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ORIGINAL ARTICLE

Small things can make a big difference: a comparison of pollen and macrobotanical records of some food plants from medieval and post-medieval cesspits in the Netherlands and northern Belgium

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Abstract

This paper presents a review of records of pollen and botanical macroremains of a selection of food plants from late and post-medieval cesspits (12th century-19th century AD) in the Netherlands and northern Belgium. The presented data demonstrate that several food plants remain largely invisible in the macrobotanical records. These are all plants from which the flowers or flower buds (*Borago officinalis, Capparis, Carthamus tinctorius, Crocus sativus, Syzygium aromaticum*) or leaves (*Anthriscus cerefolium, Spinacia oleracea*) are eaten, or that are typical components of honey (*Cistus*). As a result, little is known about the import or local production and consumption of these food plants in these times. This review now shows that past use of some of these plants is reflected in the pollen assemblages of (post-) medieval cesspits. For the first time, a large archaeobotanical dataset is presented, including pollen, providing information on the past use of these plants between the 12th and 19th century AD in the Netherlands and Belgium.

Keywords Pollen · Macroremains · Cesspit · Medieval · Post-medieval · Taphonomy

Introduction

Medieval and post-medieval cesspits are frequent finds during archaeological excavations in historic cities in north-western Europe (Sabine 1934; Greig 1982a; Addyman 1989; van Oosten 2015, 2017). The contents are frequently analysed for botanical macroremains as they can potentially provide much information on former diet and other types of plant use (Moffet 1992; Dickson 1996; Hellwig 1997; Badura 2003; Märkle 2005; Smith 2013; Badura et al. 2015; Speleers and van der Valk 2017). Nevertheless, several food plants, mostly plants from which the flowers, flower buds or leaves are eaten, are not reflected in the macrobotanical assemblages of these cesspits, although historical documents indicate that these plants were regularly eaten (Greig 1996; Badura et al. 2015). As a result, little is known about the import or local production and consumption of these food plants in the past.

The past use of some of these plants can be demonstrated by pollen analysis of (post)medieval cesspits despite the constraints of the generally lower taxonomic identification levels of pollen vs. botanical macroremains (Greig 1994; van Haaster 2008; Deforce 2010, 2017). In contrast to the study of botanical macroremains, pollen analysis of cesspits is still not a common practice however (Smith 2013), though there is a growing number of pollen analyses of medieval and post-medieval cesspits from many regions in Europe (UK: Greig 1981, 1994; Scaife 1982; France: Diot and Laborie 1989; Germany: Wiethold 1999, 2000; Meurers-Balke et al. 2015; Italy: Bosi et al. 2011; Norway: Krzywinski et al. 1983; Czech Republic: Jankovská 1987, 1995; Latvia:

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Brown et al. 2017) and beyond (United States: Kelso 1998; Samford 1991; New Zealand: Horrocks and Best 2004; Japan: Matsui et al. 2003).

In the Netherlands, and more recently also in northern Belgium, these archaeological features are far more routinely studied palynologically. Based on the results of these analyses, this paper presents a first review of pollen finds of several food plants that have remained largely invisible in the archaeobotanical records until now. For each of these plants, comparison is made between pollen and macrobotanical finds, demonstrating the differences in 'visibility' of these plants in both types of records. In addition, possible identification levels of the respective pollen types are discussed.

Materials and methods

The study area comprises the Netherlands and northern Belgium, together also called the Low Countries (Fig. 1). This region showed an exceptionally high level of urbanisation during the Middle Ages, second only to the northern part of present-day Italy (Verhulst 1999; Pounds 2005). As a result, a large number of medieval and post-medieval cesspits and other structures containing human faecal material have been excavated in this region, mostly during rescue excavations preceding construction works (van Oosten 2015).

Data from the analysis of both pollen and botanical macroremains from these features have been collected. For the Netherlands, these data have been extracted from the RADAR database (van Haaster and Brinkkemper 1995). For northern Belgium, they have been collected from previously published analyses (Deforce 2017 and references therein) and some unpublished reports. A list of all these sites, structures, analysed samples and references to the publications and reports of the archaeobotanical analysis is given in ESM 1 .

First, an inventory was made of all samples from medieval and post-medieval cesspits in the Low Countries from which pollen or botanical macroremains of a selection of food plants have been identified, with the restriction that the included food plants should have more or less comparable identification levels for both their pollen and

Fig. 1 Study area (the Netherlands and northern Belgium) for botanical macroremains (M) (P/M)

macroremains. In addition, it was noted which of these food plants are mentioned in historical manuscripts from the Low Countries to illustrate that they were effectively part of (post)medieval diet in the study region (Table 1).

The inventory was then used to calculate the ratio of samples with pollen identifications and/or botanical macroremains of these food plants to show which of them are represented in the pollen records, while remaining largely invisible in the macrobotanical records. Taxa of which pollen is regularly identified from cesspits and which occur only sporadically or not at all as botanical macroremains, with a minimum proportion of 2:1, have also been included in this review. Only the presence of pollen or macroremains of a specific plant in a sample has been taken into account, as total numbers or percentages of identified remains of a taxon in the samples might bias the results in favour of plants that have been found in only few samples but with high percentages. Also, the differences in quantification methods used in pollen analysis (percentages) and macrobotanical analysis (often semi-quantitative) do not permit the use of absolute numbers or percentages in which each taxon was present in a sample. Most samples have been dated from pottery typology or other cultural objects present in the cesspits and have a rather narrow age range of c. 50 years. Some samples have a broader age range, however, and these have been attributed to the middle value of their age range. All samples were than grouped by century.

Results

Data from 279 analysed pollen samples and 578 analysed macrobotanical samples from the Netherlands and northern Belgium have been collected (ESM 1). Most of these samples come from sites in the Netherlands, with only 45 pollen samples and 29 macrobotanical samples originating from sites in northern Belgium (Fig. 1). The oldest samples used in the dataset date to the 12th century, the youngest to the 19th century. Two samples for macrobotanical analysis from an 11th century cesspit (Smeerdijk and Kooistra 2001) and one sample from a 20th century cesspit (Kooistra et al. 1998) have been studied from the Netherlands, but no pollen analysis has been done on samples of the same age, so these data have not been included in the dataset for this review.

Most of the data come from the historical cities in the Low Countries, with the largest datasets from 's-Hertogenbosch, Amsterdam and Rotterdam (Fig. 1; ESM 1); however, the city of Ghent, which was the largest urban centre during the 12th century in the Low Countries, is missing from the dataset. There are only a few data from rural settlements as these rarely had cesspits or sewers. Exceptions are monasteries and castles that were situated in rural areas, such as Herkenrode (Deforce 2017) and Middelburg (De Clercq et al. 2007), and the fisherman's village Walraversijde (Pieters et al. 2013). For most of the studied cesspits, no detailed information is available on the social or economic status of the related households.

Table 1 Number of samples with pollen or botanical macroremains of a selection of food plants from (post-) medieval cesspits from the Netherlands and northern Belgium, and historical manuscripts that mention these food plants

	Pollen samples (*n*)	Macroremain samples (*n*)	Historical sources mentioning these plants
Anethum graveolens	7	63	1, 2, 3, 7, 8, 10, 11, 13
*Anthriscus cerefolium**	209	15	1, 2, 5, 6, 7, 8, 10, 11, 12, 13
Beta vulgaris	25 + 8cf	41	2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13
*Borago officinalis**	45 + 5cf	1	2, 3, 6, 7, 8, 10, 11, 12, 13
*Capparis**	37	5	3, 5, 7, 8, 10, 11, 12, 13
*Carthamus tinctorius**	20	2	7, 8, 11
*Cistus**	27	–	1h, 3l, 4h, 5h, 6h, 7l, 8l, 10h, 11l, 12h, 13h
Coriandrum sativum	70 + 4cf	190	2, 3, 7, 8, 9, 10, 11, 12, 13
*Crocus sativus**	1	–	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13
Myrtaceae*	118	2s + 1p	1s, 3s, 5s, 6s, 7m, 8m, 9s, 10s, 11s, 12s, 13s
Petroselinum crispum	10	33	1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13
Pimpinella anisum	47	45	2, 3, 6, 7, 8, 9, 10, 11, 12, 13
Pisum sativum	34	57	1, 2, 3, 4, 6, 7, 8, 9, 10
*Spinacia oleracea**	46 + 5cf	5	1, 2, 6, 7, 8, 10, 11, 12, 13
Verbena officinalis	2	10	2, 3, 4, 7, 8
Vicia faba	86	53	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Only taxa with an asterix (*) are further discussed in this review

s Syzygium, m Myrtus, p Pimenta dioica, h honey, *l* la(b)danum. The list with analysed pollen samples (n = 279) and samples for botanical macroremains (n = 578) is presented in ESM 1. References to the historical manuscripts are given in ESM 2

Table 1 shows that the number of samples in which pollen of *Anthriscus cerefolium, Borago officinalis, Capparis spinosa, Carthamus tinctorius, Cistus, Crocus sativus*, Myrtaceae and *Spinacia oleracea* has been identified is much higher than the number of samples in which botanical macroremains of these plants have been found. Considering the lower number of analysed pollen samples (n = 279) compared to the number of macrobotanical samples (n = 578), this must even be an underestimate. In combination with the numerous mentions of these plants in historic manuscripts (Table 1), this indicates that they were regularly used in medieval and post-medieval cuisine, and also that they are underrepresented in the macrofossil record. Also, pollen records of *Pimpinella anisum, Pisum sativum* and *Vicia faba* are relatively more numerous compared to finds of macroremains from these respective plants. However, the difference between the numbers of both types of remains is less important and these plants are not further discussed in this review.

Anthriscus cerefolium **(garden chervil)**

Anthriscus cerefolium is native to Asia Minor, the Caucasus and southern Russia, and was introduced into north-western Europe during Roman times, where it has now become naturalized (Hegi 1975; Vaughan and Geissler 1997). The leaves of *A. cerefolium* are used as a herb to flavour several dishes and soups (Vaughan and Geissler 1997). According to historical manuscripts, it was also used in the past as a medicinal herb, especially for the treatment of digestive problems according to Dioscorides' *Materia Medica* (Osbaldeston 2000; Dodoens 1644; Barton et al. 1877).

Anthriscus cerefolium belongs to the Apiaceae family. Pollen from most taxa within this family cannot be identified to species level using standard light microscopy (LM) techniques. Several pollen identification keys permit identification to family level (Fægri and Iversen 1989) or type level, grouping several taxa within this family (Moore et al. 1991). Some species from this family, including *A. cerefolium*, have a distinctive pollen morphology however, and can be identified to species level (Punt 1984; Beug 2004).

Pollen of *A. cerefolium* has been found in 209 out of 279 samples dating from the 12th to the 19th century (Fig. 2). In contrast, seeds of *A. cerefolium* have been found in only 15 out of 578 analysed samples. As well as the large number of samples with pollen of *A. cerefolium* in medieval and post-medieval cesspits in the Netherlands and northern Belgium, its pollen has also been identified from a Roman age cesspit in the Netherlands (Kuijper and Turner 1992) and medieval cesspits in Germany (Meurers-Balke et al. 2015).

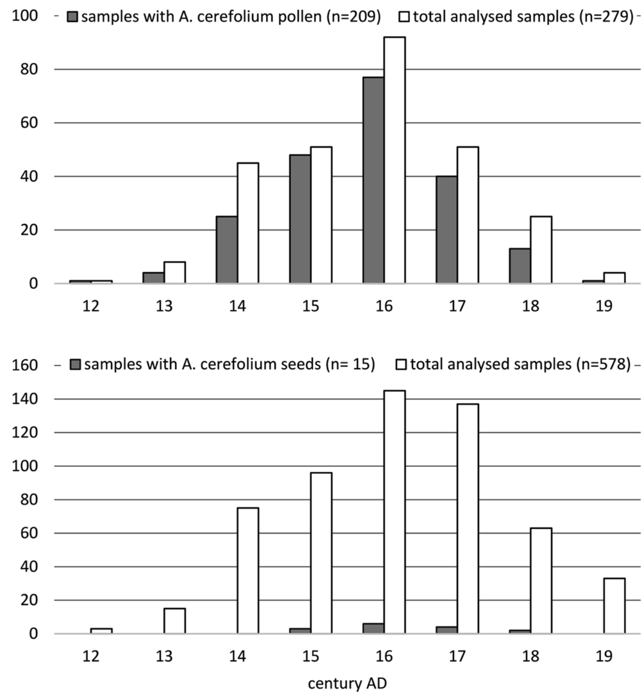

Fig. 2 Number of samples with pollen (top) and macroremains (bottom) of *Anthriscus cerefolium* from medieval and post-medieval cesspits in the Low Countries

Borago officinalis **(borage)**

Borago officinalis originates from the western Mediterranean region and was introduced to the Low Countries during the Middle Ages where it was cultivated as a kitchen herb and vegetable (van Haaster 1997). The flowers, and sometimes the leaves from this plant, which both taste slightly like cucumber, are eaten (Kiple and Ornelas 2000).

Several members of the Boraginaceae family, including *B. officinalis*, produce pollen with distinctive morphological characters and can be identified to species level (Clarke 1977; Fægri and Iversen 1989; Beug 2004), though *B. officinalis* is missing in the pollen identification key of Moore et al. (1991). In polar view the pollen grains of *B. officinalis* can be mistaken for members of the Pedaliaceae family however, such as *Sesamum indicum* (sesame) (van Haaster 1990; Greig 1994).

Pollen of *B. officinalis* has been found in 50 samples, dating from the 13th to the 19th century (Fig. 3). Seeds of *B. officinalis* have been found in only one sample, from a 14th century unlined cesspit in 's-Hertogenbosch (NL; van Haaster 1997).

Capparis **(caper)**

Capers are the pickled flower buds of *Capparis*, a small shrub native to the Mediterranean and the Near East, used

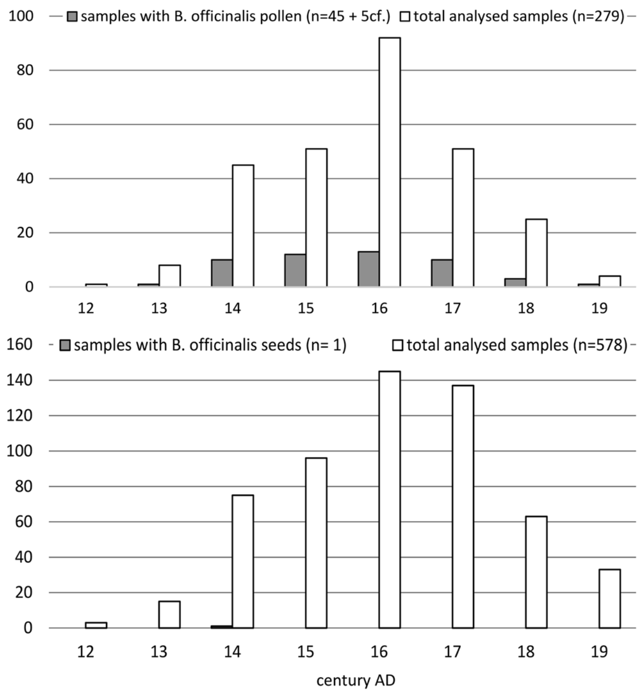

Fig. 3 Number of samples with pollen (top) and macroremains (bottom) of *Borago officinalis* from medieval and post-medieval cesspits in the Low Countries

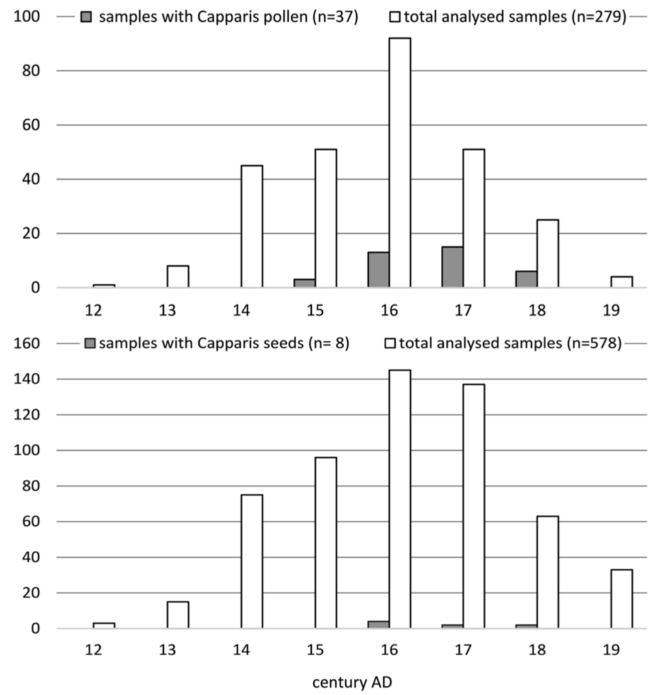

Fig. 4 Number of samples with pollen (top) and macroremains (bottom) of *Capparis* from medieval and post-medieval cesspits in the Low Countries

as a condiment (Kiple and Ornelas 2000; Rivera et al. 2002). The fruits of *Capparis* can be prepared and eaten in the same way. *Capparis spinosa* is the species most frequently used for capers, but the flower buds of other *Capparis* spp. (*C. sicula, C. orientalis*) can also be used (Rivera et al. 2002, 2003).

Capparis pollen can be identified to species level according to Beug (2004), though no other *Capparis* species are included in the identification key and it is unlikely that these can be differentiated by their pollen morphology using LM. Moreover, the small pollen grains require special attention, as they can be easily overlooked or mistaken for other tricolporate psilate pollen types.

Pollen of *Capparis* has been found in 37 samples, dating from the 15th to the 18th century. Seeds of *Capparis* have been found in eight samples from cesspits dating to the 16th-18th century (Fig. 4).

Carthamus tinctorius (safflower)

Carthamus tinctorius is traditionally cultivated for its seeds to produce vegetable oil, and for its flowers which are used to dye textiles and to colour foods (Zohary et al. 2012). It was most probably domesticated in the Near East and spread from there during the Bronze Age into the Mediterranean region and eastern Europe (Marinova and Riehl 2009).

The earliest mention of safflower in northwestern Europe is probably in the herbal book by Albertus Magnus (1200–1280) and it was cultivated in Thüringen and Baden-Württemberg in Germany at least from the 16th century onwards, mainly as a food colouring (Körber-Grohne 1995). *C. tinctorius* is also used as a substitute for saffron. Both can be used for colouring food but saffron is much more expensive. Therefore safflower was used, and still is, for the adulteration of saffron (Hagh-Nazari and Keifi 2006). The occurrence of pollen of *Carthamus* can therefore be the result of both the intentional use of this plant or the use of adulterated saffron.

Carthamus is not included in the *Northwest European Pollen Flora* (Punt and Hoen 2009). *Carthamus*-type as defined by Beug (2004) includes *C. tinctorius*, *C. lanatus* and *Leuzea rhapontica*. None of these taxa occur naturally in Belgium or the Netherlands (van der Meijden and Heukels 1996; Lambinon et al. 1998), but *Carthamus*-type pollen has regularly been identified from medieval and post-medieval cesspits in this region. Since *C. tinctorius* is the only plant used in food preparations, it is very likely that the identified *Carthamus*-type pollen must be attributed to *C. tinctorius*.

Carthamus-type pollen has been found in 20 samples, while botanical macroremains have been found from only two post-medieval cesspits in Amsterdam up to now (Paap 1983) (Fig. 5).

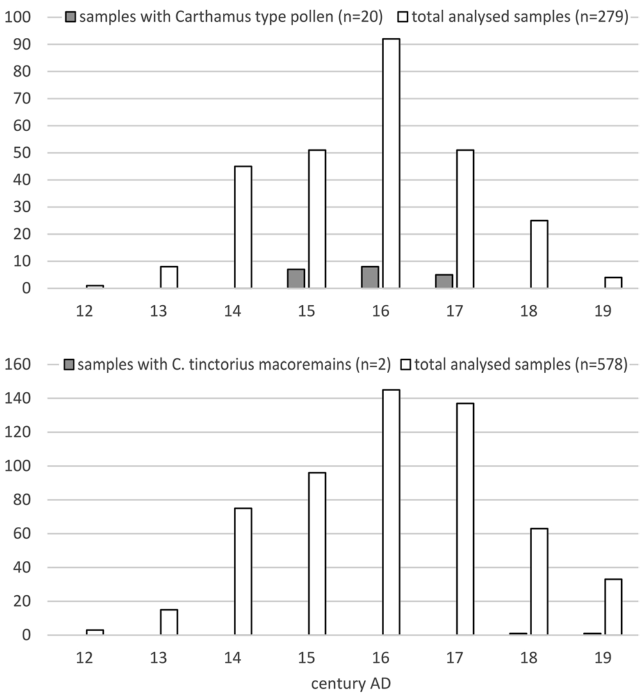

Fig. 5 Number of samples with *Carthamus*-type pollen (top) and *C. tinctorius* macroremains (bottom) from medieval and post-medieval cesspits in the Low Countries

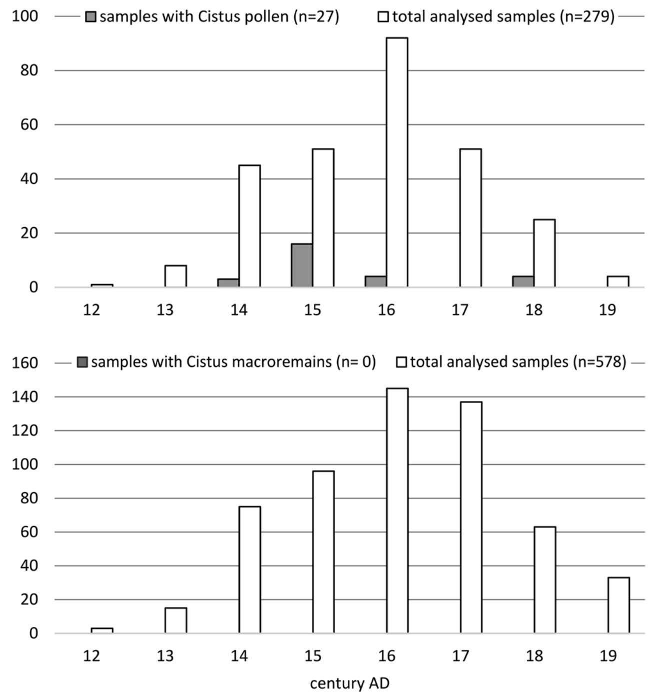

Fig. 6 Number of samples with pollen (top) and mcroremains (bottom) of *Cistus* from medieval and post-medieval cesspits in the Low Countries

Cistus (rock-rose)

Cistus is not a food plant, but it has been included in this review as the occurrence of *Cistus* pollen in (post-) medieval cesspits is believed to result from the consumption of honey or its products originating from southern Europe (Deforce 2010, 2017) or, though less likely, from the use of ladanum (or labdanum), a resin produced by several *Cistus* species, which was historically used in herbal medicine and perfumes (Deforce 2006). *Cistus* is a typical element in pollen assemblages of modern honeys from the Mediterranean region (Gómes Ferreras and Sáenz de Rivas 1980; Bonvehi and Coll 1993; Maia et al. 2005). Its co-occurrence with other typical honey plants from the same region in some of the analysed cesspit samples is a strong indication that its presence is the result of the consumption of honey (Deforce 2010, 2017). The distribution of most *Cistus* species is restricted to the Mediterranean, but *C. albidus* also occurs north of the Mediterranean region (Tutin et al. 1978).

Pollen from *C. ladanifer* can be identified to species level, but this is not possible for most other species in this genus (Jean and Pons 1962, 1963; Sáenz de Rivas 1979; Valdés et al. 1987; Beug 2004).

Cistus pollen, including *C. ladanifer*, has been identified in 26 samples from medieval and post-medieval cesspits in the Netherlands and Belgium (De Groote et al. 2004; Deforce 2006, 2010, 2013, 2017; van Haaster 2010, 2011, 2012). No *Cistus* macroremains have been found (Fig. 6).

Crocus sativus (saffron)

Crocus does not occur naturally in the study area, though many *Crocus* species are cultivated as ornamental plants in the area and some of these, such as *C. chrysanthus, C. vernus* and *C. tommasiniaus* sporadically occur as (semi-) naturalised plants in the wild (Lambinon et al. 1998). The dried stigmas of *C. sativus* (Iridaceae) are known as saffron, an early condiment and food colourant. It was grown in southwest Asia and the Mediterranean basin at least since classical times (Zohary et al. 2012). Though saffron was an extremely expensive condiment during the Middle Ages in northwestern Europe, it is mentioned in many medieval recipes (Wilson 1973; Flandrin and Lambert 1998; van Winter 2007). Adulteration of saffron was not uncommon, including by replacement with *Carthamus tinctorius*, and was severely penalized (Bowles 1952).

Crocus sativus pollen is large (88.5 ± 13.2 µm) pantoaperturate and echinate, though it may appear inaperturate using both LM and scanning electron microscopy (SEM) and its exine frequently shows large cracks (Caiola et al. 2000). Its pollen probably cannot be distinguished from several other *Crocus* species such as *C. vernus* and *C. nudiflorus* (Beug 2004).

Crocus pollen has been found in only one sample from an 18th century cesspit in Amsterdam (van der Meer, in prep.). There are no macrobotanical finds of *C. sativus* from the study region (Fig. 7).

Myrtaceae (myrtle family)

There are no members of the Myrtaceae family native to northwestern Europe. The only member of this family native to Europe is *Myrtus communis* (common myrtle), which occurs in the Mediterranean region (Tutin et al. 1978). The berries of *M. communis* can be eaten and its leaves and berries have been used as an antiseptic since antiquity (Sumbul et al. 2012). Two other exotic taxa from this family have been used in medieval and post-medieval times in northwestern Europe however, *Syzygium aromaticum* (cloves) and *Pimenta dioica* (allspice).

Cloves are the dried flower buds of *S. aromaticum* and therefore contain large amounts of pollen. *S. aromaticum* is a tree that is native to the Moluccas, a group of islands in the eastern part of the Indonesian archipelago and its distribution was restricted to these islands until the late 18th century, when it started to be planted on other islands in the Indian Ocean (Weiss 2002). Cloves are frequently mentioned in historical sources as an expensive spice that was used in medieval and post-medieval cuisine in northwestern Europe (Spencer 2000). Allspice is the unripe, dried fruit of *Pimenta dioica*, which is used as a culinary spice. *P. dioica* is native to central America and was introduced to European cuisines in the 16th century (Purseglove et al. 1981).

It is probably not possible to differentiate between pollen from *Syzygium aromaticum, Myrtus communis* and *Pimenta dioica* using LM (Jankovská 1995). *Syzygium* is parasyncolpate whereas *M. communis* and *P. dioica* are brevicolpate (Thornhill et al. 2012a, b), though this is only clearly visible using SEM. Using LM it seems as if the colpi of both *M. communis* and *P. dioic*a are fused at the poles, which gives them a syncolpate appearance (Thornhill et al. 2012a, b). Beug (2004), Moore et al. (1991) and Valdés et al. (1987) also classify *M. communis* as syncolpate.

Only one single fruit of *P. dioica* has been found in the study region, from a sewer dating to the 18th/19th century (van der Meer 2008). Finds of macroremains of *P. dioica* from other regions of northwestern Europe are very scarce as well, with finds from Gdańsk (Poland) (Badura 2003), London (UK) (Giorgi 1997) and Greifswald (Germany) (Ansorge and Wiethold 2005), all from 18th century cesspits.

Only two flower buds of *S. aromaticum* (cloves) have been found in the study area, from an 18th and a 19th century cesspit. No botanical macroremains from *M. communis* have been found in cesspits in the Low Countries.

Pollen of the Myrtaceae family has been found in 118 samples, dating from the 14th to the 19th century (Fig. 8). In contrast to the consumption of cloves, the use of leaves or berries of *M. communis* and fruits of *P. dioica* is not likely to have resulted in a significant input of pollen into cesspits. It is thus most likely that the identified Myrtaceae pollen should be attributed to *S. aromaticum*, especially those predating the 16th century. Moreover, the absence of macroremains of *M. communis* and the scarce finds of macroremains of *P. dioica* indicates that these plants were uncommon food plants in northwestern Europe during medieval and post-medieval times.

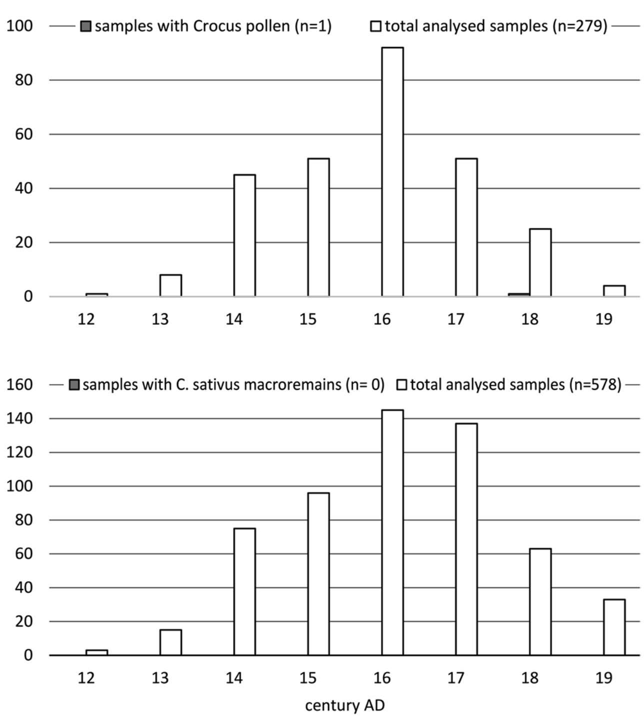

Fig. 7 Number of samples with *Crocus* pollen (top) and *C. sativus* macroremains (bottom) from medieval and post-medieval cesspits in the Low Countries

Spinacia oleracea (spinach)

Spinacia oleracea does not occur naturally in Europe. It is likely to have originated in the Caucasus or Central Asia and was probably introduced as a cultivated plant to southern Europe by the Moors during the 11th century, from where it spread further north (Andersen and Torp 2011; Hallavant and Ruas 2014).

Spinacia oleracea is a member of the Amaranthaceae family (ex-Chenopodiaceae subfamily Chenopodioideae). Pollen from this family is almost never identified beyond family level in pollen studies. Identification is indeed not possible for most members of this family using LM, but pollen of *S. oleracea* can be distinguished from northwest

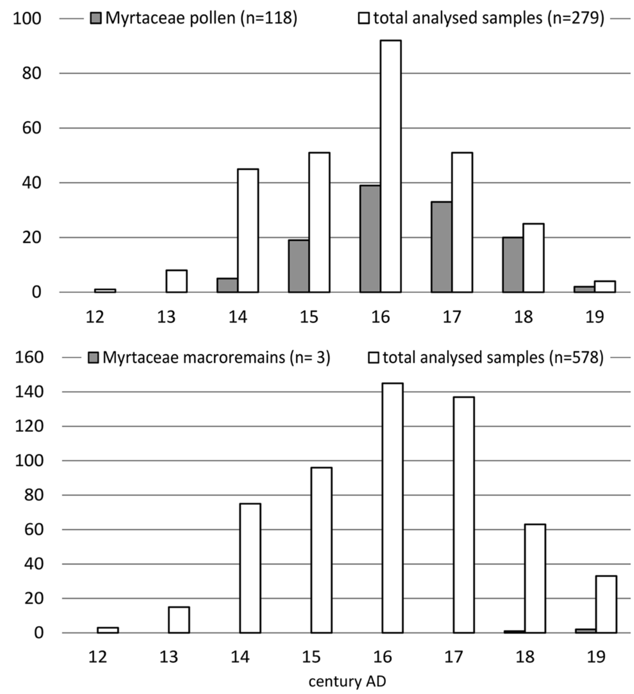

Fig. 8 Number of samples with pollen (top) and macroremains (bottom) of Myrtaceae from medieval and post-medieval cesspits in the Low Countries

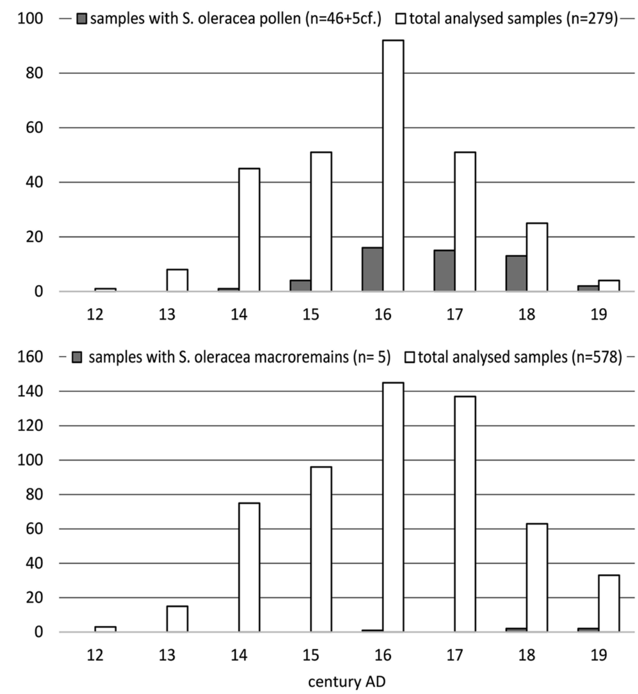

Fig. 9 Number of samples with pollen (top) and macroremains (bottom) of *Spinacia oleracea* from medieval and post-medieval cesspits in the Low Countries

European species by its size and number of pores (Beug 2004; Flores Olvera et al. 2006) (Fig. 10).

Spinacia oleracea pollen has been found in 51 samples and occurs from the 14th century onwards. Macroremains of *S. oleracea* have been found in only five samples, the oldest dating to the 16th century (Fig. 9). There are only a few finds of *S. oleracea* macroremains from elsewhere in Europe. The oldest ones date to the late 12th or early 13th century and have been found in southern France (Hallavant and Ruas 2014). There are also some finds of *S. oleracea* macroremains from Germany, dating from the 13th century onwards (see Hallavant and Ruas (2014) for an overview).

Discussion

There are many possible sources from which pollen recovered from medieval and post-medieval cesspits can originate (Greig 1982a, b, 1994), but for several taxa the consumption of plant food is the most likely origin (Greig 1994; Deforce 2017). The consumption of flowers or flower buds is likely to be especially well reflected in the pollen assemblages of cesspits. Due to the fragility of these plant parts, their consumption remains invisible in the macrobotanical records however, as they are easily destroyed during food processing with grinding and cooking, and by chewing and passage through the digestive tract (Knörzer 1984). Pollen, on the other hand, will largely remain unaltered by all these processes (Linskens and Jorde 1997; Dean 2006; Kelso and Solomon 2006). The above overview indeed shows that the past consumption of *Borago officinalis, Capparis, Carthamus tinctorius* and *Syzygium aromaticum*, all plants from which the flowers or flower buds are eaten, is well reflected in the pollen assemblages from (post-) medieval cesspits. In contrast, the consumption of these plants is only very poorly reflected in the macrobotanical records or not at all. *Crocus sativus* (saffron), another plant from which (parts of) the flowers are eaten, is an exception, remaining largely invisible in both the pollen and macrobotanical records. Next to the 'exotic' plants such as *Syzygium aromaticum, Capparis, Crocus sativus* and *Carthamus tinctorius* which did not occur locally, either wild or cultivated, flowers from native plants were also eaten during (post-) medieval times. For example, the pickled flower buds of both *Sambucus nigra* and *Cytisus scoparius* were used as locally produced substitutes for capers (Dodoens 1644; Tack et al. 1999). Extremely high percentages of pollen from these plants in the assemblages of cesspits are most probably the result of the use of this food type, but as these plants occur in the local vegetation, other possible origins for these pollen types cannot fully be excluded (Deforce 2017). A remarkable concentration of *Sambucus* pollen was found together with that of hundreds of *Capparis* pollen grains from a post-medieval cesspit in Rotterdam. Exceptionally large pores possibly

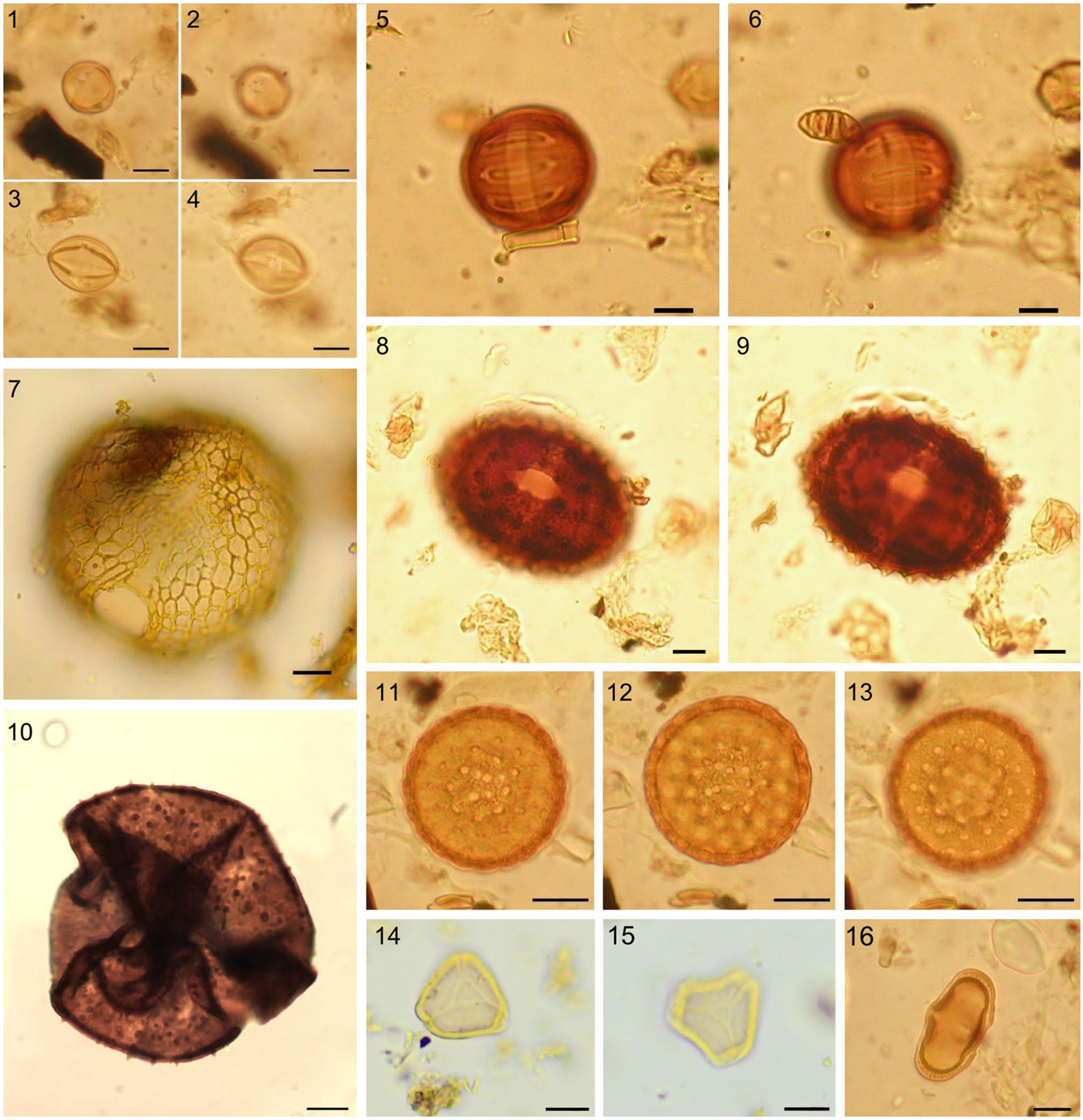

Fig. 10 Images of pollen types identified from medieval and post-medieval cesspits from The Netherlands and Belgium. **1–4**, *Capparis* ('s-Hertogenbosch, Keizershof, AD 1600–1650); **5–6**, *Borago officinalis* (Alkmaar, Langestraat, AD 1350–1450); **7**, *Cistus ladanifer* (Oudenaarde, Kasteel, 15th century); **8–9**, *Carthamus*-type (Oldenzaal, Ganzenmarkt, AD 1375–1425); **10**, *Crocus* (Amsterdam, Waterlooplein, AD 1725–1775); **11–13**, *Spinacia oleracea* (Alkmaar, Langestraat, AD 1418–1500); **14–15**, Myrtaceae (Dendermonde, De Cop, 15th century); **16**, *Anthiscus cerefolium* ('s-Hertogenbosch, Citadel, AD 1325–1375)

resulting from processing to make surrogate capers lead to the suggestion of such a use of elderberry flower buds here (Brinkkemper 2013).

Another group of food plants that is well represented in the pollen records of (post-) medieval cesspits and virtually absent as macroremains includes some leafy vegetables and herbs, such as *Anthriscus cerefolium* and *Spinacia oleracea*. As people eat the leaves of these plants, seeds have very little chance to be incorporated in a recognisable form in the archaeobotanical record after consumption. Pollen, on the other hand, will stick to the leaves, and if these are not thoroughly washed, this pollen will end up in a cesspit after consumption of the leaves. Pollen from other leafy vegetables and herbs such as *Anethum graveolens, Beta vulgaris, Coriandrum sativum* and *Pimpinella anisum* also occur frequently in cesspits (van Haaster 2008; Deforce 2010, 2017), but as the seeds of these plants are also regularly found (Table 1), these are not considered to be underrepresented.

The regular occurrence of pollen from *Cistus* in cesspits and the complete absence of botanical macroremains from this plant are less straightforward to explain. The presence of *Cistus* pollen in this type of archaeological context is believed to result from the consumption of honey or honey-based food products originating from the Mediterranean, which also explains the absence of finds of botanical macroremains from this plant. Honey, or food products such as mead, have been suggested by many authors to be a major source of part of the pollen assemblages from human coprolites (Hadorn 1994; Moe and Oeggl 2014) and cesspits (Jankovská 1987; van den Brink 1989; Greig 1994; De Groote et al. 2004, 2009; Gauthier 2006; Deforce 2010, 2017; Meurers-Balke et al. 2015; Brown et al. 2017) based on large numbers of bee pollinated taxa. Rather than resulting from the consumption of honey imported from the Mediterranean, the presence of *Cistus* pollen in the pollen assemblages from cesspits is more likely to result from honey-based food products produced in the Mediterranean region such as honey-flavoured wines such as hippocras and claret, since locally produced honey was also available in the Low Countries. Another possible source of *Cistus* pollen would be the use of ladanum (Deforce 2006).

This review not only demonstrates the difference in visibility of the past use of several food plants using botanical macroremains or pollen analysis. It also provides new information on the past use of some food plants. Many of the food plants discussed in this paper are not included in reviews of the use of food and other useful plants during the medieval and post-medieval period in Europe (Livarda and van der Veen 2008; Livarda 2011; Preusz et al. 2015), as these studies are generally based only on results of analysis of botanical macroremains.

Conclusions

This review of finds of both pollen and macroremains of a selection of food plants shows that several of these plants, especially those of which the flowers, flower buds or leaves were eaten, do not occur or are strongly underrepresented in the macrobotanical assemblages from medieval and post-medieval cesspits. It also shows that the past use of these plants can be demonstrated using pollen analysis from such archaeological contexts. The presented data show that plants such as *Anthriscus cerefolium, Borago officinalis, Capparis, Carthamus tinctorius, Spinacia oleracea* and *Syzygium aromaticum* were far more regularly consumed during the medieval and/or post-medieval period than has been indicated by their macrobotanical finds. This was known from historical sources, but up to now, these plants were largely missing from the archaeobotanical dataset, which was based on macroremains only. This review, which also includes finds of pollen, is likely to give a better reflection of the past uses of these plants. However, to achieve a more complete image of the import or local cultivation and use of these plants, both in space and time, data from a larger region and preceding periods are needed. Although there is a growing number of pollen analyses of archaeological finds of cesspits, this is still not common practice outside the Netherlands and Belgium.

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