Vegetation History and Archaeobotany (2020) 29:681–697
https://doi.org/10.1007/s00334-020-00772-4

ORIGINAL ARTICLE

Archaeobotanical evidence of food plants in Northern Italy during the Roman period

Giovanna Bosi[1] · Elisabetta Castiglioni[2] · Rossella Rinaldi[1] · Marta Mazzanti[1] · Marco Marchesini[3] · Mauro Rottoli[2]

Received: 16 April 2019 / Accepted: 30 January 2020 / Published online: 7 February 2020

Abstract

This paper is a review of the seeds/fruits obtained from about one hundred Roman period archaeological sites (ca. 3rd century BC to 6th century AD) located in Northern Italy. The types of deposit involved are various, and come from residential, productive and other structures (A sites), and cemeteries and cult areas (B sites). The aim of this study is to highlight the seeds/fruits of food plants that have been found in the Roman archaeological sites in this area. Only cultivated and wild plants that, according to Latin literary sources, were used for food are considered. The result is a list of about one hundred plant taxa. There are four principal categories: cereals, pulses, fruit s.l. and vegetables/spices. Moreover, finds of "bread" were recorded in several sites. The subdivision of most detailed data into four chronological phases ("Romanization"/Republican Age, Imperial Age, Late Roman, Late Antiquity) shows clearly the evolution of plant food consumption that attained maximum complexity during early Imperial times and progressively changed and fragmented in subsequent periods.

Keywords Seeds/fruits · Food plants · Literary sources · Roman period · Northern Italy

Introduction

The Romans in Northern Italy

In the 4th and 3rd centuries BC, in addition to Veneti and Ligures, various Celtic populations were present in Northern Italy in the central part of the Po Valley. The Romans had various contacts with these peoples, above all for trade (Curina et al. 2015).

By the end of the 3rd century BC, the Romans governed nearly all the Italian peninsula, including a large part of Cisalpine Gaul (David 2002), the ancient name of Northern Italy. Based on the archaeological data, it can be deduced that the Roman colonisation took place gradually, but with precise planning (Curina et al. 2015).

During the 2nd and 1st centuries BC, after the Second Punic War, the area was completely subject to Roman domination. Different methods of conquest (which, in any case, were neither rapid nor painless) were used north and south of the River Po. However, an ethnically mixed population resulted, where the Celtic cultural facies overlaid—but did not destroy—other previous or contemporary cultures. The Celtic facies was then superseded by Roman culture (Brizzi 2000; Cresci Marrone 2015). In this period, the foundation of colonies continued (e.g. Cremona, Piacenza, Bologna, Modena, Parma, Aquileia, Verona, Vicenza, Padova, Altino, Milan, Brescia, Como and Mantova) and important roads were established (e.g. Via *Flaminia*, *Æmilia*, *Posthumia*, *Annia*, *Popilia*), connecting the new towns with one another and with Rome (Cresci Marrone 2015; Curina et al. 2015). In many large *municipia* and minor centres of Northern Italy, whose economic vitality and strategic and commercial importance are referred to in written sources, archaeological investigations have brought to light numerous luxurious

Communicated by C. C. Bakels.

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00334-020-00772-4) contains supplementary material, which is available to authorized users.

✉ Giovanna Bosi
giovanna.bosi@unimore.it

[1] Laboratorio di Palinologia e Paleobotanica, Dipartimento di Scienze della Vita, Università di Modena e Reggio Emilia, Viale A. Allegri 9, 42121 Modena, Italy

[2] Laboratorio di Archeobiologia, Musei Civici di Como, Via Vittorio Emanuele II, 97, 22100 Como, Italy

[3] Laboratorio di Palinologia e Archeobotanica, Centro Agricoltura Ambiente "G. Nicoli", Via Marzocchi 17, 40017 S. Giovanni in Persiceto, Italy

domus that testify to the high level of civilisation attained in Northern Italy, also from a cultural viewpoint (Sena Chiesa 2001).

Julius Caesar first recognized the region's strategic importance, in part as a base for his expansionist policies. Augustus thus found solid economic bases there and was able to conclude the process of "Romanization" of Cisalpine Gaul (Mansuelli 1962). Northern Italy was subsequently divided into the "Augustan regions": VIII-*Æmilia*, IX-*Liguria*, X-*Venetia et Histria*, XI-*Transpadana* (Roncaglia 2018). Only then did ancient Italy become the real centre of the Roman Empire, in part thanks to its excellent road network (Mansuelli 1962).

The Roman ruling class organized Cisalpine Gaul into an extensive region able to protect and make secure the northern boundaries, and the resettlement there from Central Italy of many settlers loyal to Rome was encouraged (David 2002). Its geographical position and the reorganisations performed first by Caesar and later by Augustus made the area crucial for all commercial exchange (Mansuelli 1962).

From the third century AD onwards, civil wars and repeated invasions by Germanic populations destabilised a situation that had long been more or less in balance, leading to a reorganisation of the "Roman system" in Northern Italy that took the form of direct and invasive State intervention (Roncaglia 2018).

Landscape, cultivated fields and economy

When trying to understand the history of a geographical area during a certain historical period, textual sources are fundamental for the light they throw on political and military aspects. However, to obtain an economic and environmental perspective all available sources are needed, including palaeoclimatic and archaeological research data (Brizzi 2000).

In Europe, there was a "climatic optimum" period in the 4th and 3rd centuries BC (Magny 2004; Holzhauser et al. 2005; McCormick et al. 2012) that coincided with the beginning of the Roman colonisation of Northern Italy (Cremaschi and Storchi 2015). At that time, according to Strabo, Cisalpine Gaul was crossed by numerous rivers and waterways and was occupied by extensive marshes (Brizzi 2000). After Roman colonisation, deforestation and drainage were carried out, reclaiming land and making the area highly productive (Pasquinucci 1993). With the foundation of the towns in the Po Valley, land surveying techniques were refined and centuriation was used to subdivide the land into regular square lots (Gabba 1985). In this area, the rural properties typically used as a basis for colonisation were of small or average size (Mansuelli 1962). Centuriation led to the widespread agricultural improvement of the entire region, integrating it into the rest of Italian territory (David 2002). Apart from the wooded slopes of mid- and high-altitude mountains, in the plain and coastal zones there were also forests untouched by drainage work. Sometimes these were artificially created, such as poplar and pine plantations (Mansuelli 1962).

From the 3rd century BC onwards, in Cisalpine Gaul an extended web of farms and rural villas was formed around the urban centres and villages. In farms and villas south of the River Po, production and processing activities prevailed over human habitation. The territory between the Po and the Alps was sparsely peopled, with a strongly agricultural economy (Fortunati and Malnati 2015). An *in agro* life required certain kinds of housing, sometimes sharply characterised: luxury panoramic villas along the coasts and near the lakes, large productive villas on the fertile plains and modest buildings with small-scale activities in the areas of the Po delta, in the Venetian lagoons and in many hilly zones (Sena Chiesa 2001). From the second half of the 1st century BC until the middle Imperial era, the wide distribution of *villae* was notable from an economic standpoint, and the agricultural economy was well-integrated with craft activities (Mansuelli 1962). Thanks to Roman control, the raw materials present in the area allowed a great development of craft production, which was based on pre-existing local traditions and sometimes specialized in high-quality products, such as bronze-plate artefacts, cloth, pottery, oil lamps and terracotta building materials (Brizzi 2000; Malnati and Manzelli 2015). Local wood was useful for constructing houses, boats, wine barrels, barrel wagons, tools and other objects, and as fuel; in Liguria, a coal industry is also documented (Mansuelli 1962).

Archaeobotanical analysis in Northern Italian Roman sites

To date, about a 100 papers presenting archaeobotanical analyses from Roman settlements (3rd century BC to 6th century AD) in Northern Italy (Emilia-Romagna, Liguria, Piemonte, Valle d'Aosta, Lombardia, Veneto, Friuli-Venezia Giulia, Trentino-Alto Adige) have been published (Mercuri et al. 2015; BRAIN 2019; unpublished data).

The archaeobotanical spectra indicate that agricultural territories were probably subdivided by shrubby hedgerows and border trees, and interspersed with grasslands and pastures (e.g. Rottoli and Marchesini 2015; Mazzanti et al. 2017). This image seems consistent with what Pliny the Elder recounted concerning the various species planted along canals and borders (which, by law, had to be protected by a series of barriers made of hedgerows and picket fences; see Forni 1995). Archaeobotanical data, particularly those from wood and charcoal (e.g. Bosi and Marchesini 2017) corroborate what is reported by Latin authors, who wrote that the grapevine was "married" to elm, maple and hornbeam in the *arbustum gallicum*, a cultivation method characterising the centuriated territory (Forni 1995).

At the end of the Roman warm and dry period (Jalut et al. 2009), documented also in other parts of Europe (e.g. Schmidt et al. 2004), in the 5th to 6th century AD the onset of a comparatively colder and damper climate is manifest, with a probable increase in rainfall and flooding. This is also demonstrated by the notable variations in depositional dynamics in the Po delta, starting from 1,500 to 1,300 cal years BP (Stefani and Vincenzi 2005). Archaeobotanical research shows, with varying degrees of clarity, that the decrease in agricultural organisation which had already begun in later Imperial times became more and more evident. But this regression shows a mosaic pattern: in some sites, archaeobotanical contexts reveal continued intense human activity; in others, human presence and activities clearly become sporadic. Reduced water management implies that larger areas were flooded, at least periodically, as is indicated by archaeobotanical data; these data also reveal, at higher altitudes and in cold places, an increase in anthropic woodlands with chestnut (Accorsi et al. 1999; Bosi et al. 2015b, 2019).

Currently, for the Roman period of Northern Italy only partial summaries of archaeobotanical data exist (e.g. Bandini Mazzanti et al. 2014). These include syntheses regarding certain areas (e.g. Marchesini 1998; Marchesini and Marvelli 2009; Rinaldi et al. 2013; Bosi et al. 2015a, b, 2017a, 2019; Torri et al. 2017), some taxa (e.g. Bosi et al. 2011b) and, concerning food plants, several thematic studies such as certain plants that were cultivated and consumed during the Roman period (e.g. Bandini Mazzanti et al. 2001; Bosi et al. 2017b, d) or used as funerary offerings (e.g. Rottoli and Castiglioni 2011; Bosi et al. 2017e). In this paper, finds of food plants from many of the Roman sites studied in this area have been considered. Funerary and ritual sites are included, but treated separately; in fact they provide a lot of information, but it must be assessed differently.

Materials and methods

The sites

We took into account 114 sites where macroremains (mostly seeds/fruits = sf) of "food plants" had been found: 70 sites classifiable as inhabited places and infrastructures (A sites—c. 3rd century BC to 6th century AD; details in Table ESM 1) and 44 cemeteries and cult places (B sites—c. 3rd century BC to 5th century AD; it must be noted that most of the B sites fall into the 1st to 2nd century AD chronological range; Table ESM 2). Numerous analyses of seeds/fruits collected from the 114 sites have been published in journals or books, but other data are unpublished (See ESM 7 references of Tables ESM 1 and 2); the authors of the present article take scientific responsibility for this additional material.

The sites are located in seven northern Italian regions: Piemonte (4 A and 2 B), Lombardia (19 A and 21 B), Trentino-Alto Adige (8 A and 3 B), Veneto (8 A and 6 B), Friuli-Venezia Giulia (6 A), Liguria (4 A and 1 B) and Emilia-Romagna (21 A and 11 B) (Fig. 1a, b) (Mercuri et al. 2015; BRAIN 2019; unpublished data). They are mostly situated in plain areas; of the A and B sites only 4% and 9% respectively are in hilly terrain, and 13% and 5% in mountainous zones (Tables ESM 1 and 2).

Among the 70 A sites (with over 300 sampled layers), different types can be distinguished (see Table ESM 1). Unfortunately, foodstuff storage contexts are very rare, whereas deposits related to various kinds of waste disposal are very common. In many sites (46) the initial quantity of material that was sieved is known (from 0.4 to over 600 l), whereas for other sites (24) the quantity examined is unknown or only visual sampling was performed (Table ESM 1). The macroremains of A sites are mainly preserved by carbonization

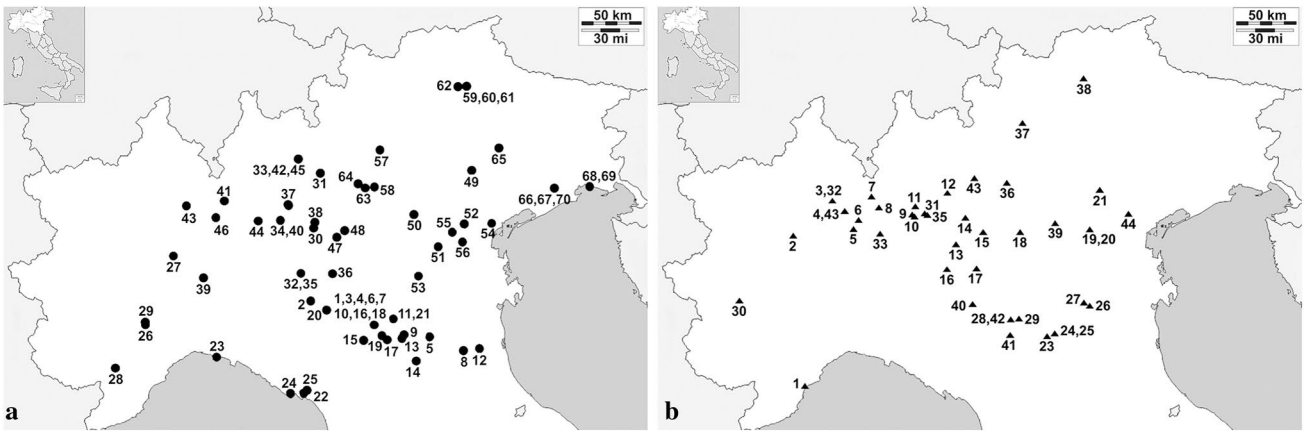

Fig. 1 Location of A (**a**) and B (**b**) sites in Northern Italy

(about 70%) and waterlogged, whereas mineralized seeds/fruits are very few.

The B sites include 39 cemeteries (with 374 examined contexts), with mostly cremation burials and rare inhumations. For sites 1–27, already considered in a previous synthesis (Rottoli and Castiglioni 2011), data were checked and in some cases updated; sites 28–39 were added *ex novo*. Overall, c. 400 graves with food plant remains were found. In addition, the B sites also comprise 5 cult places (40B, 41B, 42B, 43B, 44B—with 25 sampled layers), mostly shrines. In the various sites, sampling was sometimes systematic (samples—for every burial found—from 0.2 to c. 50 l) and at other times only visual sampling was performed (Table ESM 2). The macroremains of B sites are almost all (about 95%) charred.

In order to obtain seeds and fruits, soil samples were floated/sifted in water (0.5–0.2 mm smaller mesh size).

For further details, see the references in Tables ESM 1 and 2.

Remains and taxa considered

In making this synthesis, we took into account the "food taxa" (from both cultivated and wild plant sources), which were cited for the Roman period (principal sources: André 2009, 2010; Dalby 2003; Prance and Nesbitt 2005. In some cases the principal relevant Latin writers, in particular Cato, Varro, Columella, Pliny the Elder and Apicius—see References—were consulted directly); these were useful for the archaeobotanical remains under consideration (generally seeds/fruits, as well as a rhizome and a bulb). We bore in mind that the principal Latin sources were based mainly on the uses and customs of Central Italy (with Rome as its hub). The four fundamental categories examined here are: cereals, pulses, fruit plants s.l. and vegetables/spices. Remains of bread or similar prepared food were also recorded (details in Tables ESM 3 and 4).

In addition, we also took into consideration the "other food plants" category, i.e. the plants for which alimentary uses of other parts (e.g. leaves, flowers and stems), different from those found known to date, may well have existed during the Roman period. All of these plants were cited in the sources mentioned above (Table ESM 5).

Botanical nomenclature was updated according to Pignatti et al. (2017–2019), APG (2018) and The Plant List (2018). The terminology concerning cereals follows that of the "traditional classification" sensu Zohary et al. (2012).

The data

The first interesting aspect to be analyzed was the frequency of the various taxa, divided into categories (cereals, pulses, fruit plants s.l. and herbs/spices) over the whole Roman Period in Northern Italy, comparing A and B sites (Figs. 2, 3, 4, 5, 6).

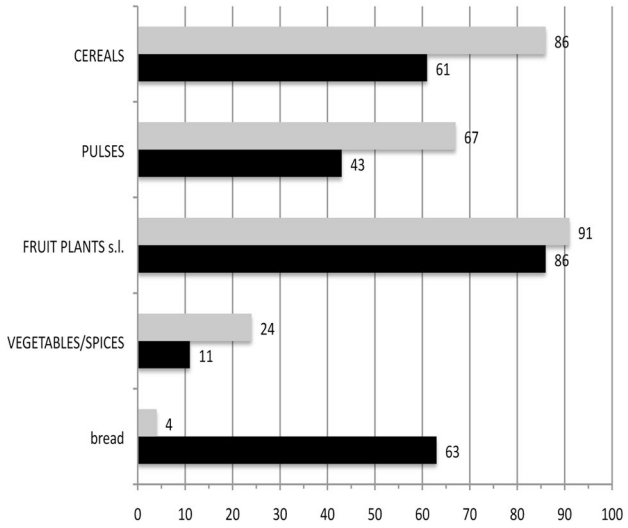

Fig. 2 Frequency graph (%) of principal categories (A sites: grey; B sites: black)

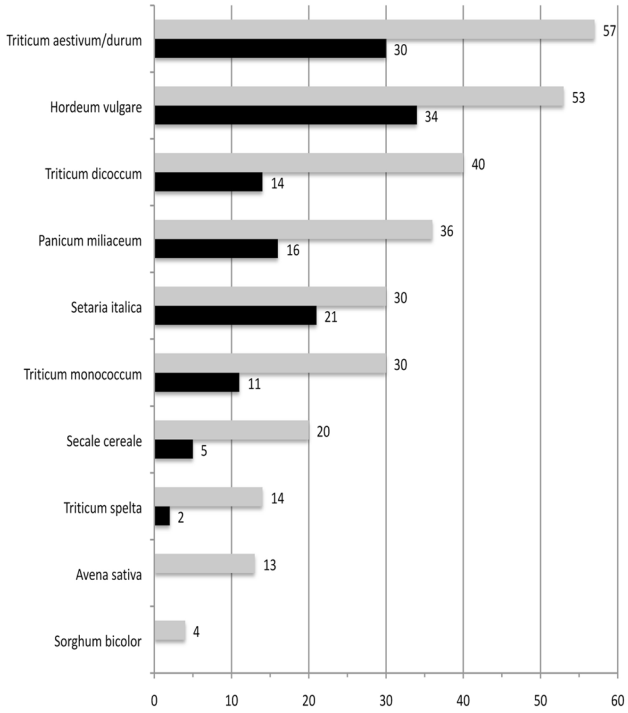

Fig. 3 Frequency graph (%) of cereals (A sites: grey; B sites: black)

To examine the chronological trends of taxa presences, the period was divided into four phases: (1) "Romanization"/Republican (3rd to 1st century BC); (2) Imperial (1st to 2nd century AD); (3) Late Roman (3rd to 4th century AD); (4) Late Antiquity (5th to 6th century AD). The sites were then displayed in chronological order in Table ESM 3 (A sites) and

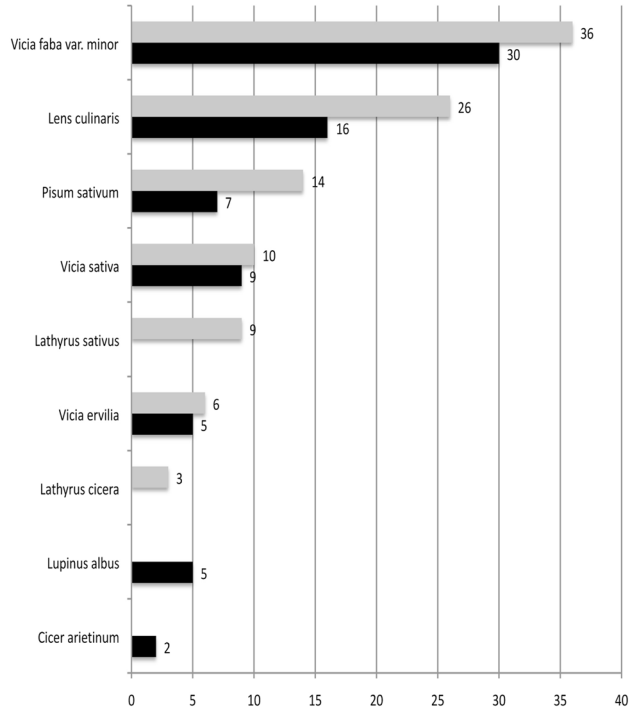

Fig. 4 Frequency graph (%) of pulses (A sites: grey; B sites: black)

4 (B sites); at the end of the tables were placed those with a chronological range identified only as "Roman Period" (see Tables ESM 1 and 2).

For the most relevant taxa, the frequency chronological trend was highlighted (Figs. 7, 8) considering the 35 A sites with dates that coincide precisely in the four phases considered (phase 1, 6 sites: 30, 65, 31, 32, 23 and 66; phase 2, 12 sites: 51, 4, 5, 6, 35, 36, 58, 7, 27, 60A, 61 and 14; phase 3, 9 sites: 40, 41, 28, 42, 43, 62, 29, 16 and 25; phase 4, 8 sites: 45, 46, 70, 64, 47, 17, 48 and 18).

To compare the quantitative data (percentage) of the four main categories, we considered 20 A sites with a precise dating and at least 100 remains (Table ESM 6).

For the "other food plants" we indicated the A and B sites where the remains were present, their frequencies and the parts used mostly according to literary sources (Table ESM 5).

Almost all photographs were taken with a Leica MC 170 HD and measurements were obtained using the ImageJ programme; photographs of *Sorghum* were taken with scanning electron microscopy (SEM).

Results and discussion

Considering only detailed numerical data (not those regarding range or presence), the remains of undisputed food plants number about 450,000 (in the A sites more than 430,000; in the B sites a little more than 9,000). In the A sites, concentrations per litre, whenever it was possible to calculate them, vary from < 1 to 1,715 sf/l (in site 36A the exceptional concentration of more than 16,000 sf/l was reported; Rottoli 1996); in the B sites, concentration varies from < 1 to 13 sf/l (with the sole exception of the ritual site 40B, where concentration is over 1,400 sf/l; Bosi et al. 2011a). The taxa identified at least to the genus or type level number 81 (78 in the A and 50 in the B sites): 12 cereals (12 and 8), 9 pulses (7 and 7), 45 fruit plants s.l. (45 and 28) and 15 vegetables/spices (14 and 7). Remains of "bread" were found in more than 60% of the B sites (in 4 of which it was the only type of plant-related food residue found), and in just 4% of the A sites (Fig. 9).

Concerning the other food plants, which were found mostly in A sites, 45 taxa with altogether over 20,000 seeds/fruits were recorded (considering only the detailed numerical data).

The state of preservation of the remains is indicated in Tables ESM 3 and 4. In B sites they are mostly charred (= c), whereas in the A sites there are many remains that are not charred (= nc). Among the latter, many were found in waterlogged conditions, principally in the sites south of the River Po; completely mineralised remains are rare (photographs of some seeds/fruits are shown in Fig. 10).

Cereals

Remains of cereals are present in 86% of the A and 61% of the B sites. The most frequent are *Triticum aestivum/durum* type (naked wheats—both taxa could be recognized on the basis of floret base and rhachis segment) and *Hordeum vulgare* (barley): these are present in more than half of the A sites (57–53%) and in c. 1/3 of the B sites (30–34%). In the A sites *Triticum dicoccum* (emmer) is also often present (40%), followed by a group made up of *Panicum miliaceum* and *Setaria italica* (millets) and *Triticum monococcum* (einkorn) in c. 1/3 of the sites (36–30%). In the B sites, however, only *S. italica* (foxtail millet) is fairly frequent (21%), whereas *P. miliaceum* (broomcorn millet), *T. dicoccum* and *T. monococcum* are less common (16–11%). In the A sites, *Secale cereale* (rye), *Triticum spelta* (spelt) and *Avena sativa*, *Avena* sp. (oats) are of average to low frequency (20–13%), whereas *Sorghum bicolor* (sorghum) was found in 3 sites only. In the B sites, *S. cereale* and *T. spelta* are present (in 1 or 2 sites), whereas *A. sativa* and *S. bicolor* are absent. Nearly all cereals are well distributed in the A sites of the regions considered here. The clearest exception is *S. bicolor*; the few sites where it appears are located only in Veneto and Lombardy (Rottoli 1998; Castiglioni and Rottoli 2013; Castiglioni and Cottini 2016). We have also found forks of "new glume wheat" (sensu

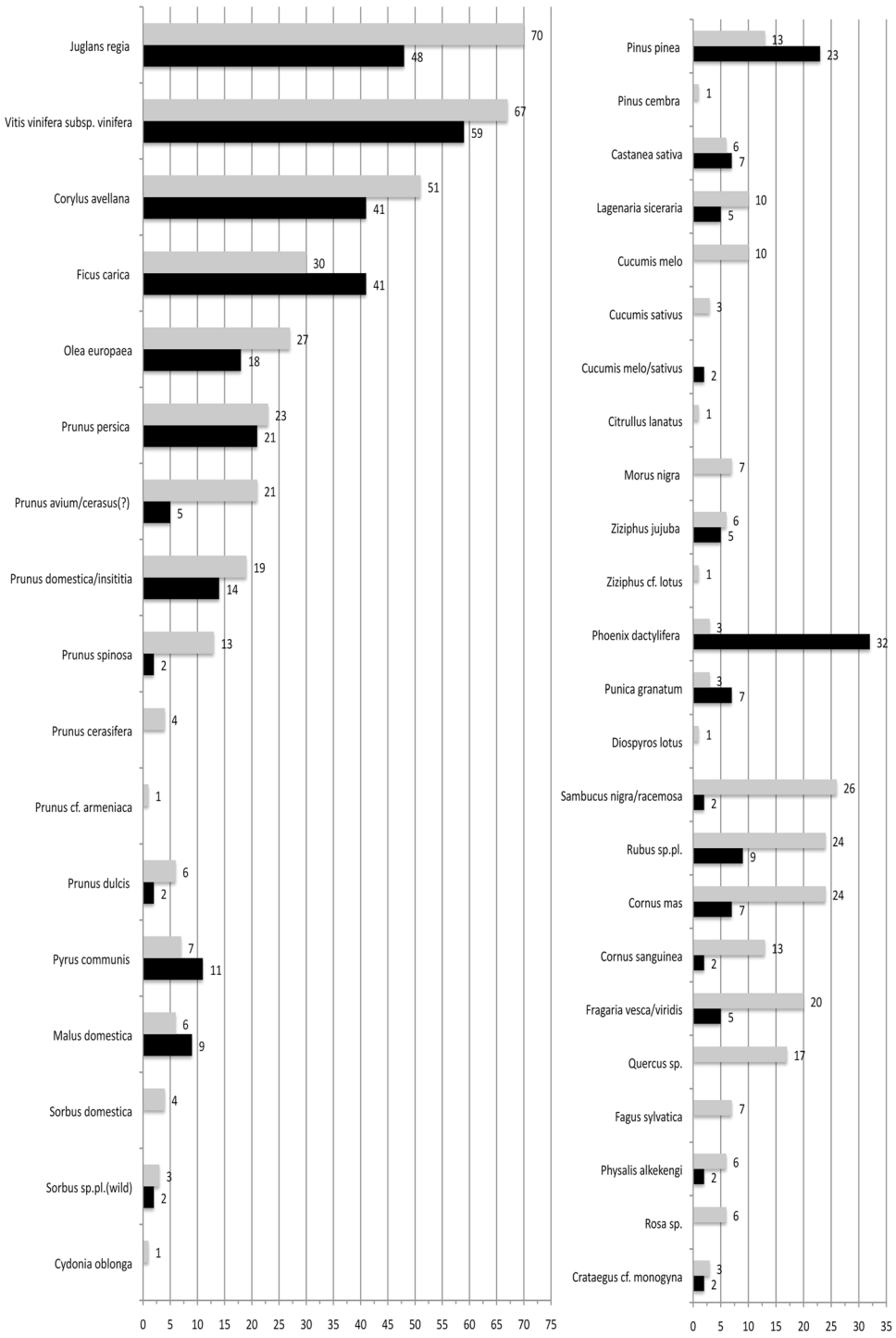

Fig. 5 Frequency graph (%) of fruit plants s.l. (A sites: grey; B sites: black)

Jones et al. 2000) only in site 30A in Lombardy (Castiglioni et al. 2014). Both these cereals seem to be niche products that were not widespread.

We have to note that naked wheats and barley were important for human nutrition. Among the so-called hulled grains, *T. dicoccum* is dominant, whereas *T. spelta* was scarcely used, thus confirming the data from northern Italian sites of the Bronze Age onwards (e.g. Mercuri et al. 2006).

Pulses

Remains of pulses are present in 67% of the A and in 43% of the B sites.

In both A and B sites, *Vicia faba* var. *minor* (faba bean) is the most common pulse (36 and 30%), followed by *Lens culinaris* (lentil, 26 and 13%). *Pisum sativum* (pea), *Vicia sativa* (common vetch) and *V. ervilia* (bitter vetch) have a

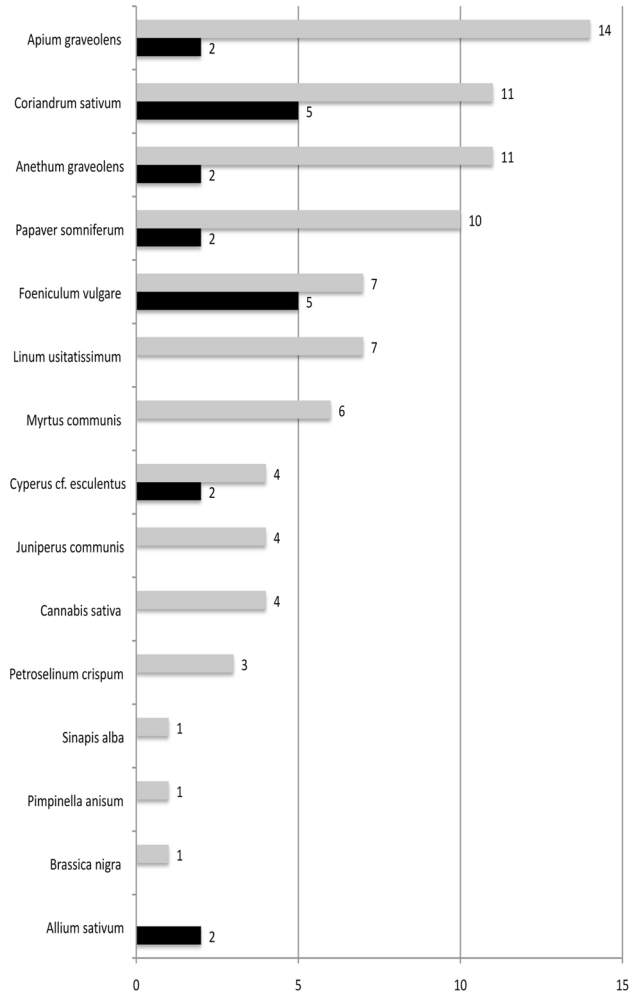

Fig. 6 Frequency graph (%) of vegetables/spices (A sites: grey; B sites: black)

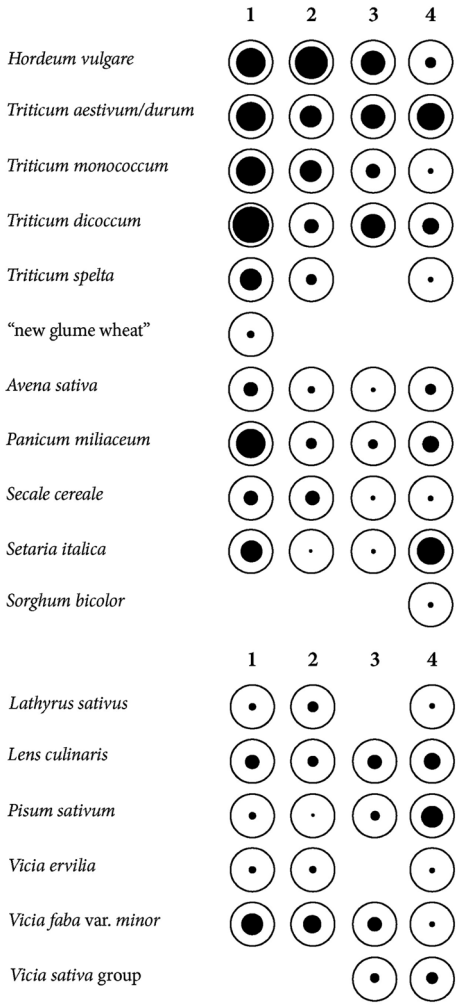

Fig. 7 Frequency graph (%) of cereals and pulses from 35 A sites with date ranges divided into 4 chronological phases

minor diffusion in both the A (14–6%) and B sites (9–5%). *Lathyrus sativus* (grass pea, 9%) and small amounts of *Lathyrus cicera* (red pea, 3%) are found only in the A sites, whereas only in the B sites *Lupinus albus* (white lupin) and *Cicer arietinum* (chickpea) occur sporadically. Probably these last two pulses, that were widespread in the Classical world as a popular "street food" (Dalby 2003), were not important for human nutrition in Northern Italy. They were, though, used in ritual contexts, for example *C. arietinum* in Pompeii (2nd century BC to 1st century AD; Robinson 2002; Matterne and Derreumaux 2008) and *L. albus* in French cemeteries (1st to 3rd century AD; Bouby and Marinval 2004; Preiss et al. 2005).

Even if at a qualitative level they are well diversified, it may be noted that the pulses—particularly in the A sites—seem to be secondary with respect to cereals, with regard to both frequency (Table ESM 3) and quantity (Table ESM 6). It should however be noted that pulses tend to be poorly preserved with respect to cereals—and we must also remember that only a few storehouses of plant foodstuffs are included in this analysis (see Materials and methods).

Fruit plants s.l.

The remains of fruits s.l. are the most ubiquitous, being present in 91% of the A and 86% of the B sites.

The most common taxa (A sites: 70–67%; B sites: 48–59%) are, respectively, *Juglans regia* (walnut) and *Vitis vinifera* (grape). *Corylus avellana* (hazelnut), *Ficus carica* (fig), *Olea europaea* (olive) and *Prunus persica* (peach) follow, with frequencies from high to medium in both A (51–23%) and B sites (41–18%).

Apart from *P. persica*, among the Prunoideae there are some taxa often found in the A sites (20–10%): *P. avium/cerasus* (sweet/sour cherry), *P. insititia*, *P. domestica* (bullace and damson) and *P. spinosa* (sloe). The *P. insitita/*

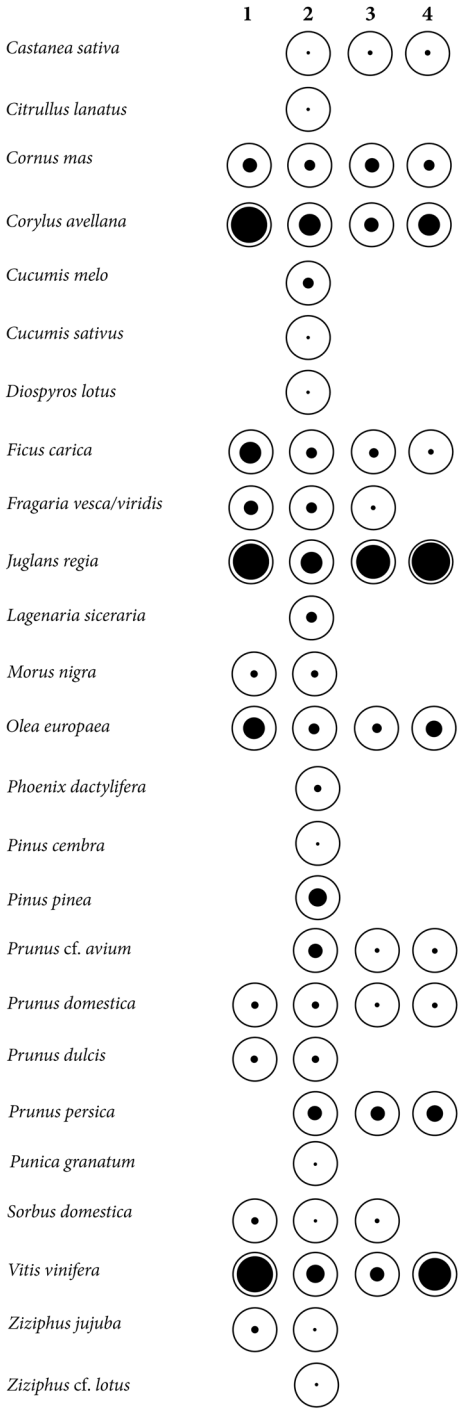

Fig. 8 Frequency graph (%) of fruit plants from 35 A sites with date ranges divided into 4 chronological phases

domestica-type is also fairly common in the B sites (14%), whereas the other taxa are sporadic (5–2%). Lastly, *P. dulcis* (almond), *P. cerasifera* (cherry plum) and *P. armeniaca* (apricot), the latter two exclusive to the A sites, are only rarely present (1 to 4 sites). In Northern Italy during the Roman period, only the presence of *P. avium* is certain;

Fig. 9 Bread from site 3B (ca. 9.5 cm diameter and 2.5 cm thickness – photograph by M. Rottoli)

whereas that of *P. cerasus* seems unlikely, since it is attested with certainty only from the Middle Ages onwards (e.g. for Emilia-Romagna see Bandini Mazzanti and Bosi 2006; Bosi et al. 2009).

Among the Pomoideae, *Pyrus communis* (pear) and *Malus domestica* (apple) have frequencies of between 6 and 11% in both site types, whereas *Sorbus* spp. (sorbs), both cultivated and wild, and *Cydonia oblonga* (quince) are rare (4–1%) and present almost exclusively in the A sites (apart from the seeds of wild sorbs in the ritual site 40B).

Phoenix dactylifera (date) and the remains of *Pinus pinea* (stone pine) are present in both site types, but are much more frequent in the B sites (32 and 23%) than the A sites (3 and 13%). Overall, the presence of expensive imported dates seems to be linked to funerary rituals, with the exception of a unique find (berry) from a rubbish dump in *Mutina* (site 7A; Bosi et al. 2015b, 2017a), and a certain quantity of charred berries and stones found in site 35A (a sumptuous Cremona *domus* that probably belonged to an imperial functionary). It may be supposed that they were kept in the residents' luxury storeroom (Castiglioni and Rottoli 2018).

Seeds of Cucurbitaceae taxa are present in between 1 and 10% of the sites. *Lagenaria siceraria* (bottle gourd) is present both in the A sites (9%) and in the B sites (5%). In the A sites, *Cucumis melo* (melon) has been found in 9% of the sites, *Cucumis sativus* (cucumber) in two sites, and *Citrullus lanatus* (watermelon) in one site only. Given the charred preservation state of the remains, in 3% of the B sites only the *Cucumis melo/sativus* type can be identified. Thus, during the Roman period in Northern Italy these three

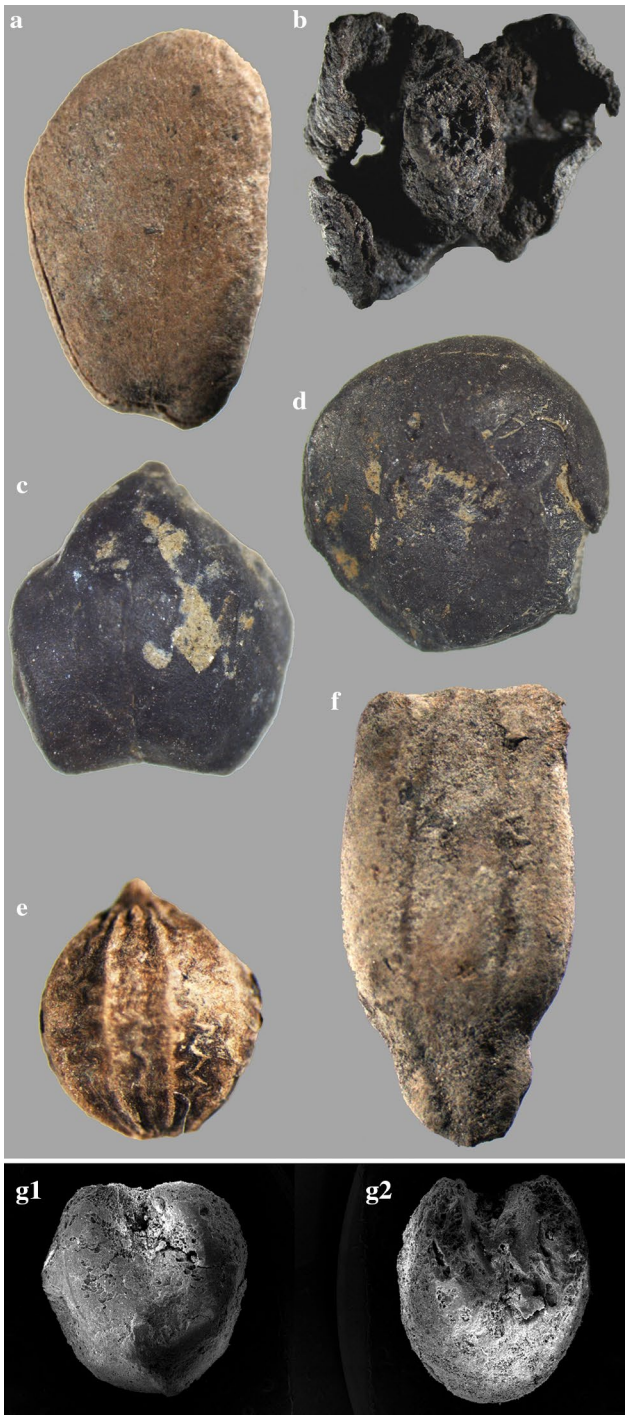

Fig. 10 Some findings of taxa treated in this paper: a. *Pinus cembra* (pine nut, uncharred, 8.4 mm); b. *Diospyros lotus* (calyx, uncharred, 18 mm); c. *Cicer arietinum* (seed, charred, 6.4 mm); d. *Lupinus albus* (seed, charred, 6.7 mm; e. *Coriandrum sativum* (mericarp, uncharred, 3.1 mm); f. *Lagenaria siceraria* (seed, uncharred, 14.5 mm); g1-g2. *Sorghum bicolor* (caryopsis, charred, 3.3 mm) (photographs by R. Rinaldi, G. Bosi and M. Rottoli)

taxa appear in the human diet—even if they only became widespread in the Middle Ages, especially the melon and bottle gourd (e.g. Bosi et al. 2009), whereas cucumber was probably less significant, since it was usually consumed when still unripe, before the seeds (the potential archaeobotanical finds) are completely formed.

Castanea sativa (chestnut) appears in both the A (7%) and B sites (8%), only in locations at altitudes below 300 m a.s.l. in Piemonte, Lombardia and Friuli-Venezia Giulia (Tables ESM 1–4). Three other woody plants cultivated for their fruits appear in both A (3–7%) and B sites (5–7%): *Morus nigra* (mulberry, exclusively in the A sites), *Punica granatum* (pomegranate) and *Ziziphus jujuba* (jujube).

Traces of three very unusual taxa appear in two A sites only: nuts of *Pinus cembra* (zirbe) and calyxes of *Diospyros lotus* (date-plum) in site 4A (Bosi et al. 2017a, c), and probable endocarps of *Ziziphus* cf. *lotus* (lotus tree) in site 27A (Table ESM 3). These remains form part of the "luxury food" category (see below).

A group of plant taxa whose fruits are collected from wild specimens (or individuals subject to human maintenance) is well represented in the A sites (26–13%), but rare in the B sites: *Sambucus nigra/racemosa* (elderberry), *Rubus* spp. (blackberry), *Cornus mas*, *C. sanguinea* (cornels) and *Fragaria vesca/viridis* (strawberries). Remains of acorns (*Quercus* sp., 17%), beechnuts (*Fagus sylvatica*, 7%) and rose hips (*Rosa* sp., 6%) are present only in the A sites. Two other taxa with small fruits, which were probably collected from wild plants, are present both in the A and B sites: *Physalis alkekengi* (winter cherry, 6 and 2%) and *Crataegus* cf. *monogyna* (hawthorn, 3 and 2%).

In general, among the fruit plants of great nutritional value from an energetic standpoint, the considerable presence of *Olea europaea* (even quantitatively—e.g. site 4A—Bosi et al. 2017a) suggests that these came from local plantations rather than being imported, although these plantations would have been outside of the traditional cultivation zones. In addition, given the integrity of the endocarps found so far (see e.g. site 4A, Bosi et al. 2017a), it seems that olives were principally destined to be consumed as such, rather than used for oil production activities, except for in some areas of Liguria (Gervasini 2005) and around Lake Garda (Ghiroldi 1995–1997).

Vegetables/spices

Remains of this category are present in 24% of the A and 11% of the B sites.

In the A sites, the most frequent taxa belonging to this category (14–10%) are *Apium graveolens* (celery), *Anethum graveolens* (dill), *Coriandrum sativum* (coriander) and *Papaver somniferum* (opium poppy), followed (7–3%) by *Foeniculum vulgare* (fennel), *Linum usitatissimum* (flax),

Myrtus communis (myrtle), *Cyperus esculentus* (chufa), *Juniperus communis* (juniper), *Cannabis sativa* (hemp) and *Petroselinum crispum* (parsley). Only in site 4A we find *Brassica nigra* and *Sinapis alba* (black and white mustard) and *Pimpinella anisum* (anise).

In the B sites we find again (but with lower frequencies: 5–2%) many of the species just mentioned, such as *Coriandrum*, *Foeniculum*, *Apium*, *Anethum*, *Papaver*, *Cyperus* (charred rhizomes) and *Allium sativum* (garlic, clove). Among the B sites, site 40B is particularly notable: it is a probable place of worship with evidence of foundation rituals (Bosi et al. 2011a). Three taxa belonging to this category are found there (*Coriandrum*, *Foeniculum* and *Papaver*) and the concentration of seeds is noteworthy (167/2 l). In one funerary site only (7B) there are three taxa belonging to this category: *Coriandrum*, *Apium* and *Anethum* (Rottoli and Castiglioni 2011).

Other potential food plants

There are also carpological remains of 45 plants (cultivated or wild) that, based on textual sources, the leaves, roots or flowers of which could be used for food (Table ESM 5). For some of these taxa, particularly the wild ones, it cannot be excluded that their seeds/fruits were found in the deposits due to their presence as weeds s.l. However, the direct consultation of references in Roman literary texts (see Materials and methods) yielded useful information indicating that these species were potential vegetable foods that contributed to the diet during the Roman period in Northern Italy.

Remains of these taxa appear in c. 50% of the A (44 taxa) and 14% (mostly in places of worship) of the B sites (17 taxa).

Various taxa are cited mainly for the consumption of their leaves, which were cooked like spinach: *Amaranthus blitum/graecizans*, *Atriplex hortensis*, *Beta vulgaris*, *Brassica napus*, *Chenopodium album*, *Lamium album*, *Malva sylvestris*, *Plantago* spp., *Stellaria media* and *Urtica* spp.

Other taxa are cited because of the prevailing use of their leaves (especially the basal rosettes), which were eaten raw, but also sometimes cooked: *Cichorium intybus*, *Eruca vesicaria*, *Lactuca* spp., *Nasturtium officinale*, *Papaver rhoeas/dubium*, *Sanguisorba minor*, *Sonchus oleraceus* and *Taraxacum officinale*.

Of four wild plants, the young leaves, shoots and stems (raw, cooked and sometimes even pickled or stored in vinegar) were consumed: *Bryonia dioica*, *Convolvulus arvensis*, *Humulus lupulus* and *Portulaca oleracea*.

The aromatic leaves and green parts of some taxa were instead appreciated as flavourings: *Melissa officinalis*, *Mentha* spp., *Origanum* spp., *Ruta graveolens*, *Salvia officinalis*, *Satureja hortensis* and *Thymus* spp.

Of some plants mainly the roots were consumed, mostly cooked, but raw at times because of their aroma: *Brassica rapa*, *Daucus carota*, *Pastinaca sativa* and *Raphanus raphanistrum*.

The flowers and fruits of *Carthamus* spp. could be used as food colouring (as also *Amaranthus* spp. fruits) and to make oil (as also *Brassica* spp. seeds).

It is clear that many of these species, particularly the cultivated/cultivable ones, might be ascribed to the vegetables/spices category. In this regard, taking Apicius' work as a reference (it mentions about 60% of all the plant taxa named in this synthesis), particularly for the aromatic plants s.l. group there is a good correspondence between those most cited in *De re coquinaria* (see André 2017) and those found most frequently in the A sites. In the vegetables/spices category *Apium*, *Coriandrum*, *Anethum* and *Foeniculum* are among the most frequent plants, both in archaeobotanical records (as they occur in the NW provinces of the Empire; Livarda and van der Veen 2008) and in written sources; among the other food plants, the most common are *Mentha* spp., *Satureja hortensis* and *Origanum* spp. In addition, all these taxa are also present in the B sites, thus confirming their importance in ritual matters too.

Roman period food plants in Northern Italy: markers of change or tradition

In Italy there are signs of novelty in culinary ingredients and diet since the Etruscan epoch (Sassatelli 2003), but only for the Roman period is there abundant concrete evidence of a real "food revolution" and of particular attention to the associated practices (Dupont 2003). In the Roman world, the variety of food and ways of preparation are sometimes strongly linked to the consumer's position in the social hierarchy (Corbier 2003).

Both Strabo and Polybios recounted that already in the Republican period Cisalpine Gaul showed great economic prosperity, and they described its demographic exuberance, the wealth of its towns and the vitality of certain production sectors. Agriculture flourished because of the fertile terrain, producing abundant (and therefore cheaply priced) cereals and grapes, mostly for local consumption. The production of vegetable foodstuffs was accompanied by the breeding—at times very intensive—of various animals, mostly pigs, sheep and goats (Mansuelli 1962; Brizzi 2000; Malnati and Manzelli 2015).

Archaeobotanical data confirm diverse elements reported by written sources concerning Northern Italy. More detailed information may be obtained by focusing on the chronological sequence, when site dating allows it (Figs. 7 and 8; Table ESM 6).

The "Romanization" of Northern Italy (3rd to 1st century BC)

The "Romanization" of Northern Italy is composed of a variegated mosaic of diverse situations: colonies founded *ex novo* (e.g. Cremona, Modena, Parma), confederated zones that were gradually incorporated into the Roman domain (e.g. Brescia) and areas that, in this initial phase, remained marginal (Curina et al. 2015).

When urbanized in a colony, small fields of crops were often substituted for by gardens, where ornamental and useful plants were grown together since Republican times (e.g. site 1A—Guandalini and Benassi 2017; Mazzanti et al. 2017).

Cereals were widespread and diversified, thus indicating that agriculture was well developed (see e.g. site 30A). Overall, the major cereals (wheats and barley), but also the millets, were frequent (Fig. 7). Site 65A (Friuli Venezia-Giulia) is particularly worthy of attention, because here was discovered a certain quantity of remains of cultivated oat, a species not greatly appreciated by Romans (Dalby 2003). Its use here was probably associated with pre-existing traditions. Pliny, who considered *Avena* to be a "degeneration" (*vitium*) of *Triticum*, recounts that Germanic populations cultivated it and generally consumed it as a gruel (*pulte*; *NH 18, 149–150*). Cultivated as fodder or for the grain, *Avena* could be used in animal feed (André 2009), but at site 65A there is no evidence of breeding.

Among the pulses, *Vicia faba* was already widespread and at times abundant; it declined only in Late Antiquity. Of the others, only *Lens* is fairly common in all the four periods (Fig. 7).

The nearly ubiquitous presence of various fruits, mostly cultivated, since the beginning is typical of Roman sites in Northern Italy, and overall represents a novelty, with certain aspects of continuity and change with respect to preceding periods. For instance, the remains of *Cornus mas*, which are already frequent in the Neolithic (Rottoli and Castiglioni 2009a) and abundant in the Bronze Age (e.g. Mercuri et al. 2006; Rottoli and Castiglioni 2009b), seem to be a possible link with past practices (24% of the A, 7% of the B sites). In site 32A, in a productive area, there are more than 1,500 endocarps/3.5 l (Castiglioni and Rottoli 2018), that can be interpreted as waste from the preparation of e.g. a syrup or fermented beverage, which was probably part of the tradition of populations present in the area before the foundation of the Roman colony, given also the scarcity of information about this taxon in Roman sources (Dalby 2003). However, Columella writes that cornels and wild plums were preserved and consumed as were olives (some endocarps of which were found together with cornels in site 32A), with vinegar, cooked wine or *sapa* and salt (*XII, 10.2*).

In the passage from this phase to the next, we start to find mulberry—that seems to have been known to Varro, and was thus perhaps known to the Romans from the first century BC onwards (André 2009)—almond, cultivated sorb and jujube.

An important change, which had already began during the Iron Age (Rottoli et al. 2016) but increased from the early Roman period, is marked by the widespread finds of grape (about 70% and 60% in the A and B sites respectively), often indicated (e.g. Bosi and Marchesini 2017) by pollen percentages compatible with *in loco* cultivation (sensu Turner and Brown 2004). From the beginning there are also remains of olives, which were distributed throughout the various regions: they were perhaps partly imported produce and partly cultivated in areas where the climate was most suitable.

This first chronological phase also includes the cult locations considered here (B sites, 40 to 44). Site 40B, which is probably a votive deposit in a zone with abundant surface water, contains many remains of *Fragaria*, *Ficus*, *Vitis* and *Papaver*. Both the archaeological and archaeobotanical evidence suggest that the site may have been used for rituals that perhaps linked the Celtic populations already present in the area with the first Roman settlers, who built the most important temple of their new settlement next to it (Bosi et al. 2011a; Marini Calvani 2012). The mericarps of *Coriandrum*, considered a marker of the northward spread of Roman occupation (Livarda and van der Veen 2008), may here represent the transition between the two cultures that met in this religious place.

Pax Augusti and the government of the region (1st to 2nd century AD)

In this phase, the greatest effort was made to introduce Roman practice and customs into the territory. This is clearly visible in Emilia, where interventions and actions were particularly frequent and invasive, especially during Imperial times (Roncaglia 2018). The archaeobotanical remains also point to an increased abundance of the resources available in the various zones, testifying to a phase of peace and well-being.

The presence of *Hordeum* and *Triticum* is still high, whereas minor cereals (especially *P. miliaceum*) that were abundant in the Iron Age (Rottoli et al. 2016) and during the "Romanization" phase, underwent a severe reduction (Fig. 7). Pulses were also diversified, but, as in the preceding phase, always remained less important than cereals.

Fruit was still a major dietary item, indeed more so due to the presence of several new taxa, some exclusive to this period. *Prunus persica* appeared during the 1st half of the 1st century AD, probably passing through the Balkans up to Aquileia (Sadori et al. 2009), and becomes a quite constant feature in northern Italian sites. Cherries are also found from this phase onwards, but are always infrequent (Fig. 8). Ten fruit taxa are only found in this phase: all

the Cucurbitaceae (*Cucumis melo*, *C. sativus*, *Citrullus lanatus* and *Lagenaria siceraria*), *Diospyros lotus*, pine nuts (of *P. pinea* and *P. cembra*), *Punica granatum* and *Ziziphus jujuba* (Fig. 8).

All these species (apart from *C. sativus*) appear together in site 4A (for further details see Bosi et al. 2017a), that proved to be extremely rich in interesting finds. It yielded unique remains, such as those of luxury foods: *Diospyros lotus* (first and only remains in a European site, Bosi et al. 2017c), *C. lanatus* and *P. cembra* nuts, all of them considered to be imported products (Bosi et al. 2017a). *Punica granatum* and *Phoenix dactylifera* may also be considered further traces of luxury foodstuffs, especially in domestic contexts. *Punica granatum* appears only in two A sites (4A and 67A) and is confirmed in three B sites belonging to the same chronological phase. Dates are present in two other A sites (7A and 35A) and are very common as funerary offerings (more than 1/3 of the B sites) from the 1st century AD onwards. In the case of site 7A, it may be thought that the presence of the dates is due to the funeral rites carried out in the nearby necropolis (29B); but for site 35A, a probably aristocratic *domus* (Castiglioni and Rottoli 2017b), it is a clear sign of luxury food.

Between the Imperial and late Roman phases, certain fruits like *Cydonia oblonga* and *Prunus armeniaca* appear (site 67A, Rottoli 2018); they reappear in the Middle Ages (Bandini Mazzanti and Bosi 2006; Bosi et al. 2009 and unpublished data).

Fruit for the Romans had to play an important role; in the 1st century BC, Varro describes Italy as a lush orchard (R.R. 1, 2, 6). Moreover, the dinner (*cena*) ended often with fruits (*pomum*), both fresh and processed, which were considered the most civilized foods (Dupont 2003).

In the Roman period of Northern Italy, fruit, which was increasing both in variety and quantity of archaeobotanical remains, appears to be one of the most important elements to highlight a change from the past. Even in the transalpine regions the findings of "new" fruits, cultivated or even imported, mark the Roman advance and the occupation of new territories (Bakels and Jacomet 2003; van der Veen et al. 2008; Livarda 2017), as a continuation of a process begun in Northern Italy (Table 1).

Fruit (as already demonstrated by Rottoli and Castiglioni 2011) is also the characteristic element in the B sites that contain the greatest amount of evidence in the Imperial epoch. The “food of the dead” provides further confirmation of the “Romanization” of the territory, also because of the varied types present. The rituals related to funerary practices diffused among the middle-high classes came also to be used by the freedmen, whose tombs display abundant evidence of these rites (Rüpke 2018).

The floods and climate change of the Late Roman period (3rd to 4th century AD)

From the 3rd century AD onwards, several flooding events affected Northern Italy, particularly the Po Plain in Emilia-Romagna, Lombardia, Veneto and Piemonte (Bosi et al. 2019). These episodes were accompanied by a general cooling of the climate and political disorders, which led to the end of the Roman Empire (Roncaglia 2018). In this phase, the plain territory, even though troubled by natural events, did not lose its organisation, but was in part reduced by the increase of wetlands (Bosi et al. 2019).

From then on, *T. monococcum* seems to have been less widespread and the presence of *Secale* became quantitatively more important (site 28A, Motella de Carlo 1996; and in the subsequent period 46A, Rottoli and Castiglioni 2015) especially on the plain, whereas in the mountains it arrived later (Castiglioni and Rottoli 2015). *Secale*, particularly appreciated in north-eastern Europe for its tolerance to rigid winters and poor soils (Zohary et al. 2012), could be substitute for *Triticum* for bread-making. This occurrence was probably due to the major presence in Northern Italy in this period of foreigners who used this more rustic cereal: Pliny writes that the Taurini, a population of Celtic origin who lived at the foot of the Alps, consumed this “bad cereal, which is good only for keeping hunger away” (*NH, 18, 141*).

Castanea remains appear in A sites between the end of the preceding phase (site 27A) and the beginning of the Late Roman period (site 29A); during the Imperial era they were limited solely to the B sites (9B, 2B and 8B). In this phase, an increased interest in *Castanea* and its cultivation can also be deduced from palynological studies (e.g. Bosi et al. 2019).

With regard to the B sites, in this phase the evidence of plant foods in funerary contexts drastically diminishes: for instance, in the site 29B 4th to 5th century AD inhumation burials there are only charred *P. perica* endocarps (Rinaldi et al. 2017). Given the increasing number of inhumations, certain practices were greatly reduced, although the traces of pagan rituals are still clearly recognizable (Ortalli 2017).

The Late Antiquity autarchy (5th to 6th century AD)

From the 5th century AD, Ravenna, an important town in Northern Italy, became crucially important to emperors; when at the end of the century the Western Roman Empire collapsed, Ravenna could maintain its primacy because of the new Gothic kings of post-Roman Italy. However, throughout Northern Italy the system constructed in the Roman epoch was adapted and maintained in function during Late Antiquity and the Early Middle Ages; the histories of the Roman centres thus helped to create their new civic identities (Roncaglia 2018).

Table 1 Selected fruit taxa in Roman period: comparison between Northern Italy and transalpine regions

Reference	This paper	A, B	A	B
Area	Northern Italy	Central Europe & Britain	Central Europe	Britain
No. sites	114	694		
Chronology (century)	3rd BC—6th AD	mid 1st BC—end 4th AD		
Castanea sativa	X	*		int
Citrullus lanatus	*			
Cucumis melo	*	*	imp	
Cucumis sativus	*	*		int
Cydonia oblonga	*	**		
Dyospyros lotus	*			
Ficus carica	X	*	imp	int
Juglans regia	X	*	c	int
Lagenaria siceraria	(X)	*	imp	
Malus cf. *domestica*	X	*	c	int (n)
Mespilus germanica		**		
Morus nigra	*	*		int
Olea europaea	X	*	imp	int
Phoenix dactylifera	*	*	imp	int
Pinus cembra	X			
Pinus pinea	(X)	*	imp	int
Pistacia vera		*	imp	
Prunus avium/cerasus	X	*	c	int (n)
Prunus cerasifera	*	*		int
Prunus armeniaca	*	**		
Prunus dulcis	*	*	imp	int
Prunus domestica/insititia	X	*	c	int
Prunus persica	*	*	c	int
Punica granatum	*	*	imp	int
Pyrus cf. *communis*	X	*	c	int
Sorbus domestica	*			
Vitis vinifera	X	*	c	int
Ziziphus jujuba	*			
Ziziphus cf. *lotus*	*			

X archaeobotanical evidence already present before the Roman Period in examined areas (in brackets—still uncertain)

A for Central Europe (Bakels and Jacomet 2003), *imp* imported, *c* cultivated/cultivable

B for Britain (van der Veen et al. 2008), *int* introduced, *n* wild form, native

*First archaeobotanical evidence in examined areas

**Introduced in Roman Provinces beyond the Alps (Livarda 2017)

With regard to food plant remains, along with the persistant dominance of the naked *Triticum* spp. and the importance of *Secale*, among the cereals the millets (especially *Setaria*) acquired a certain importance in some contexts (Fig. 7). In three sites only, situated in Veneto and Lombardy, for the first time *Sorghum* appeared, but seems to have been a merely occasional presence, as it was also in the Middle Ages (Castiglioni and Rottoli 2013).

Vicia faba, previously very common, became rare in the A sites, as had already happened during the previous phase in the B sites. Thus its marked popularity in Northern Italy seems to diminish, although *V. faba* is found again during the Middle Ages (Bosi et al. 2016), a period for which large-seeded remains of this taxon have so far never been found. *Pisum sativum* became important, accompanying *Lens culinaris* and *V. sativa* (Fig. 7).

Among the fruit, *Castanea* is worthy of note; in site 46A an intact *olla* was found containing a large quantity of naked *Triticum* spp. and *Secale* (80% and 20% respectively), and a considerable number of chestnuts (Fig. 11). It has been hypothesized that it may have been a mixture ready to be ground to make bread (Castiglioni and Rottoli

Fig. 11 *Olla* (ca. 25 cm high; capacity ca. 10 l) found in site 46 A with cereals and chestnuts (photograph by LANDE srl)

2015). In addition, in the Alpine foothills between Como and Brescia, finds of *Castanea* charcoal become more and more frequent between the preceding chronological phase and the present one; at the same time, finds of *Quercus* charcoal diminish. We can speculate that *Castanea* woods replaced those of *Quercus*, first in the plain then in the hills; initially, *Castanea* served mostly to provide timber for agricultural purposes (Castiglioni and Rottoli 2017a). The consolidation of *Castanea* as a fruit tree took place a little later and reached its peak in the Early Middle Ages, when written sources also recount that it was cultivated on the Po Plain (Squatriti 2013).

Conclusions

The "Romanization" of Northern Italy was conducted in many different ways, depending on the situations (political and social) of the different areas and other features; a sort of uniformity can be seen only from the Imperial period onwards due to Augustus. These conditions are also reflected by archaeobotanical data linked to food plants.

The total number of sites considered in this synthesis is more than 100, and, apart from burial grounds, they are of various types. Most of the sites have structures devoted to collecting waste: for this reason, it was possible to obtain much more information about the consumption of plant foods than agricultural production in Northern Italy during the Roman period.

The enormous quantity of data collected yields a valuable general picture that can be divided into a series of phases spanning nearly nine centuries of history. During this time, with some exceptions, a substantial continuity in the consumption of cereals (especially the major ones) and pulses can be observed. Compared to the pre-Roman epoch, the new introductions are a certain variety of kitchen garden/aromatic species and fruit s.l. in general, mostly cultivated or even imported, that mark a discontinuity in diversity and quantity especially from Imperial times onwards. The great variety of fruit, here highlighted for the first time, was a quite widespread characteristic during the Middle Ages in Northern Italy (Bosi et al. 2016).

This summary may serve as a basis for some interesting developments and insights on various topics. For example, aDNA analyses may be performed on remains of particularly interesting taxa, as has been already done for some grape pips from the deposits of Modena. It was possible to compare the results obtained from two sites of *Mutina* with a series of modern varieties. In both cases, the remains are genetically more similar to western European vines than to eastern ones, and they all are of white grape. In one case, a notable genetic similarity with the Colombard cultivar was discovered, while in another a certain proximity to Riesling and Gewürtztraminer vines was found (Wales et al. 2016). This kind of investigation can produce information with levels of detail nearly unthinkable some decades ago, yielding very precise data not deducible from written or iconographic sources concerning plant cultivation and consumption.

Acknowledgements Thanks to those who have worked with us: archaeologists, other archaeobotanists and students. Thanks to Fabrizio Buldrini and Jim Bishop for help with the English language.

References

Accorsi CA, Bandini Mazzanti M, Mercuri AM, Trevisan Grandi G, Farello P, Pellegrini S (1999) Archeologia e paesaggio. Indagini archeologiche, botaniche e zoologiche integrate applicate ai sondaggi geognostici in un settore urbano di Mutina. In: Quilici Gigli S (ed) La forma della città e del territorio. Seconda Università di Napoli, Roma, pp 157–186

André J (2009) L'alimentation et la cuisine à Rome, 2nd edn. Les Belles Lettres, Paris

André J (2010) Le Noms des Plantes dans la Rome antique. Les Belles Lettres, Paris

André J (ed) (2017) Apicius. L'art culinaire, Les Belles Lettres, Paris

APG (2018) https://www.mobot.org/MOBOT/research/APweb/ (version 14)

Bakels C, Jacomet S (2003) Access to luxury foods in Central Europe during the Roman period: the archaeobotanical evidence. World Archaeol 34:542–557

Bandini Mazzanti M, Bosi G (2006) La frutta sulle tavole medievali/rinascimentali emiliane: testimonianze carpologiche nei siti archeologici. Informatore Botanico Italiano 38:25–32

Bandini Mazzanti M, Mercuri AM, Bosi G, Marchesini M, Accorsi CA (2001) "The archaeobotanical archive: plants used by man (which, where, how, when?)". What fruits did Romans eat in Emilia Romagna (Northern Italy)? Some responses from seeds and fruits. In: Guarino A (ed) Science and Technology for the safeguard of Cultural Heritage in the Mediterranean Basin, vol I. Alcalà, CNR, pp 318–324

Bandini Mazzanti M, Marchesini M, Bosi G (2014) I romani in Italia settentrionale. In: Kustatscher E, Roghi G, Bertini A, Miola A (eds) La storia delle piante fossili in Italia. Museo Scienze Naturali Alto Adige, Bolzano, pp 366–367

Bosi G, Mercuri AM, Guarnieri C, Bandini Mazzanti M (2009) Luxury food and ornamental plants at the 15th century AD Renaissance court of the Este family (Ferrara, Northern Italy). Veget Hist Archaeobot 18:389–402

Bosi G, Bandini Mazzanti M, Florenzano A et al (2011a) Seeds/fruits, pollen and parasite remains as evidence of site function: Piazza Garibaldi—Parma (N Italy) in Roman and Mediaeval times. J Archaeol Sci 38:1,621–1,633

Bosi G, Rinaldi R, Bandini Mazzanti M (2011b) Flax and weld: archaeobotanical records from *Mutina* (Emilia Romagna, Northern Italy), dated to the Imperial Age, first half 1st century AD. Veget Hist Archaeobot 20:543–548

Bosi G, Benatti A, Rinaldi R et al (2015a) The memory of water: archaeobotanical evidence of wetland plants from Modena (Emilia-Romagna, Northern Italy) and palaeoecological remarks. Plant Biosys 149:144–153

Bosi G, Mercuri AM, Bandini Mazzanti M et al (2015b) The evolution of Roman urban environments through the archaeobotanical remains in Modena—Northern Italy. J Archaeol Sci 53:19–31

Bosi G, Rottoli M, Castiglioni E, Bandini Mazzanti M (2016) Archaeobotanical evidences of food plants in Northern Italy during the Medieval and Renaissance periods. In: Abstracts book 17th IWGP-Conference Paris, pp 47–48

Bosi G, Marchesini M (2017) Reperti archeobotanici di vite a Mutina. In: Malnati L, Pellegrini S, Piccinini F, Stefani C (eds) Mutina splendidissima. La città romana e la sua eredità. De Luca Editori d'Arte, Roma, pp 288–289

Bosi G, Bandini Mazzanti M, Montecchi MC, Torri P, Rinaldi R (2017a) The life of a Roman colony in Northern Italy: ethnobotanical information from archaeobotanical analysis. Quat Internat 460:135–156

Bosi G, Corti C, Pederzoli A (2017b) Circuiti commerciali e consumo alimentare a Mutina. In: Malnati L, Pellegrini S, Piccinini F, Stefani C (eds) Mutina splendidissima. La città romana e la sua eredità. De Luca Editori d'Arte, Roma, pp 312–323

Bosi G, Herchenbach M, Buldrini F, Rinaldi R, Bandini Mazzanti M (2017c) On the trail of date-plum (*Diospyros lotus* L.) in Italy and its first archaeobotanical evidence. Econ Bot 71:133–146

Bosi G, Rinaldi R, Mazzanti M (2017d) L'alimentazione vegetale: reperti archeobotanici. In: Malnati L, Pellegrini S, Piccinini F, Stefani C (eds) Mutina splendidissima. La città romana e la sua eredità. De Luca Editori d'Arte, Roma, pp 329–331

Bosi G, Riso FM, Rinaldi R, Marchesini M (2017e) Le offerte vegetali nei contesti funerari. In: Malnati L, Pellegrini S, Piccinini F, Stefani C (eds) Mutina splendidissima. La città romana e la sua eredità. De Luca Editori d'Arte, Roma, pp 182–185

Bosi G, Labate D, Rinaldi R et al (2019) A survey of the Late Roman period (3rd–6th century AD): pollen, NPPs and seeds/fruits for reconstructing environmental and cultural changes after the floods in Northern Italy. Quat Int 499:3–23

Bouby L, Marinval P (2004) Fruits and seeds from Roman cremations in Limagne (Massif Central) and the spatial variability of plant offerings in France. J Archaeol Sci 31:77–86

BRAIN (2019) brainplants.successoterra.net

Brizzi G (2000) Le fonti scritte. In: Marini Calvani M (ed) Æmilia. La cultura romana in Emilia Romagna dal II secolo a.C. all'età costantiniana, Marsilio, Venezia, pp 19–24

Castiglioni E, Rottoli M (2013) Broomcorn millet, foxtail millet and sorghum in North Italian Early Medieval sites. Eur J PCA 3:131–144

Castiglioni E, Rottoli M (2015) Coltivazioni ed uso del legno in Valtellina dalla protostoria all'età moderna: i dati archeobotanici di Sondrio, Teglio e Bormio. Analisi archeobotaniche: schede. In: Mariotti V (ed) La Valtellina nei secoli: studi e ricerche archeologiche, vol. 2. Ricerche e materiali archeologici. SAP, Mantova, pp 909–920

Castiglioni E, Cottini M (2016) I carboni di legna, i semi e i frutti per una ricostruzione del paesaggio e delle coltivazioni. In: Gaino M, Rossignoli C, Tuzzato S (eds) Archeologia, Storia e Idraulica. L'area del bacino di laminazione a Caldogno, SAP, Mantova, pp 45–48

Castiglioni E, Rottoli M (2017a) Brescian archaeobotanical studies, Romanization to Early Medivial periods. Europ J PCA 8:91–116

Castiglioni E, Rottoli M (2017b) La frutta e i semi. In: Arslan Pitcher L (ed) *Amoenissimis… Aedificiis*. Gli scavi di Piazza Marconi a Cremona, vol. 1. Lo scavo, Studi e Ricerche di Archeologia 4. SAP, Mantova, pp 121–122

Castiglioni E, Rottoli M (2018) Materiali botanici. In: Arslan Pitcher L (ed) *Amoenissimis… Aedificiis*. Gli scavi di Piazza Marconi a Cremona, vol. 2. I materiali, Studi e Ricerche di Archeologia 5. SAP, Mantova, pp 495–502

Castiglioni E, Fanetti D, Rottoli M (2014) Uno strano frumento coltivato a Brescia. In: Rossi F (ed) Un luogo per gli dei. L'area del Capitolium a Brescia. All'Insegna del Giglio, Firenze, pp 187–188

Cato (*Marcus Porcius Cato*), 2nd cent. BC. L'agricoltura (*De agricoltura*). Mondadori, Milano (2000—translate: L. Canali, E. Lelli).

Columella (*Lucius Iunius Moderatus*), 1st cent. AD. L'arte dell'agricoltura (*De re rustica*). Einaudi, Torino (1977-translate: R. Calzecchi Onesti).

Corbier M (2003) La fava e la murena: gerarchie sociali dei cibi a Roma. In: Flandrin JL, Montanari M (eds) Storia dell'alimentazione. Laterza, Bari, pp 161–177

Cremaschi M, Storchi P (2015) L'area centro padana tra il IV e il III secolo a.C.; aspetti geomorfologici e impatto antropico. In: Malnati L, Manzelli V (eds) Brixia. Roma e le genti del Po. Giunti, Firenze, pp 284–285

Cresci Marrone G (2015) Il quadro storico e le istituzioni. In: Malnati L, Manzelli V (eds) Brixia. Roma e le genti del Po, Giunti, Firenze, pp 56–58

Curina R, Malnati L, Manzelli V, Rossi F, Spagnolo Garzoli G, Tirelli M (2015) La Cisalpina tra III e I secolo a.C. alla luce dell'archeologia. In: Malnati L, Manzelli V (eds) Brixia. Roma e le genti del Po. Giunti, Firenze, pp 42–54

Dalby A (2003) Food in the Ancient World from A to Z. Routledge, London

David JM (2002) La romanizzazione dell'Italia. Laterza, Bari

Dupont F (2003) Grammatica dell'alimentazione e dei pasti romani. In: Flandrin JL, Montanari M (eds) Storia dell'alimentazione. Laterza, Bari, pp 145–160

Forni G (1995) Le colture agrarie padane e la loro produttività all'epoca della romanizzazione. Rivista Archeologica dell'Antica Provincia e Diocesi di Como 176:17–82

Fortunati M, Malnati L (2015) L'organizzazione del territorio: fattorie e villaggi al servizio di un'economia agricola. In: Malnati L, Manzelli V (eds) Brixia. Roma e le genti del Po, Giunti, Firenze, pp 288–289

Gabba E (1985) Per un'interpretazione storica della centuriazione romana. Athenaeum 63:265–284

Gervasini L (2005) Noccioli d'olivo. Il *torcularium* della villa romana del Varignano Vecchio. In: Bulgarelli F (ed) Cibi e sapori nell'Italia antica. Per un'archeologia del cibo. Produzione, consumo, abitudini alimentari, pratiche cultuali e offerte nella Liguria antica. Soprintendenza Beni Archeologici Liguria, Genova, pp 17–18

Ghiroldi A (1995–1997) Padenghe sul Garda (BS), loc. S. Emiliano. Controllo lavori della deviante del centro abitato. Notiziario della Soprintendenza Archeologica della Lombardia:111–113

Guandalini F, Benassi F (2017) La domus di via Università (ex Cinema Capitol). In: Malnati L, Pellegrini S, Piccinini F, Stefani C (eds) Mutina splendidissima. La città romana e la sua eredità. De Luca Editori d'Arte, Roma, pp 102–109

Holzhauser H, Magny M, Zumbühl HJ (2005) Glacier and lake-level variations in west-central Europe over the last 3500 years. Holocene 15:789–801

Jalut G, Dedoubat JJ, Foutugne M, Otto T (2009) Holocene circum-Mediterranean vegetation changes: climate forcing and human impact. Quat Internat 200:4–18

Jones G, Valamoti S, Charles M (2000) Early crop diversity: a ''new'' glume wheat from northern Greece. Veget Hist Archaeobot 9:133–146

Livarda A (2017) Tastes in the Roman provinces: an archaeobotanical approach to socio-cultural change. In: Rudolph KC (ed) Taste and the ancient senses. Routledge, London, pp 179–196

Livarda A, van der Veen M (2008) Social access and dispersal of condiments in North-West Europe from the Roman to the medieval period. Veg Hist Archaeobot 17:S201–S209

Magny M (2004) Holocene climate variability as reflected by mid-European lake-level fluctuations and its probable impact on prehistoric human settlements. Quat Int 113:65–79

Malnati L, Manzelli V (2015) Economia ed attività produttive. In: Malnati L, Manzelli V (eds) Brixia. Roma e le genti del Po, Giunti, Firenze, pp 290–291

Mansuelli GA (1962) I Cisalpini (III sec. a.C.—III sec. d.C.). Sansoni, Firenze

Marchesini M (1998) Il paesaggio vegetale nella pianura bolognese in età romana sulla base di analisi archeopalinologiche e archeocarpologiche. Doctoral Dissertation, University of Florence

Marchesini M, Marvelli S (2009) Ricostruzione del paesaggio vegetale e antropico nelle aree centuriate dell'Emilia Romagna attraverso le indagini archeobotaniche. Agri Centuriati 6:313–323

Marini Calvani M (2012) La palude (Fase 0). In: Marini Calvani M (ed) Ventidue secoli a Parma. Lo scavo sotto la sede centrale della Cassa di Risparmio in piazza Garibaldi. BAR Internat Ser 2406:22–23

Matterne V, Derreumaux M (2008) A Franco-Italian investigation of funerary rituals in the Roman world "Les rites et la mort à Pompéi" the plant part: a preliminary report. Veg Hist Archaeobot 17:105–112

Mazzanti M, Bosi G, Torri P, Mercuri AM, Marchesini M, Montecchi MC, Rinaldi R (2017) L'ambiente vegetale a Mutina dal periodo repubblicano al tardo romano. In: Malnati L, Pellegrini S, Piccinini F, Stefani C (eds) Mutina splendidissima. La città romana e la sua eredità. De Luca Editori d'Arte, Roma, pp 20–24

McCormick M, Büntgen U, Cane MA et al (2012) Climate change during and after the Roman Empire: reconstructing the past from scientific and historical evidence. J Interdiscip Hist 43:169–220

Mercuri AM, Accorsi CA, Bandini Mazzanti MG et al (2006) Economy and environment of Bronze Age settlements—Terramaras—in the Po Plain (Northern Italy): first results of the archaeobotanical research at the Terramara di Montale. Veg Hist Archaeobot 16:43–60

Mercuri AM, Allevato E, Arobba D et al (2015) Pollen and macroremains from Holocene archaeological sites: a dataset for the understanding of the bio-cultural diversity of the Italian landscape. Rev Palaeobot Palynol 218:250–266

Motella De Carlo S (1996) Sui cereali nel contesto agroforestale subalpino dei secoli II-XIII: nuovi dati dalle ricerche di Peveragno-Castelvecchio e di Cherasco-Manzano. In: Comba R (ed) Montagne e pianure. Atti del Convegno, Rocca de' Baldi, Cuneo

Ortalli J (2017) Gli spazi funerari di Mutina: topografia, architettura, ritualità. In: Malnati L, Pellegrini S, Piccinini F, Stefani C (eds) Mutina splendidissima. La città romana e la sua eredità. De Luca Editori d'Arte, Roma, pp 166–172

Pasquinucci M (1993) Il territorio modenese e la centuriazione. In: Settis S, Pasquinucci M (eds) Misurare la terra: centuriazione e coloni nel mondo romano. Il caso modenese, Franco Cosimo Panini, Modena, pp 31–59

Pliny (*Plinius Secundus*), 1st cent. AD. Storia Naturale (*Historia naturalis*), III. Einaudi, Torino (1984, translation: F. Lechi)

Pignatti S, Guarino R, La Rosa M (2017–2019) Flora d'Italia (2nd ed). Edagricole, Bologna

Prance G, Nesbitt M (eds) (2005) The cultural history of Plants. Routledge, New York

Preiss S, Matterne V, Latron F (2005) An approach to funerary rituals in the Roman provinces: plant remains from a Gallo-Roman cemetery at Faulquemont (Moselle, France). Veg Hist Archaeobot 14:362–372

Rinaldi R, Bandini Mazzanti M, Bosi G (2013) Archaeobotany in the urban sites: the case of *Mutina*. Annali di Botanica 3:217–230

Rinaldi R, Bosi G, Bandini Mazzanti M (2017) Offerte vegetali nei contesti funerari. In: Labate D, Malnati L (eds) Parco Novi Sad di Modena: dallo scavo al parco archeologico. Quaderni di Archeologia dell'Emilia Romagna, 36. All'Insegna del Giglio, Firenze, pp 191–195

Robinson M (2002) Domestic burnt offerings and sacrificies at Roman and pre-Roman, Pompeii, Italy. Veg Hist Archaeobot 11:93–99

Roncaglia CE (2018) Northern Italy in the Roman World. Johns Hopkins University Press, Baltimore

Rottoli M (1996) I resti vegetali. In: Passi Pitcher L (ed) *Bedriacum*. Ricerche archeologiche a Calvatone, 1.2. Edizioni ET, Milano, pp 49–52

Rottoli M (1998) I resti botanici. In: Ghiroldi A (ed) Sirmione (BS) Via Antiche Mura 11. Villa romana. Soprintendenza Archeologica della Lombardia-Notiziario 1995–97:120–121

Rottoli M (2018) L'ambiente e l'agricoltura ad Aquileia: le indicazioni fornite dai macroresti botanici dello scavo. In: Maggi P, Maselli Scotti F, Pesavento Mattioli S, Zulini E (eds) Lo scavo di Canale Anfora (2004–2005). Materiali per Aquileia, Scavi di Aquileia IV. Editreg, Trieste, pp 41–51

Rottoli M, Castiglioni E (2009a) Prehistory of plant growing and collecting in Northern Italy based on seed remains from the early Neolithic to the Chalcolithic (c. 5600–2100 cal. BC). Veg Hist Archaeobot 18:91–103

Rottoli M, Castiglioni E (2009b) Indagini sui resti vegetali macroscopici. In: Bernabò Brea M, Cremaschi M (eds) Acqua e civiltà nelle terramare. La vasca votiva di Noceto, Skira, Milano, pp 152–163

Rottoli M, Castiglioni E (2011) Plant offerings from Roman cremations in Northern Italy: a review. Veget Hist Archaeobot 20:495–506

Rottoli M, Castiglioni E (2015) I semi e i frutti delle dispense. In: Grassi B, Miedico C (eds) Il profumo del pane e delle castagne. Dai semi di Cislago ai panini di Angera. Parte I: la villa rustica di Cislago, i resti organici e il paesaggio agro-alimentare in età romana. Lavrano Editore, Arona, pp 41–54

Rottoli M, Marchesini M (2015) L'impatto sul territorio: la trasformazione del paesaggio. In: Malnati L, Manzelli V (eds) Roma e le genti del Po. Giunti, Firenze, pp 286–287

Rottoli M, Fanetti D, Bosi G, Castiglioni E (2016) The agriculture in Northern Italy during the Iron Age: a review. In: Abstracts book 17th IWGP Conference, Paris, pp 66–67

Rüpke J (2018) Pantheon. Einaudi, Torino

Sadori L, Allevato E, Bosi G et al (2009) The introduction and diffusion of peach in ancient Italy. In: Morel JP, Mercuri AM (eds) Plants and culture: seeds of the cultural heritage of Europe. EdiPuglia, Bari, pp 45–61

Sassatelli G (2003) L'alimentazione degli Etruschi. In: Flandrin JL, Montanari M (eds) Storia dell'alimentazione. Laterza, Bari, pp 135–144

Schmidt G, Shindell DT, Miller RL, Mann ME, Rind D (2004) General circulation modelling of Holocene climate variability. Quat Sci Rev 23:2,167–2,181

Sena Chiesa G (2001) Introduzione. In: Verzár-Bass M (ed) Abitare in Cisalpina, I vol. Editreg, Trieste, pp 19–24

Squatriti P (2013) Landscape and Change in Early Medieval Italy. Chestnuts, Economy and Culture. Cambridge University Press, Cambridge

Stefani M, Vincenzi S (2005) The interplay of eustasy, climate and human activity in the late Quaternary depositional evolution and sedimentary architecture of the Po Delta system. Marine Geol 222(223):19–48

The Plant List (2018) https://www.theplantlist.org/

Torri P, Mazzanti M, Bosi G, Montecchi MC, Florenzano A, Rinaldi R (2017) Segnali di pascolo nei siti di Mutina. In: Malnati L, Pellegrini S, Piccinini F, Stefani C (eds) Mutina splendidissima. La città romana e la sua eredità. De Luca Editori d'Arte, Roma, pp 257–258

Turner SD, Brown AG (2004) *Vitis* pollen dispersal in and from organic vineyards I. Pollen trap and soil pollen data. Rev Palaeobot Palynol 129:117–132

Van der Veen M, Livarda A, Hill A (2008) New plant foods in Roman Britain: dispersal and social access. Environ Archaeol 13:11–36

Varro (*Marcus Terentius Varro*), 1st BC. Il fondo rustico (*De re rustica*). Editrice Torinese, Torino (1974—translate: A. Traglia)

Wales N, Ramos Madrigal J, Cappellini E et al (2016) The limits and potential of paleogenomic techniques for reconstructing grapevine domestication. J Archaeol Sci 72:57–70

Zohary D, Hopf M, Weiss E (2012) Domestication of plants in the old world, 4th edn. Oxford University Press, Oxford