Vegetation History and Archaeobotany (2018) 27:31–44
https://doi.org/10.1007/s00334-017-0638-7

ORIGINAL ARTICLE

Plant storage in Neolithic southeast Europe: synthesis of the archaeological and archaeobotanical evidence from Serbia

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Received: 3 December 2016 / Accepted: 11 September 2017 / Published online: 19 September 2017
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Abstract
This paper presents and evaluates the archaeobotanical and archaeological evidence of plant product storage from Early and Late Neolithic sites in Serbia, southeast Europe. The commonly stated and widely accepted archaeological evidence of storage in the region includes ceramic pots, clay bins and pits. However, as shown in our study, the archaeobotanical evidence does not always support the interpretation of these structures and objects as plant storage containers, as it is often of secondary origin and composed of discarded plant material such as by-products of plant use. On the other hand, the available botanical record points to some other possible ways of storing plant products, such as in perishable containers that do not normally survive archaeologically in this part of the world. Although limited, the combined evidence indicates variability in plant storage practices and solutions within the cultural phenomena associated with the Neolithic Starčevo and Vinča cultures of the region. For instance, plant storage in large clay pots was noted at some of the sites, and in clay bins at others. Also, different structures and features may have been used for storing crop products, whilst wild plants seem to have been kept in perishable and/or small ceramic containers. A further impression is that finds of the same plant (type) in different containers may reflect different stages in processing.

Keywords Neolithic · Serbia · Crop storage · Wild plant storage · Pots · Pits

Introduction

Storage of food is a key element in securing long-term nutrition, and the development and transformation of storage methods over time have had profound effects on the economy, residential pattern, social relations and demography (Flannery 1972, 2002; Testart 1982; Halstead 1989; Kuijt 2008). Archaeological investigations of prehistoric societies worldwide have identified a great diversity of plant food storage systems both in foraging/pre-domestication and in agricultural contexts (for example, Jones et al. 1986; Henriksen and Robinson 1996; Bouby et al. 2005; Bogaard et al. 2009; Kuijt and Finlayson 2009).

In the prehistoric central Balkans, a range of different features have been recognised in which plant products may have been stored for later and/or protracted use (Garašanin 1961; Hopf 1974; Medović 1988, 2011; Marinova 2007; Stojanova-Kanzurova and Rujak 2016; Urem-Kotsou 2017). The plant storage contexts have been identified mainly on the grounds of indirect evidence, for instance archaeological features such as subterranean structures and clay bins, and ceramic vessels, principally the large ones (Garašanin 1960; Jež 1985; Medović 1988; Jevtić 2011). The function of these contexts is often interpreted from analogies with ethnographically documented storage techniques and also through comparison with similar archaeological features found in association with (concentrations of) plant remains such as, for instance, the storage contexts at the Neolithic

Communicated by F. Toulemonde.

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00334-017-0638-7) contains supplementary material, which is available to authorized users.

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sites of Selevac in Serbia and Slatina in Bulgaria (Tringham and Stevanović 1990, pp. 58–62; Nikolov 1992, pp. 65–77).

Using published data, Tripković recently provided a comprehensive overview of the archaeological evidence of (plant) storage at Late Neolithic/Vinča culture sites in Serbia (2007, pp. 27–34, 2011). His list includes pits, clay bins and large pots, but also possible above-ground wooden granaries and perishable containers (Tripković 2011, Fig. 2). The affirmation that these features and objects were used for storing plant food rests again on their similarity with the ethnographic examples and, in several cases, the very scanty archaeobotanical information which was published at the time.

In this paper, we return to the records of (ethno)archaeologically determined types of Neolithic storage containers and, where possible, look at their archaeobotanical content. From the archaeobotanical point of view, we accept large, concentrated remains that are entirely composed of, or dominated by, one particular edible or otherwise useful plant resource, as a likely storage deposit (Cannon and Yang 2006, p. 125). Our aim is to explore if and how archaeological and archaeobotanical archives from Neolithic sites in Serbia inform each other in terms of identification of plant storage facilities, that is whether the two are compatible. We show that the archaeobotanical evidence does not always support the archaeological interpretation. The cases where the two datasets agree indicate diversity in Neolithic plant storage solutions across the study area.

Materials and methods

Table 1 provides the list of sites, that is, features and objects, for which archaeological and archaeobotanical information is available and which were thus considered in this study. Figure 1 indicates the locations of the sites. We summarise the criteria according to which different forms of archaeological record were previously interpreted as plant storage facilities, below. Also, the archaeobotanical approach, applied in order to evaluate the archaeological interpretations, is briefly outlined.

The parameters used by archaeologists in the identification of storage structures at Neolithic sites in Serbia normally include the type of structure; its shape, size, certain constructional elements and sometimes location (in relation to a house); presence of (specific) plant content, such as cereal grain; and, most prominently, analogies with ethnographic and/or other archaeological examples. In the case of ceramic vessels, it is generally the large ones (pithoi) for which storage function was taken as obvious, based on their size; the interpretation was justified using ethnographic examples and the finds in the region of large pots with preserved plant contents, as at the site of Slatina in Bulgaria (Nikolov 1992). The finds of smaller vessels such as bowls containing grain were described as possible evidence of the use of these objects for "scooping" grain from larger vessels prior to food preparation and/or as measuring pots (Tripković 2011, p. 164). Different types of built-in clay containers or bins were also recognised as having been used for storage, though it was acknowledged that they were not necessarily, or not only, used for storing plants; some of the bins discovered contained pots, loom weights, stone tools and even possible symbolic deposits such as a bull skull with horns (Todorović 1981; Bogdanović 1988). The size and number of storage pots and bins, as well as the locations in which they were encountered, indoor/outdoor, central/side room etc., were taken as potentially reflecting the economic, social and symbolic importance of storage (Tripković 2011; Spasić and Živanović 2015).

Storage function was also commonly associated with conical, bell or pear-shaped and cylindrical pits ("underground silos"), especially those characterised by a wall and floor finish in the form of a clay lining. For example, Minichreiter ascribes probable storage purpose to pits of >1 m in depth and up to c. 2 m in diameter, often cylindrical or kidney-shaped in vertical cross-section and detected at some Early Neolithic/Starčevo culture sites (2001, p. 202). The archaeological classification of pits as storage containers heavily relies on the parallels found in ethnographic sources on food storage solutions (Buttler 1936; Currid 1985; Sigaut 1988; Cunliffe 1992; Gronenborg 1997; Peña-Choccaro et al. 2015) and/or on observations from experimental studies (Reynolds 1974; Hill et al. 1983; Currid and Navon 1989). The similarities were seen particularly in the shape and size of subterranean storage facilities, and in the constructional elements and techniques such as the lining and sealing methods, and materials.

The archaeological accounts report only a few cases in which any direct evidence of storing plants in pits/bins/pots was available, in the form of large concentrations of cereal grain (overview in Tripković 2011). In other instances, the plant evidence may have been absent or minor, but it is also highly possible that it was not collected or (properly) recorded (Filipović and Obradović 2013). Added to this is the possibility that, even if these features or objects were used for plant storage, the contents may have been emptied in the past, or may have simply decayed away; as regards pits, they have often in the past been (re-)used for disposing of rubbish or for other purposes (Cunliffe 1992; Garrow 2015). This obscures the archaeological record and hence the interpretation of some of these structures as 'grain containers' may be problematic.

No other kind of study, such as micro-plant, micromorphological, or biochemical analysis (Kadowaki et al. 2015) has been conducted that would confirm or refute the

Table 1 List of sites and brief descriptions of the archaeological and archaeobotanical evidence considered in this study, and the conclusions (see text for references)

Period/ culture	Site	Location	Context/deposit interpreted as storage	Characteristics of the context	Recovery of plant material	Archaeobotanical content	Conclusion on plant storage
Early Neolithic / Starčevo culture (end of 7th – mid-6th mill. BC)	Nosa	Vojvodina, N Serbia	Outdoor pits	Clay-lined; cylindrical, 'askoid' or biconical shape; c. 0.60 m deep, up to 1 m wide at the base; some with earthen 'lids'	Hand-picked	Small amount of remains: millet grains, acorns and beechnuts; unconfirmed identification	Use of pits for plant storage not confirmed
	Ludoš-Budžak	Vojvodina, N Serbia	Outdoor pits	Clay-lined; variously shaped		Not reported	
	Badovinci	W Serbia	Large ceramic vessel in a pit			Large quantity of barley grain (unconfirmed)	Poorly recorded; not examined by specialist; inconclusive
	Drenovac	Central Serbia	In situ burnt seed concentration within a burnt house rubble	Found within a collapsed, burnt wattle and daub structure	Systematic sampling and flotation	Lentil (75%), pea (20%), einkorn and emmer grain+chaff and wild seeds/fruit (5%)	Decomposable containers (or clay/daub containers destroyed together with the structure)
Late Neolithic / Vinča culture (mid-6th – mid-5th mill. BC)	Vinča	N / central Serbia	Small ceramic bowl with burnt wheat grain	On floor of a burnt house, part of a cluster of various ceramic vessels	Hand-picked	"Different kinds of wheat" (Vasić 1936, p 171)	Small pot (intermittent / short-term storage)
			Two large ceramic pots containing grain	Burnt building (01/06), within house rubble (burnt remains of wattle and daub construction)	Systematic sampling and flotation	Large concentration of in situ burnt emmer grain	Large pots
			"Caches" of seeds			Smaller amounts of emmer grain	Perishable containers (pots or clay bins also possible)
						Quantities of flax/linseed and bitter vetch seeds	Perishable containers
				In rubble of some of the burnt buildings		Clusters of seed of gathered fruit (blackberry, wild strawberry)	Bags or similar perishable containers
			"Caches" of fruit	Burnt building (02/06), within house rubble		Wild pear fruit	Bags or small pots
			Large ceramic pot containing grain			Large concentration of in situ burnt (mostly) emmer grain	Large pots
	Medvednjak	N / central Serbia	Ceramic pots of various size and shape, containing grain	In burnt houses	Hand-collected	Mostly emmer grain	Small, medium-sized and large pots = short- and long-term storage ?
	Selevac	Central Serbia	In situ burnt grain conc. within two clay bins	In a burnt building	Sampling and flotation	Einkorn grain, a little lentil	Clay bins
			In situ burnt conc. of grain	In a burnt building, on floor or within the rubble		Einkorn grain, a little lentil	Perishable containers and/or ceramic vessels
	Banjica	N / central Serbia	In situ burnt conc. of grain	On house floor		Not examined by specialist	Decomposable container (suggested: " 'storage box' made of wood")
	Matejski Brod	Vojvodina, N Serbia	Conc. of "wheat" remains	In a house		Not examined by specialist	Perishable containers or ceramic vessels
	Valač	Kosovo	Conc. or clusters of plant remains	Layer on the floor of a burnt house	Hand collected	Cereals, wild pear fruit, Cornelian cherry fruit stones (pea, acorns)	Perishable containers or ceramic vessels

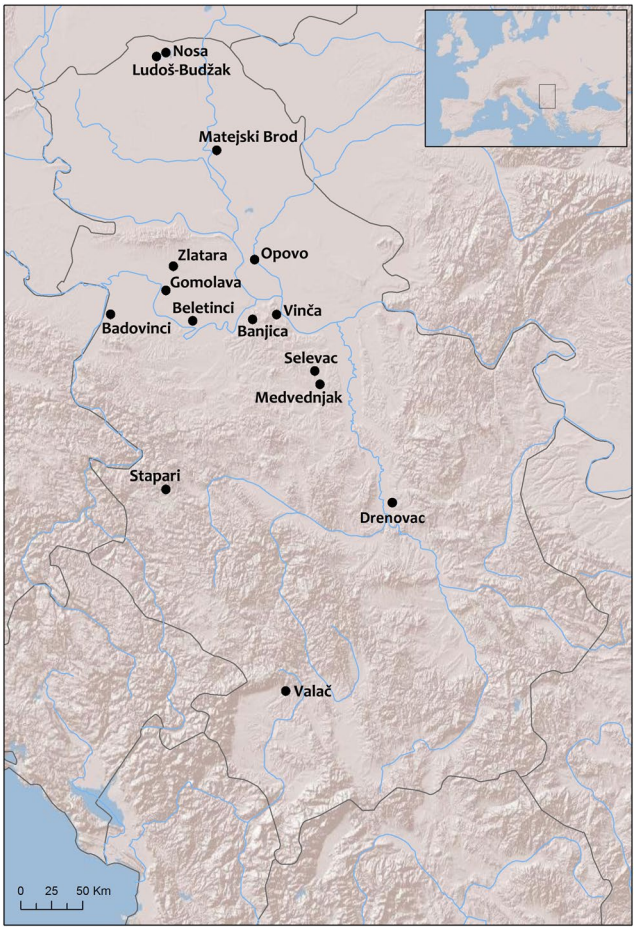

Fig. 1 Map of Serbia showing the locations of the sites considered in the study

proposed archaeological interpretation. Thus the only currently available direct evidence is in the form of archaeobotanical remains, but these exist only for a handful of sites. As is shown below, this evidence confirms plant storage purposes for some of the designated plant-keeping structures, whereas it questions this idea for the others. Where burnt concentrations dominated by a particular edible or otherwise useful plant resource, such as one or more cereal or pulse types, were discovered in close physical association with probable storage containers, they are taken as being consistent with the archaeological interpretation. "Loose" (unconfined) concentrations of botanical material are understood as being potentially indicative of storage in containers that did not survive because they were perhaps made of leather, plant fibres or other soft plant parts (stems, leaves), branches, cork, dung and/or similar materials recorded ethnographically (Ertuğ-Yaraş 1997; Peña-Choccaro and Zapata 2014; Smerdel 2014). There are also instances where loose concentrations may have derived from non-perishable containers that were destroyed when the buildings collapsed; or where perhaps wooden containers were used and subsequently reduced to charcoal fragments.

Results and discussion of the archaeological and archaeobotanical evidence of plant product storage

Early Neolithic

The appearance of elements of the "Neolithic package" of cultivated plants in most of the central Balkans is associated with the Early Neolithic Starčevo culture of c. 6200–5300 cal BC (Whittle et al. 2002). The culture is seen as epitomising the first adaptations of (incoming) farmers to the new environment and/or gradual adoption of a farming lifestyle by indigenous groups, as indicated by the apparently small-sized, ephemeral occupations and great economic reliance on wild resources, faunal ones in particular (Tringham 1971; Whittle 1996; Jongsma and Greenfield 2001; Greenfield and Jongsma 2008). At the vast majority of sites attributed to this culture in Serbia, the only surviving remains are scatters of characteristic pottery (Tasić 1997). A certain number of sites yielded remains of structures, in the form of variously shaped more or less subterranean spaces, or "pit-huts" (Bailey 2000, p. 41), sometimes furnished with compact clay or limestone floors, low dry stone and/or wattle walls, entry ramps, clay benches, fire installations, etc. (Aranđelović-Garašanin 1954; Vetnić 1974; Stanković 1991; Bogdanović 2004; Marić 2013; Borić 2014). Based on their differences in size, shape and internal features, the Starčevo pits were interpreted as living or working spaces, storage, borrow or rubbish pits, or ritual/burial areas (Stalio 1984; Minichreiter 2001; Bánffy 2013, p. 128; Greenfield et al. 2014). A few Starčevo sites contained preserved traces of surface structures, such as houses made of wattle and daub walls held in place by wooden posts (Bogdanović 1988; Leković 1995).

Information on plant remains is available only from a very small number of Starčevo culture sites in Serbia, because only from a few of these were archaeobotanical samples collected and analysed (Filipović and Obradović 2013, Table 1). For two sites it was reported that plant material derived from storage. As is presented and discussed below, the botanical record from one of these does not necessarily support the archaeological reading of the contexts, whereas at the other it opens up different possibilities.

"Underground silos" at Nosa through the lens of archaeobotanical remains

The site of Nosa, c. 5500 cal BC (Whittle et al. 2002, Table 1) is located near Ludoško jezero, a lake in Vojvodina, northern Serbia. In the excavations of the 1950s, remains of floors and parts of walls of two rectangular houses, about 6.5 m long and 3 m wide, were discovered here. Several, presumably indoor, hearths were also detected (Garašanin 1960, 1961). Furthermore, the site yielded over 50 large outdoor clay-lined pit features of cylindrical, "askoid" or bi-conical shape, about 0.6 m deep and up to 1 m wide at the base, although much smaller examples were also found, and some with earthen "lids" (ESM Fig. 1). They were interpreted as grain storage features or "silos". They were cut into the sandy subsoil and lined with 2–3 cm thick layers of yellowish-bluish lake marl which, over time, dried and became very hard. Thanks to this, the archaeologists could easily remove the soil from around the containers, leaving them free-standing, and they could remove some of them for conservation purposes. The similar, so-called "dried pottery", along with remains of surface-level structures, was also found at the site Ludoš-Budžak of about the same date, c. 5600/5500 cal BC (Whittle et al. 2002, Table 1) located on the lakeshore of Ludoško jezero opposite Nosa (Sekereš 1967). At Nosa, it was established that the pit features derived from different phases of site occupation, but it is not known approximately how many of them were in simultaneous use. Based on the location of the storage containers outside the houses, it was proposed that they were used for "communal", perhaps settlement-level, storage (Garašanin 1961).

The fills of the Nosa pits contained Starčevo-type potsherds which, according to the excavator, were deliberately placed there. There were also pottery fragments deposited by chance (unclear if also of Starčevo-type), animal bones and a small amount of charred plant material; the excavator reported the presence of grains of *Panicum miliaceum* (common millet), *Quercus* sp. (acorns) and *Fagus* sp. (beechnuts) (Garašanin 1960, p. 229, 1961, pp. 304–305), but this has not been archaeobotanically confirmed. As mentioned, the "silos" were not baked or heated, which is also indicated by their pale colour, and no traces of burning were reported in their interiors (Grbić 1959, p. 14; Garašanin 1960, 1961). Thus the charred plant remains must be of secondary origin; they may have derived from the identified fire installations. The mixed composition of the pit fill also suggests a secondary origin for at least some of its components. In conclusion, the charred botanical material within these features was not directly associated with them. Further, given that the site was used in the Early Eneolithic/Copper Age (Garašanin 1959), the pits might have been (partially) infilled after the end of the Neolithic occupation. The single so far available radiocarbon date for this site was obtained on an *Equus hydruntinus* (wild ass) radius for which the archaeological provenance is unknown (Whittle et al. 2002, p. 73). While the date confirms the Early Neolithic age for the site, it does not necessarily indicate the same age for the archaeobotanical remains; particularly questionable is the status of common millet (Motuzaite-Matuzeviciute et al. 2013).

The absence of archaeobotanical evidence, however, does not exclude the possibility that the pits at Nosa and, along the same line, those at Ludoš-Budžak were used for storing food, and it does not rule out their potential function as communal storage facilities. The "communal level" in this case may in fact be equated with the "household level" since, following the classification of Neolithic settlement types based on empirical data (Chapman 2008), Nosa could be considered as a single household community. If this was the case, it would be interesting to explore if and what kind of storage there was indoors. However, the published data for Nosa do not specify the contents of the identified surface-level structures or houses. With respect to the pits, without any direct evidence, for instance burnt agricultural products in situ, or a different kind of analysis such as of micro-plant remains or relevant biochemical components, the view that they were used for the storage of plant products is unsubstantiated.

Archaeobotanical indicators of the use of perishable containers at Drenovac

Some likely evidence of Early Neolithic storage of plant products comes from the site of Drenovac, where an in situ burnt seed concentration was discovered within a collapsed burnt wattle and daub structure (Perić and Obradović 2012; Obradović 2013). Drenovac is a c. 35 ha large Early to Late Neolithic site located in the Velika Morava valley in central Serbia (Perić et al. 2016). The cultural stratum is up to 6.5 m thick, with an Early Neolithic Starčevo culture layer at the base, which was radiocarbon dated to c. 6000 BC (S. Perić, personal communication). So far, only a small portion, c. 50 m^2, of the Early Neolithic horizon has been investigated and, within it, two structures have been identified: a semi-subterranean space or "pit-dwelling" (Perić 2009) and a small c. 1.8×0.5 m accumulation of burnt daub, probably representing remains of a burnt structure (ESM Fig. 2). Within the latter, a large concentration of almost pure, charred, very well preserved and mostly complete pulse seeds was discovered (Fig. 2); the deposit was composed chiefly of *Lens culinaris* (lentils) which amounted to c. 75% or over 5,000 seeds, whilst *Pisum sativum* (peas) were also present at about 20%. A small number of highly eroded *Triticum monococcum* (einkorn) and *T. dicoccum* (emmer) grains and chaff were detected in and around the pulse concentration, as well as few dozen seeds of wild taxa including some wild fruit and weedy plants, which most probably represent intrusions into the

Fig. 2 Sub-sample of seeds from the pulse-rich deposit found within the Early Neolithic burnt structure at the site of Drenovac, central Serbia

pulse deposit. On the basis of the archaeological context, and the archaeobotanical content and its composition, the charred pulse seed deposit is interpreted as a burnt store. Notably, the lentils were mainly concentrated around a large flat stone projecting from the burnt rubble, whereas the peas were more abundant in the area further away from the stone. This could indicate that peas and lentils were kept separately and became mixed when the structure collapsed. No traces of storage containers were identified. The plants may have been kept in decomposable containers that were destroyed in the fire. It is also possible that the plant products were kept in some sort of containers made of clay or daub (like storage bins) that, after burning and collapsing, became indistinguishable from the similar material used for the construction of the building.

This find from Drenovac demonstrates that in the Early Neolithic, plant food may have been stored indoors, possibly in perishable containers and perhaps in quantities intended for food preparation on a daily basis. To this end, it is worth mentioning the supposed "grain processing areas" found inside two shallow pit features or "activity zones" within the Starčevo culture layer at the site of Zlatara near Belgrade, identified as such because of the presence of charred "cereal grain" (Leković 1995, pp. 28–30). However, the plant material collected from Zlatara was never analysed and neither was there any detailed information on the context of the find. The so-called "activity zones" were located near several other semi-subterranean structures designated as houses, while one of them was also adjacent to a pear-shaped pit, at least 2 m deep, interpreted as a silo. There may have been some functional or other relationship between these features, but this remains a speculation.

Plant storage in ceramic containers?

Besides the apparent storage pits, some large pottery types (pithoi) noted in the Starčevo ceramic assemblages could also have been used for storing plant products (Tringham 1971, pp. 78–79, 87; Tasić 1997). For instance, the large vessel discovered inside a Starčevo culture pit hut at the site of Badovinci in western Serbia was, reportedly, filled with barley grains (Trbuhović and Vasiljević 1983). This find was never examined by a specialist and is thus uncertain.

Late Neolithic

A new lifestyle and material expression known as the Late Neolithic Vinča culture developed towards the end of the sixth millennium BC across the central Balkans and parts of the east and west. The culture flourished for nearly a millennium, c. 5,400–4,500 cal BC (Borić 2009) and is known from large settlements that, in places, succeeded Starčevo culture occupations (Ćelić 1984; Bogdanović 1988; Srejović 1988; Stanković 1991; Marić 2013). The Vinča culture settlements were characterised by substantial architecture, both above and below the ground, such as pit features and wattle and daub buildings, subsistence based on domestic and wild plants and animals, elaborate production of pottery, tools and other objects, and participation in trade networks circulating obsidian, shells and salt (Chapman 1981; McPherron and Srejović 1988; Tringham and Krstić 1990; Russell 1993). Many settlements were large, densely occupied and long-lasting, quite a contrast to the small, perhaps short-lived Early Neolithic occupations mentioned above. Frequent and sometimes large-scale house burning at Late Neolithic sites in the Balkans enabled preservation and good visibility of structures and features made of clay, of which some may have played a part in plant food storage and handling (Tringham and Stevanović 1990; Crnobrnja 2012; Hoffman and Müller-Scheeßel 2013; Spasić and Živanović 2015). As shown below, the burning was also often conducive to preservation of plant material, sometimes in the form of large seed or fruit concentrations probably representing stored food.

Large pots and decomposable containers at Vinča

The eponymous Vinča culture site, the Vinča tell, is located in north-central Serbia, at the southern edge of the Pannonian plain, on the right bank of the river Danube. The preserved portion of the site is over 10 ha in extent, but part of the site was destroyed by Danube floods. The c. 10 m thick cultural deposit spans the Early to Late Neolithic, c. 5,600–4,500 cal BC (Tasić et al. 2015, 2016) and is topped by several layers containing traces of use of the site during the Copper, Bronze, Iron and Middle Ages (Ćelić 1984; Nikolić

2008). The most recently excavated (final) Late Neolithic occupation layer yielded the remains of a number of burnt and unburnt buildings from which archaeobotanical samples have been systematically collected. Botanical assemblages from the unburnt buildings are invariably of low density; they are, however, highly diverse in terms of the range of taxa and plant parts recovered (Filipović and Tasić 2012). The burnt buildings show similar taxonomic diversity of plant remains to the unburnt ones, but the amount of the material preserved, mostly within or under the burnt house rubble, is much greater. The concentrated, in situ, burnt material indicates potential plant stores.

In one of the burnt buildings, House 01/06 (ESM Fig. 3), two large, almost complete vessels (pithoi) were discovered containing more or less pure emmer grain (ESM Fig. 4). Concentrations of mostly emmer grain were discovered in a few other locations within the building collapse, and they may show storage in containers that did not survive (ESM Fig. 5). In one of the emmer deposits, relatively large numbers of *Linum usitatissimum* (flax/linseed) and *Vicia ervilia* (bitter vetch) seeds were detected (Borojević 2010), possibly also representing traces of crop stores in perishable containers. However, it cannot be excluded that these products were kept in some of the pots, pieces of which were found in abundance throughout the destruction layer of the house. Or perhaps they were stored in built-in earthen bins or similar structures that would have been destroyed in the fire and their contents spilled and mixed with the wall debris. Two such features were discovered in another burnt building (1/98), but were not examined for plant material.

Another burnt building at Vinča, House 02/06 (ESM Fig. 6), yielded a concentration of c. 5 kg of emmer grain, with minor inclusions of einkorn and 'new' type glume wheat grain, all contained within a large broken pot (ESM Fig. 7). The structure has not yet been fully excavated and it may produce further evidence of storage. Interestingly, within the deposit with emmer in a pot, a cache of well-preserved cf. *Pyrus pyraster* (wild pear) fruit was encountered (Fig. 3). Charred pears were also found in three other burnt buildings at Vinča, usually in the form of in situ preserved clusters found within the remains of walls or adjacent to ovens, sometimes associated with potsherd concentrations (Fig. 4; Filipović and Marić 2013). They may have been kept in bags hung up on walls or suspended from a ceiling, or in pots perhaps placed on "shelves" along the walls. In addition to the *Pyrus* fruits, caches of seeds and fruits of wild taxa such as *Rubus fruticosus* agg. (blackberry), *Fragaria vesca* (wild strawberry), *Sambucus ebulus* (dwarf elder) and *Physalis alkekengi* (Chinese lantern) were found within the destruction layers of the burnt houses. It seems that, at Neolithic Vinča, crops and wild plants were stored inside houses, in pots, decomposable containers and perhaps also in clay bins or basins.

Fig. 3 Charred *Pyrus pyraster* (wild pear) fruit from House 02/06 at the site of Vinča, Serbia

Storing of plant food in pottery seems to have been a widespread practice during the Late Neolithic in this region; finds of "pots with seeds" have been reported from several other Vinča culture sites across Serbia, but only a few have been archaeobotanically examined. In two burnt houses at the site of Medvednjak in north-central Serbia, quantities of charred remains were found within some small 5–7 cm high bowls, medium-sized vessels 11–13 cm high and in a large pot 50 cm high, and also as concentrations on the house floors (Galović 1975; Medvednjak field reports). Jane Renfrew analysed grain from one of the medium-sized pots and identified emmer grain as the dominant component mixed with relatively small amounts of einkorn and bread wheat grain (Renfrew 1969, 1979); analysis of further plant deposits from Medvednjak recently re-discovered in the storeroom of the local museum confirmed the prevalence of emmer grain in the available archive. The plant stores from Medvednjak demonstrate that pots of various sizes and shapes were used for storage, or some sort of keeping, of plant produce. It is worth mentioning here a find from the earliest excavations of Vinča, of a bowl filled with wheat grain found on the floor of a burnt building, within a group of complete and broken pots lined against the wall of the house (Vasić

Fig. 4 Cluster of charred pears among fragments of pottery, found in the burnt House 01/06 at the site of Vinča, Serbia

1936, p. 171). The bowl was relatively small, 5 cm high and 15 cm across; its surface had originally been black burnished, though the fire had changed its appearance (Fig. 5). Based on this, it seems that pots of various sizes and shapes were used in grain food handling. They may have played distinct roles, thus large ones could have been used for (long-term) storage, whilst medium to small ones perhaps held grain awaiting processing or preparation.

The reported Late Neolithic origin of the "large storage jar full of carbonised grain" from the multi-period site of Stapari in southwestern Serbia (Chapman 1981, p. 67) is highly questionable, as the entire context probably belongs to the Bronze Age or even later. This is indicated by the recently conducted thorough examination of the field documentation by Obradović.

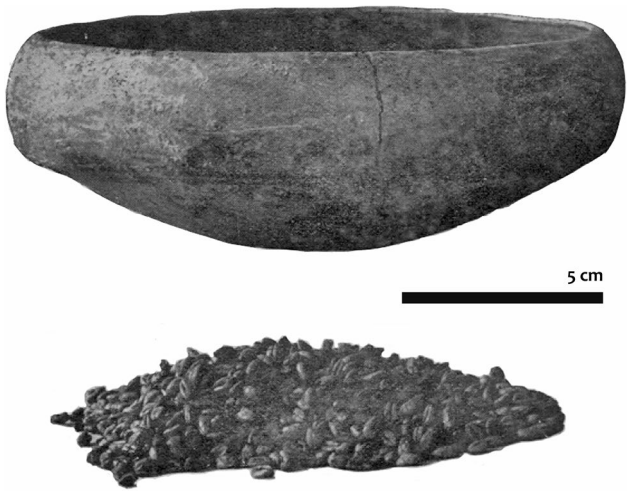

Fig. 5 Bowl from a burnt house at the site of Vinča, Serbia and the wheat grain found inside (modified after Vasić 1936, Fig. 362)

Clay bins at Selevac

An excellent example of Neolithic storage of crops in clay-built containers comes from the site of Selevac, a Vinča culture site located on a low hillside at the edge of the Velika Morava river valley in north-central Serbia. Unlike Vinča, this is a flat and spread out site, and a very large one, occupying an area of about 53 ha; it was settled during the period 5300–4500 cal BC (Tringham and Krstić 1990, pp. 2–3; Borić 2015, Fig. 2). A few of the discovered wattle and daub structures had been entirely consumed by a fire that left behind distinct accumulations of burnt daub which was rich in finds of pottery, stone and bone objects, animal bone and other materials including charred plant remains. The botanical material was recognised in the form of charred deposits within solid structures (see below), or as concentrations of remains within house rubble, or as "layers" of charred material found on house floors (Tringham and Stevanović 1990, p. 104).

In the early excavations of Selevac in the 1970s, in one of the burnt buildings, remains of two earthen containers filled with grain were found (marked 'α' and 'β' in Fig. 6, after the drawing in the Selevac field diary; see also ESM Fig. 8). They were of similar size, more or less circular in plan and semi-elliptic in cross-section; the walls were made of clay, while the domes consisted of horizontal wooden sticks or wattle, covered with a layer of clay (Fig. 6). One bin (β) had a clay partition wall built across the middle; in the other, an anthropomorphic figurine was found on top of the charred grain concentration. As reported by the excavators (Selevac field diary; Tringham and Stevanović 1990, pp. 58–62) and by Maria Hopf, who did the first archaeobotanical analysis (Hopf 1974; Renfrew 1979, p. 254), there were no indications of openings on the bins (Hopf 1974, Fig. 1). Thus Hopf

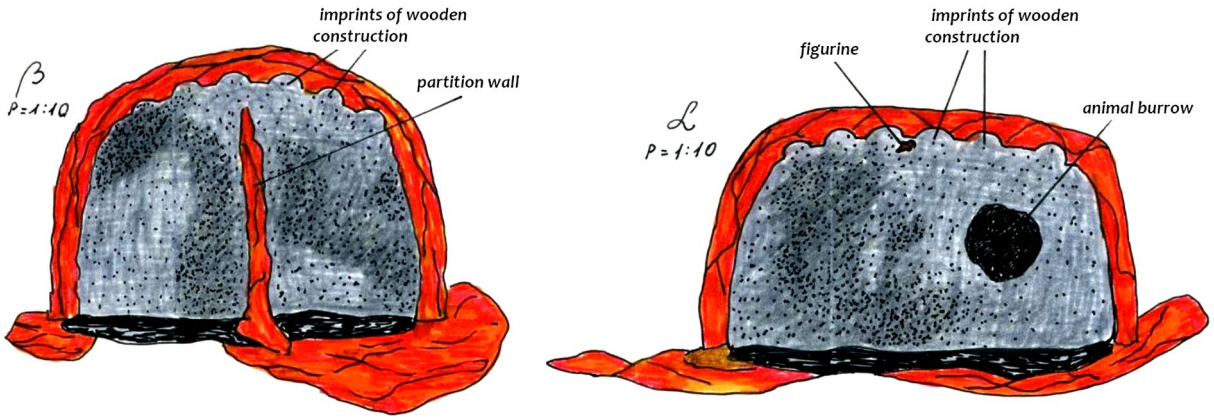

Fig. 6 Field drawing of the cross sections of the clay bins which contained einkorn at the site of Selevac, Serbia

suggested that the containers were completely sealed and, in order to retrieve the contents, the bins would have to have been broken open. The structures were burnt in the conflagration and it is likely that the discovered material represents their "original" content. In both of the bins, einkorn grain was the dominant component of the fill (Obradović 2016, Fig. 6). A very small percentage, <3%, of lentil was recorded in bin α and slightly more, c. 6%, in bin β; it is possible that the "screen wall" in bin β served to separate the two crops in the storage. Based on the rough volume of the bins, their capacity would have been around 300 kg of grain each (Obradović 2016). The significant storage capacity and the lack of easy access to the bin contents suggest that they were used for long-term keeping of the produce, for which frequent, even daily access to the grain was not intended (Sigaut 1988, pp. 10–12). The sealed containers would presumably have prevented grain spoilage through insect infestation, for instance, the threat of which is directly evidenced by the finds of charred remains of *Sitophilus granarius* (wheat weevil, Fig. 7) in a crop store which had probably been kept in a perishable container (marked as 'γ' in the reports). This store was recognised as a concentration within a house destruction layer mainly of einkorn grain with some lentil (Obradović 2016, Fig. 6).

Thus the available archaeobotanical evidence from Selevac clearly indicates storage of plant products in clay bins. Also, containers made of materials that had decayed over time or were destroyed by fire may have been used, leaving the plant contents as concentrations in the house collapse debris or spread on the house floors. For instance, a layer rich in charred botanical remains detected on the floor of House 7 at Selevac was interpreted as the remains from a plant store in an elevated structure made of wood and placed on wooden posts, an "above-ground granary" (Tringham and Stevanović 1990, p. 104). Alternatively, loose deposits of charred grain may have derived from pottery, since pieces of some large pots that may have served for storage of food

Fig. 7 Charred *Sitophilus granarius* (wheat weevil) from a loose concentration of einkorn grain discovered within the remains of a burnt house at the site of Selevac, Serbia; scale = 1 mm

were identified at the site (Tringham and Stevanović 1990, p. 114). A similar situation was encountered at the site of Banjica near Belgrade, where a grain-rich deposit was discovered on the floor of House 7 but was here interpreted as originating from a "storage box" probably made of wood (Todorović and Cermanović-Kuzmanović 1961; Tripković 2007, p. 73); the plant remains were not submitted for

specialist analysis. It should be noted here that Tripković mistakenly stated the occurrence of grain in a clay bin at the Vinča culture site of Beletinci in Vojvodina (2011, Fig. 2); see instead Brukner (1962) and Chapman (1981, p. 65).

Plant storage in perishable containers, or ceramic pots, or both

Some concentrations of charred (wheat) remains on the one hand, and the presence of "pots for keeping grain" on the other, were noted at the site of Matejski Brod in Vojvodina, northern Serbia, but it is not clear if the two were in any or direct association (Radišić 1984, p. 21). It is possible that plant products were also or instead kept in containers made of material(s) that did not survive, such as various plant or other organic materials. Archaeobotanical analysis has not been carried out for this site. Similarly, in a burnt house at the Neolithic site of Valač in Kosovo, a concentration of charred plant material was found on a floor, on which a number of complete and broken pots, clay balls and figurines were also discovered. The relationship between the artefacts and the plant remains is unknown. The excavator reports that the charred deposit included remains of cereals (presumably grains), fruit of *Pyrus* sp. (wild pear) and fruit stones of *Cornus mas* (Cornelian cherry) or *Crataegus* sp. (hawthorn) (Tasić 1960, p. 17). It is unclear whether the plant remains from Valač analysed by Maria Hopf, composed of a small amount of peas and acorns, also come from this particular deposit (Hopf 1974, pp. 7–8).

Pits for storing plants? Archaeobotanical evaluation

Concentrations of plant remains in (outdoor) pit features were found at two Neolithic sites in Serbia. Some of the pits detected within the Vinča culture layer of the Gomolava tell in Vojvodina were archaeobotanically analysed by Willem van Zeist (van Zeist 2001/2002). Two of them yielded relatively large quantities of charred material plant remains, in the order of hundreds, which in both cases chiefly included wheat processing by-products such as glume wheat glume bases, with only a minor occurrence of wheat grain (van Zeist 2001/2002, Table 2; Filipović 2014). No further details such as data on other types of material present in the pits were made available, but the composition of the botanically rich deposit clearly points to its status as discarded material and perhaps hints at the purpose of the pit as a rubbish disposal area. In contrast, the single plant-rich pit deposit from the site of Opovo in Vojvodina contained a considerable amount of charred emmer grain; however, it also contained a significant number of remains of a range of other taxa including fruit, nuts, pulses, weeds and wild plants, indicating a combination of food and food refuse, wild and domestic (Borojević 1998, pp. 148–153). On the basis of the lack of burning within the pit and the composition of the plant assemblage, it was concluded that the grain did not represent stored crop remains but was instead refuse discarded there, perhaps in the final phase of use of the pit (Borojević 1998, p. 152).

Summary and conclusions

The evidence of plant storage in the Neolithic period in Serbia is limited and unsystematic, mainly due to the lack of (adequate) archaeobotanical sampling and analysis on the one hand, and on the other, poor archaeological recording of the situation in the trench or insufficiently detailed reporting. There are some sites for which archaeological and archaeobotanical records of storage could be examined alongside each other, and they are included in this study. However, only in some cases could the relationship between potential storage features or objects and mass finds of plant remains be explored and established, or excluded.

Table 2 roughly summarises the presented evidence. Whereas archaeological reports describe pits and mention ceramic pots as facilities that could have been used for keeping plants in the Early Neolithic in Serbia, only the site of Drenovac has offered convincing evidence of plant storage. These results suggest the keeping of plant products in containers made of short-lived materials, but this remains ambiguous, and the use of earthen bins and pots cannot be entirely ruled out. Indeed, there is evidence in the wider region of the existence of Early Neolithic storage bins and vessels, of which some contained in situ burnt crops. The most prominent examples, and archaeobotanically confirmed, come from the Neolithic in Bulgaria, where over a dozen clay-built containers and two pots containing grain were discovered in a house at the site of Slatina (Nikolov 1989, 1992); pots with preserved crops were also found in a house at the site of Kapitan Dimitrievo (Marinova 1999, 2007). Both sites also yielded scattered plant deposits outside visible or preserved containers, similar to those found in the Middle/Late Neolithic layer at the site of Karanovo (Marinova 2006, Abb.

Table 2 Summary of the available evidence of plant product storage at Neolithic sites in Serbia

Storage container	Early Neolithic		Late Neolithic		
	Cereals	Pulses	Cereals	Pulses	Wild fruit
Pits					
Clay bins	(x)		x	x	
Perishable containers	x	x	(x)	x	x
Ceramic pots—large			x		
Ceramic pots—small			x		(x)

6.9). Cereals, pulses and flax/linseed were stored at these sites in various states, as grain in spikelets, unthreshed, cracked/bulgur type, and as a "pure" crop of *Lathyrus sativus* (grass pea) or as two or more crops combined (einkorn and emmer, barley and pea, etc.) (Marinova 2007). Neolithic sites in FYR Macedonia also yielded potential storage facilities, mainly in the form of clay bins and basins. Although various objects were found within these features such as pottery and querns, no plant material was found. One published case describes plant remains excavated in a relatively large quantity, c. 900 cereal grains, from within a plastered, basin-like structure at the Early Neolithic site of Vršnik (Hopf 1961); however, the connection between the burnt grain and the feature is dubious since the feature did not seem to display traces of burning (Garašanin and Garašanin 1961, p. 13). Several sites in FYR Macedonia yielded clusters of clay bins or basins located close to ovens, and these may have played a role in food storage or preparation (Stojanova-Kanzurova and Rujak 2016, pp. 70–72).

The Late Neolithic plant stores and storage facilities in Serbia are much more visible than the examples mentioned above, and a reason could be the large-scale burning, even of entire buildings, at a number of sites from this phase. This resulted in preservation of plant stores recognised in the field as large concentrations of plant remains, sometimes inside pots and clay-built bins, sometimes as accumulations of charred seeds or grain within rubble or on floors of burnt buildings. The latter may indicate use of containers, for instance bags, sacks, baskets, or boxes, that decayed over time or, perhaps more likely, that were destroyed in the fire that preserved the stored plant materials. Although still limited, the evaluated dataset demonstrates that there were many ways of storing plant products in the Neolithic of the study region. Tentatively, different storage facilities may have been used for different plant products, as perhaps can be seen from the data in Tables 1 and 2. For instance, containers made of decomposable materials appear to have been used for different crops and also for fruit gathered from the wild, whereas clay bins and large pots may have been intended specifically for cereals. As previously suggested, small ceramic vessels could have served for scooping grain or seeds out of a larger container, perhaps in the amounts required for a single meal and awaiting further processing and preparation, as "short-term" storage. They could also have been used for serving and/or for keeping small quantities of plant food, such as in the case of wild pears at Vinča and other similar "caches" of wild fruit or nuts. It is noteworthy that the find from Vinča closely resembles the one from a burnt Late Neolithic house at the site of Dikili Tash in northern Greece (Valamoti 2015). Here, numerous pears were found in association with a jar, but also as a loose concentration, showing the possible use of a perishable container.

Overall, the combined evidence shows that plant products were probably stored in clay bins, pots and containers made of perishable materials. The results of this study are in general agreement with the previously made observations using archaeological information, but it must be emphasised that only a few sites offered useful data. In contrast to the archaeological interpretations, the storage of plants in pits could not be proven archaeobotanically. Nonetheless, the possibility should not be ignored that pits may have been originally used for storing plant products, which could subsequently have been removed or have decayed. Contents of the storage deposits appear to have varied between the examined Neolithic sites in Serbia, for example stored emmer at Vinča as opposed to einkorn at Selevac, perhaps reflecting differences in crop growing and consumption across the region and over time. Also, there may have existed functional specialisation of the containers, such as the use of certain types for different plant products, for example grain vs. wild fruit, and/or for different stages or activities in plant handling. Testing these ideas requires much more relevant information, including comprehensive archaeological recording and precise dating.

Acknowledgements The paper and the IWGP 2016 oral and poster presentations by DF and ĐO are outcomes of two projects funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia: "Society, spiritual and material culture and communications in prehistory and early history of the Balkans" (Ref. 177012) and "Archaeology in Serbia: Cultural identity, integration factors, technological processes and the role of the Central Balkans in the development of European prehistory" (Ref. 177020). We would like to thank Dragana Đurđević and Nenad Šošić (National Museum of Smederevska Palanka) and Ljiljana Mandić (National Museum of Užice) for the permission to analyse archaeobotanical samples from the sites of Selevac and Stapari and publish parts of the field documentation. We are also grateful to the 'Vinča Project' for the permission to use photos from the site of Vinča. Finally, we would like to express our gratitude to the anonymous reviewers whose comments and recommendations helped us significantly improve the manuscript, and to the editors of this volume.

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