-Matterne, 2016; Derreumaux, 2012; 2017), Germany (e.g. Wiethold, 2012; Haßlinger, 2017) and the Netherlands (e.g. Eichhorn and Brinkkemper, 2018) however, including in some *villae* that are considered as important production centres of cereals, are strong indications that these taxa could locally establish in the region during the Roman period (Zech-Matterne 2010; Wiethold and Zech-Matterne, 2016; Eichhorn and Brinkkemper, 2018).

Almost all other identified food plants can also have been produced locally and evidence for the consumption of truly exotic food plants has not been found. Only fig and grape are likely to have also been imported. From fig only a single nutlet has been found, which most likely represents import from southern Europe. Once dried, the sugary figs can be stored for very long periods, and these fruits were a very common ‘sweet’ in most of the Roman empire (Bakels and Jacomet, 2003). Figs contain numerous nutlets, which are ingested when the fruit is eaten. As a result, fig nutlets generally occur in very large numbers in latrines and other

archaeological structures from the Roman period, even outside the region where fig trees grow (e.g. de Hingh and Kooistra, 1995; Knörzer, 1970; 1981; 1984; Kučan, 1992; Kuijper and Turner, 1992; Meurers-Balke and Schamuhn, 2012; Pals, 1997; Schamuhn and Zerl, 2009; Van der Veen et al., 2008).
The remains from grape are likely to represent imported fruits as well. Although it is climatologically possible to grow grapes in Belgium, in the absence of evidence for local viticulture during the Roman period, archaeobotanical finds of grape pips dating to this period are considered to represent imported fruits (Pals, 1997). In the *Treviri civitas*, evidence for viticulture seems to be restricted to a small area in the Moselle valley north of Trier, and to the Late Roman period (3th and 4th century AD) (Brun and Gilles, 2001; König, 2001; Lansival and Wiethold 2018).

All other identified food plants could have been cultivated or collected in the wild in or near Arlon. Some of these plants are Roman introductions in the region, but have been cultivated in north-western Europe since, such as sweet chestnut, walnut, coriander, cucumber, melon and anise (Bakels and Jacomet, 2003). Coriander and walnut are common Roman period archaeobotanical finds in Belgium and the Netherlands, even in small rural sites with a low degree of romanisation (e.g. Hoorne et al., 2012; Deforce et al., 2020), as is the case in other regions in north-western and central Europe within the Roman Empire (Bakels and Jacomet, 2003). Finds of cucumber/melon (e.g. Vanderhoeven et al., 1994; Bastiaens and Verbruggen, 1995) and anise (e.g. Kuijper and Turner, 1992) in Belgium and the Netherlands seem to be largely restricted to military forts or other sites with a high degree of romanisation, but the overall number of archaeobotanical studies of Roman period sites for this region is rather restricted. In north and eastern France, where more data are available, cucumber/melon is commonly found in towns beginning in the second half of the first century and is even found in rural sites at the end of the second century (Zech et al., 2017).

Also sweet chestnut is not a frequent find in Roman period archaeological contexts from northern Gaul. Sweet chestnut originates from Central Asia and southern Europe (Mattioni et al., 2013) and is a Roman introduction in Belgium and the Netherlands (Pals, 1997). Little is known about the actual distribution and occurrence of this tree during the Roman period in northern Gaul, because its seeds or fruits do not often preserve in archaeological contexts, and there are few archaeological sites with good preservation conditions for pollen. Wild varieties of apple, pear and cherry occur in the study area and might have been collected from the countryside. More likely, the identified remains represent cultivated varieties of these fruit trees, which are also Roman introductions in north-western Europe (Bakels and Jacomet, 2003; Pals, 1997).

Overall, the identified plant food remains include hardly any imported or exotic taxa such as olive, rice, peach and black pepper, which have been identified from several other Roman period latrines from north-western and central Europe. These finds are largely restricted to military sites, however (Rowan, 2019; van der Veen et al., 2008; Bakels and Jacomet, 2003).

The consumed meat mainly comes from domestic animals. Although cattle is generally dominant in the faunal assemblages from roman Arlon, a trait commonly observed in contemporary towns and *vici* of Central Belgium (Pigière, 2009), this is not the case in the latrine. In layer 01.051, which corresponds to the accumulation of faecal matter, bones of sheep and goat (40.6%) are more frequent than those of pig (32.1%) and cattle (27.3%). This could reflect butchery or waste management strategies, since the larger bones of cattle may have been discarded preferentially in pits or dumpsites. As no beef or pork tapeworm eggs were recovered from this latrine, despite their being found at other Roman sites in the region (Dittmar et al., 2002; Kuijper and Turner, 1992; Petznek, 2018), this meat was probably well-cooked before consumption.

Poultry is scarce and game or marine shells are absent, while these are commonly recorded on other Roman period settlements in Belgium (e.g. Ervynck et al., 1997; Pigière, 2009). Furthermore, the fish remains provide evidence for the consumption of locally produced fish sauce, a popular Roman condiment that was normally imported from the Mediterranean to the Roman provinces, though there is growing evidence for local production in northern Gaul as well (Van Neer et al., 2010). This locally produced fish sauce might have been a cheaper alternative for the Mediterranean original, though this is not yet clear from the archaeological dataset (Van Neer et al., 2010). Also the presence of large numbers of fish bones, representing the original ingredients of the fish sauce, might indicate that it was a lower quality fish sauce that was consumed, the unstrained *hallex* type, rather than high quality *garum* which was generally obtained through decanting and which contained few or no fish bones or scales (Curtis, 1991).

5.3. Health and sanitation

The presence of roundworm and whipworm in the fill of the Roman latrine at Arlon indicates that individuals using this latrine were infected with these helminths. Roundworm and whipworm are both soil-transmitted helminths that are transmitted by the direct-faecal oral route, thus their presence in the population at Arlon is a reflection of sanitation and hygiene conditions. As has been noted in other Roman sites, the presence of roundworm and whipworm is likely a result of various sociocultural practices. These include the use of human faecal material as fertilizer for gardens or crops, the disposal of faecal material into open street sewers, limited hand hygiene, and potential contamination of public fountains and water sources with faecal material (Mitchell, 2017; Williams et al., 2017; Ledger et al., 2018; Ledger et al., 2020).

The concentrations of *Capillaria* worm and lancet liver fluke (*Dicrocoelium* sp.) eggs in the latrine at Arlon are quite low, so it is unlikely that these represent true human infections in the population. Rather, their presence may be a result of false parasitism, when helminth eggs are ingested and pass through the gastrointestinal tract unchanged, or disposal of animal waste in the latrine. Both *Capillaria* and *Dicrocoelium* may be present in human feces if liver from infected animals is eaten. These parasites have previously been found at other Roman sites, especially in northern Europe (Pike, 1968; de Moulins, 1990; Le Bailly and Bouchet, 2010).

6. Conclusions

The analyses of botanical and animal remains, including eggs from intestinal parasites, from the fill of a Roman period cesspit from the artisan quarter of Arlon, provided information on the diet, health and sanitation of the people living in this part of the vicus. Up to now, little has been known about the food habits and living conditions of this part of the population, both from archaeological research and historic manuscripts.

Although Arlon was well-connected to the Roman long-distance trade network, and imported and exotic products must have been available at this site, this is not reflected in the content of the studied latrine. The small numbers of identified remains of grape and fig most likely represent import from more southern regions, but truly exotic foodstuffs have not been found.

Several of the consumed food plants are original Roman introductions to the region. These plants were widely adopted in local agricultural traditions and diet in northern Gaul, including in rural areas, and do not necessarily reflect a high social or economic status. Similarly, the animal remains recorded represent mostly staple foods and no exotic products have been identified. The identified remains of salted fish sauce are consistent with a typical Roman diet, but as this was a locally produced type, this might have been a cheaper and/or lower quality variant. This lack of exotics is very likely to be explained by this latrine being associated with an artisanal workshop, where people with a lower social status and purchasing power lived and worked. Also the fact that the general population may not always have valued imported and exotic foodstuffs in the same way as the part of the population that originated from southern Europe, may have played a role (Rowan, 2019). On the other hand, the consumption of locally produced fish sauce, a typical Roman food product, may indicate that the population was trying to adopt a Roman lifestyle.

Remains of parasite eggs in the latrine indicate that the people using the latrine were also infected by both roundworm and whipworm, two intestinal parasites that were probably common in the population of northern Roman Gaul, as they were across the empire (Mitchell, 2017). These are primarily sanitation related parasites indicating contamination of living areas with faecal material, or ingestion of unwashed fruits and vegetables particularly if gardens and crops were fertilized with human waste. Eggs of *Capillaria* worm and lancet liver fluke (*Dicrocoelium* sp.) likely result from false parasitism when the abdominal organs of farm animals were eaten.

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Fig. 1: Map showing localisation of the study site (A), layout of the excavated house plots (B) and stratigraphy of the studied cesspit (C).

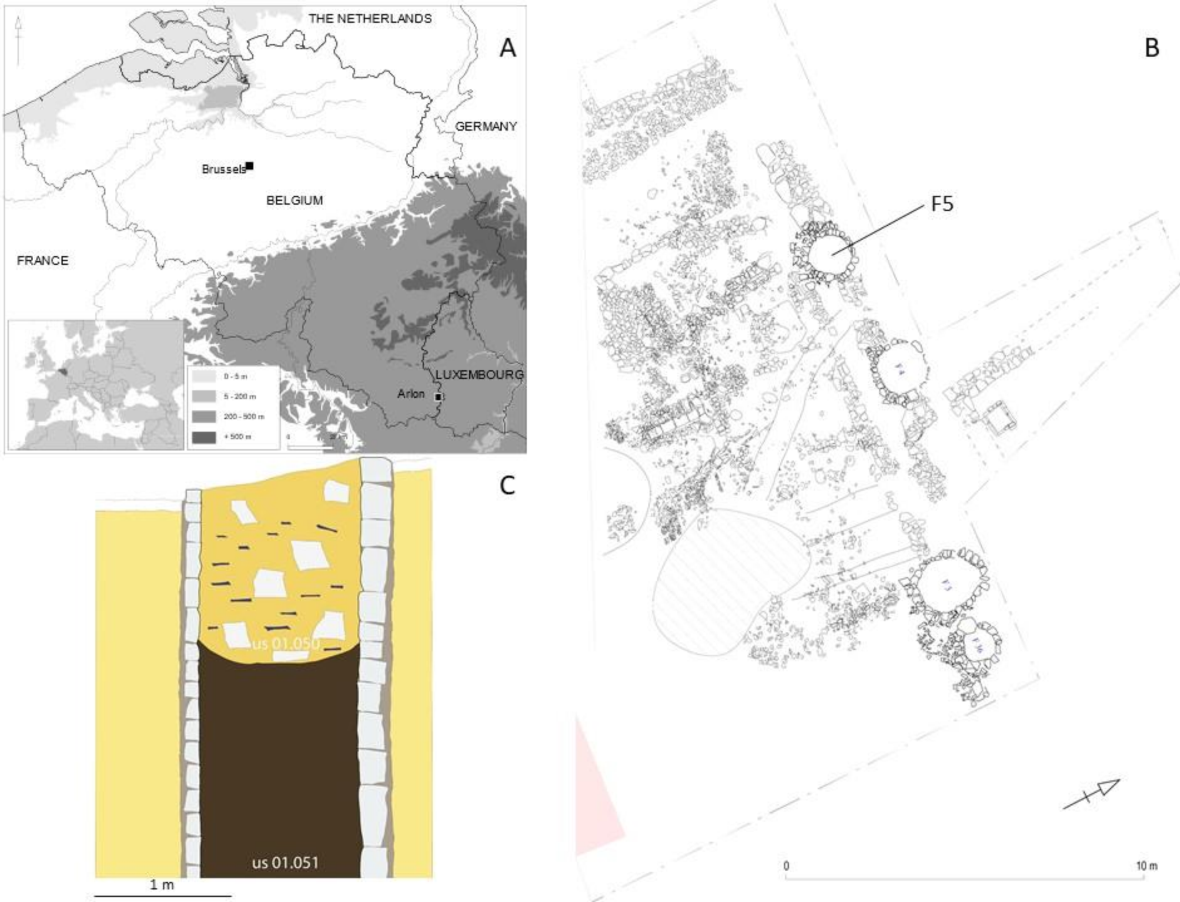

Fig. 2: Parasite eggs found in the subsample studied from the Arlon latrine. (A) *Ascaris* sp.; (B) *Trichuris* sp.; (C) *Capillaria* sp.; (D) *Dicrocoelium* sp. Scale bars are 20 µm.

Fig. 3: Plot of length and width of *Trichuris* eggs against reference ranges for *T. trichiura* and *T. suis*. Black dots represent eggs that had both polar plugs preserved, red square for eggs with one polar plug and open blue circles for eggs with no polar plugs.

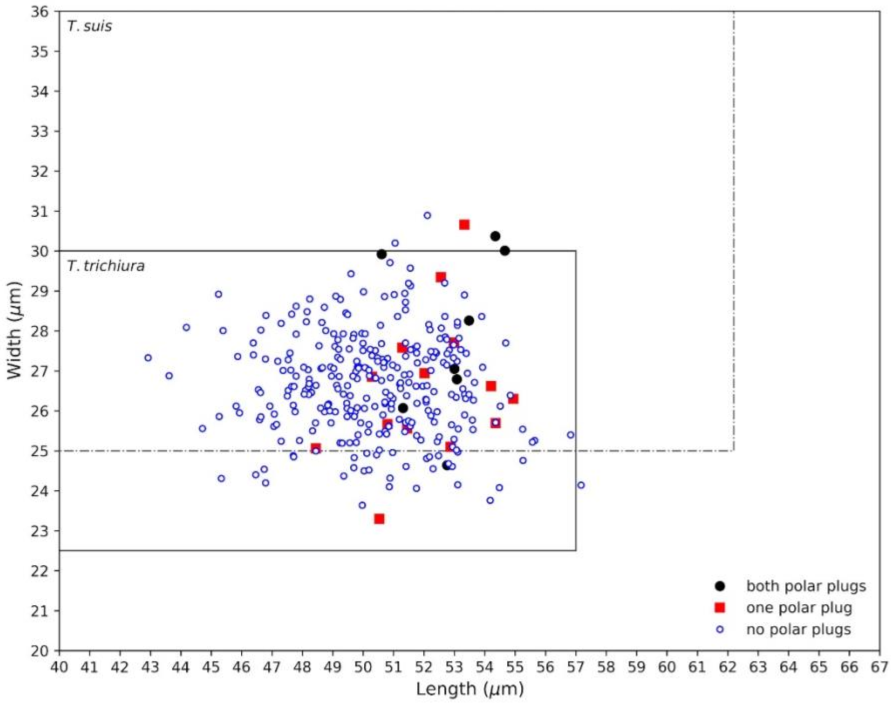

Table 1: Macro botanical results from a 5.25 L sample from F.5. layer 01.051

	charred			waterlogged		
	whole	**fragment**	**MNI**	**whole**	**fragment**	**MNI**
botanical remains (n)	9	3	12	1998	611	2261
density (n/litre)	1,5	0,4	2,4	380,6	116,4	452,2
Cereals						
Hordeum vulgare	-	1	1	-	-	-
Fruits/nuts						
Prunus sp.	-	-	-	176	49	201
Malus/Pyrus sp.	-	-	-	113	58	142
Prunus avium/cerasus	-	-	-	110	-	110
Malus sp.	-	-	-	32	-	32
Prunus cf. *padus*	-	-	-	27	-	27
Rubus idaeus	-	-	-	23	-	23
Prunus domestica subsp. *domestica*	-	-	-	8	-	8
Prunus domestica subsp. *insititia*	-	-	-	7	-	7
Rubus caesius	-	-	-	7	-	7
cf. *Vitis vinifera* (fruit tegument)	-	-	-	-	13	7
Pyrus sp.	-	-	-	5	-	5
Vitis vinifera	-	-	-	2	4	5
Prunus spinosa	-	-	-	4	-	4
Juglans regia	-	-	-		5	3
Prunus sp. (peduncle)	-	-	-	2	-	2
Ficus carica	-	-	-	1	-	1
Fragaria vesca	-	-	-	1	-	1
Corylus avellana	-	1	1	-	-	-
Spices/vegetables						
Pastinaca sativa subsp. *sativa*	-	-	-	654	165	737
Coriandrum sativum	-	-	-	108	58	137
Beta vulgaris subsp. *vulgaris*	-	-	-	89	-	89
Satureja hortensis	-	-	-	3	-	3
Cucumis sativus/melo	-	-	-	2	-	2
Possibly cultivated plants						
Rumex patientia (fruits and perianths)	-	-	-	82	-	82
Daucus carota	-	-	-	81	-	81
Raphanus raphanistrum (pod)	-	-	-	50	-	50
Brassica nigra/rapa	-	-	-	2	3	5
Sinapis arvensis/alba (tegument)	-	-	-	5	-	5
Reseda luteola	-	-	-	1	-	1
Wild plants						
Winter crop weeds						
Orlaya grandiflora	-	1	1	135	-	135
Agrostemma githago	-	-	-	11	129	76
Fallopia convolvulus	-	-	-	11	-	11

Papaver rhoas (operculum)	4	-	4	-	-	-
Myagrum perfoliatum	-	-	-	2	-	2
Neslia paniculata (silique)	-	-	-	2	-	2
Agrostemma githago (capsule)	-	-	-	-	2	1
Papaver dubium (capsule)	-	-	-	1	-	1
Senecio vulgaris	-	-	-	1	-	1
Valerianella dentata	-	-	-	1	-	1
Summer crop weeds						
cf. *Euphorbia helioscopia*	-	-	-	1	-	1
Thlaspi arvense	-	-	-	1	-	1
Ruderal-Summer crop weed						
Chenopodium abum	-	-	-	2	-	2
Persicaria lapathifolia/maculosa	-	-	-	2	-	2
Urtica urens	-	-	-	2	-	2
Ranunculus arvensis	1	-	1	1	-	1
Persicaria lapathifolia	-	-	-	1	-	1
Solanum nigrum	-	-	-	1	-	1
Sonchus asper	-	-	-	1	-	1
All crop weeds						
Aethusa cynapium	-	-	-	5	-	5
Stellaria media	-	-	-	5	-	5
Grassland and ruderal plants						
Hyoscyamus niger	-	-	-	20	-	20
Chenopodium rubrum	-	-	-	5	-	5
Plantago lanceolata	4	-	4	-	-	-
Urtica dioica	-	-	-	3	-	3
Conium maculatum	-	-	-	2	-	2
Lepidium campestre	-	-	-	2	-	2
Cirsium cf. *vulgare*	-	-	-	1	-	1
Crepis biennis	-	-	-	1	-	1
Ranunculus repens	-	-	-	1	-	1
Rumex acetosella	-	-	-	1	-	1
Woodland/Hedges						
Sambucus nigra	-	-	-	1	-	1
Several plant communities						
Agrimonia eupatoria	-	-	-	112	-	112
Apiaceae	-	-	-	5	25	18
Torilis arvense/japonica	-	-	-	13	-	13
Polygonum aviculare	-	-	-	12	-	12
Rosaceae	-	-	-	10	-	10
Galeopsis bifida/tetrahit	-	-	-	9	-	9
Carex sp.	-	-	-	4	-	4
Polygonum sp.	-	-	-	4	-	4
Ranunculus sp.	-	-	-	4	-	4
Arctium lappa/tomentosum	-	-	-	1	-	1
Asteraceae	-	-	-	1	-	1
Chenopodium sp.	-	-	-	1	-	1

Rumex sp.	-	-	-	1	-	1
Senecio sp.	-	-	-	1	-	1
Silene vulgaris	-	-	-	1	-	1
Unidentified	-	-	-	3	-	3

Table 2: Results (in percentages) of the palynological analysis of three samples from the latrine from Arlon.

Sample	**1**	**2**	**3**
Cultivated plants			
Beta vulgaris	0,3	-	0,3
Coriandrum sativum	0,3	1,7	2,9
Cerealia	17,6	19,4	31,6
Pimpinella anisum	0,3	-	-
Pisum sativum	0,3	-	-
Wild plants			
Trees and shrubs			
Acer	0,9	-	-
Alnus	0,9	0,3	0,3
Betula	0,6	0,8	0,3
Castanea sativa	-	0,3	-
Corylus avellana	0,3	2,2	1,3
Fagus sylvatica	-	1,7	0,3
Hedera helix	0,3	0,3	-
Pinus	0,3	0,8	0,3
Prunus type	1,2	0,3	0,3
Quercus	0,9	1,1	1,3
Salix	0,6	1,1	0,3
Sambucus nigra type	-	-	1,1
sum arboreal pollen (AP)	**5,9**	**9,2**	**4,8**
Herbaceous plants			
Apiaceae undiff.	2,1	2,2	3,5
Artemisia	0,3	-	2,9
Asteraceae Liguliflorae	8,2	4,7	2,1
Brassicaceae	12,1	12,8	9,1
Calluna vulgaris	1,8	0,6	2,4
Campanula type	0,3	-	0,3
Caryophyllaceae	0,3	-	0,3
Centaurea jacea type	3,5	1,1	0,8
Cirsium	-	0,3	0,3
Chenopodiaceae undiff.	1,5	3,6	1,6
Cyperaceae	0,6	0,8	-
Ericaceae undiff.	0,3	0,6	0,3
Fabaceae undiff.	-	0,3	0,3
Filipendula	3,2	4,7	1,9
Jasione montana type	0,9	0,3	0,3
Lotus	0,3	0,3	-
Matricaria type	2,9	2,2	2,1
Mentha type	0,6	-	-
Orlaya grandiflora	1,5	0,8	2,4
Plantago lanceolata	1,5	1,9	1,3
Plantago major/media	0,9	0,6	0,5
Poaceae undiff.	18,8	15,3	13,4
Polygonum aviculare type	-	0,3	0,3
Potentilla type	-	0,3	0,5

Ranunculus acris type	0,3	0,3	0,5
Ranunculus arvensis type	1,2	-	-
Rosa	0,3	-	-
Rosaceae undiff.	2,6	2,8	3,5
Rubiaceae	-	0,3	0,3
Rumex acetosa type	3,5	6,4	5,1
Senecio type	-	0,3	-
Succisa pratensis	-	0,3	0,3
Trifolium pratense type	1,2	0,8	0,8
Trifolium repens type	4,1	4,2	2,9
Urtica dioica type	0,3	0,3	-
Vicia type	0,3	0,6	-
Total non-arboreal pollen (NAP)	**94,1**	**90,8**	**95,2**
ΣP (n)	**340**	**360**	**373**
Ferns			
Filicales undiff.	0,3	-	0,3
Pteridium aquilinium	1,2	0,6	0,3
Indeterminata	5,3	5,3	5,4
Concentration (pollengrains/cm³)	16780	19803	17151

Table 3: Faunal remains from US 01.051 and US 01.050 recovered by hand.

Layer	US 1.050	US 1.051
Amphibians		
Frog (*Rana* sp.)	-	9
Freshwater fish		
Chub (*Squalius cephalus*)	-	2
Birds		
Domestic fowl (*Gallus gallus* f. domestica)	32	4
Dove (Columbidae)	1	1
Northern raven (*Corvus corax*)	-	1
Western jackdaw (*Coloeus monedula*)	3	-
Unidentified birds	7	12
Domestic mammals		
Dog (*Canis lupus* f. familiaris)	-	57
Horse (*Equus ferus* f. caballus)	-	2
Pig (*Sus scrofa* f. domestica)	135	196
Cattle (*Bos primigenius* f. taurus)	-	167
Sheep (*Ovis ammon* f. aries)	-	28
Goat (*Capra aegagrus* f. hircus)	-	21
Sheep/goat (*Ovis ammon* f. aries/*Capra aegagrus* f. hircus)	-	199
Unidentified mammals	-	615
Total	178	1.314

Table 4: Faunal remains from US 01.051 recovered by sieving. Fish and crustacean remains associated with the fish sauce are excluded (for details, see Table 3 in Van Neer et al., 2010 and Derreumaux et al., 2011).

	US 1.051 (4.5 l)			
	4 mm	2 mm	1 mm	Total
Arthropods				
Insects	-	present	present	present
Molluscs				
Rotund disc (*Discus rotundatus*)	1	7	9	17
Oxychilus sp.	-	1	1	2
Unidentified molluscs	-	2	2	4
Fish				
Salmon/trout (*Salmo* sp.)	-	6	4	10
Cyprinidae	6	11	6	23
Unidentified fish	1	14	251	266
Amphibians				
Common frog (*Rana temporaria*)	1	4	4	9
Common/moor frog (*Rana temporaria/arvalis*)	-	5	2	7
Frog (*Rana* sp.)	5	28	14	47
Unidentified amphibians	1	26	25	52
Birds				
Unidentified birds	-	3	4	7
Eggshell (weight)	0.65 gr	1.4 gr	0.26 gr	2.31 gr
Mammals				
Bank vole (*Myodes glareolus*)	-	-	1	1
Mouse (*Apodemus* sp.)	-	1	2	3
Cricetidae	-	-	1	1
Shrew (Soricidae)	-	-	1	1
Mole (*Talpa europaea*)	-	-	1	1
Unidentified mircomammal	-	11	18	29
Unidentified bone fragments	**-**	**100**	**226**	**326**
Total	15	310	841	1166

Table 5: Details of eggs found in the subsample studied for intestinal parasites. Egg concentrations are in eggs/g and mean dimensions are presented for each species.

Species	Number of eggs	Mean Length ± SD (µm)	Mean Width ± SD (µm)
Ascaris sp.	198		
fertile	155	66.7 ± 4.9	51.9 ± 4.2
infertile	11	84.0 ± 6.2	47.6 ± 4.4
Capillaria sp. (no polar plugs)	2	53.8 ± 6.4	27.3 ±4.2
Dicrocoelium sp. (with operculum)	2	41.2 ± 1.5	23.7 ± 1.7
Trichuris sp.	359	50.5 ± 2.4	26.7 ± 1.3
no polar plugs	299	50.3 ± 2.3	26.6 ± 1.3
one polar plug	16	51.9 ± 2.1	26.6 ± 1.9
both polar plugs	10	52.9 ± 1.2	27.9 ± 2.1