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Archaeobotany in Croatia: An overview

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The study of plant macro-remains from archaeological sites is an important method to study aspects of past societies such as diet, agriculture, trade/economy and the local environment. To date plant macro-remains have been identified from 70 sites within Croatia, spanning the early Neolithic (ca. 6000 cal BC) to the Middle Ages (16th century AD). Despite this number, poor recovery and a bias towards the Neolithic period have led to large gaps in our knowledge on the development of agriculture in the region, which is further hindered by the low number of excavations that include archaeobotanical recovery. This paper summarises the archaeobotanical evidence available per period in Croatia, highlighting the potential for future research, as well as providing suggestions for the recovery of carbonised plant macro-remains.

Keywords: *Neolithic, Eneolithic, Bronze Age, Iron Age, Roman, Middle Age, Methodology*

INTRODUCTION

Plants are, and have been, an integral part of our daily lives whether being eaten, drunk, used for clothing, fuel, for medicinal purposes, utilised in construction or given cultural/ideological/ritual values. Archaeobotany examines plant remains (primarily macro-fossils such as grains, seeds, nutshells, and fruit stones) recovered from archaeological excavations to reconstruct past agricultural systems, economies, environments and human activity. Common themes in European archaeobotany include the origin and spread of domestic crops, dietary breadth and variability, land use and production, as well as distribution, and social access to specific foods.[1]

In Croatia, archaeobotanical analysis is rarely undertaken as part of archaeological research, due in part to the lack of trained

[1] Van Zeist, Wasylikowsa, Behre 1991; Bogaard 2004; Colledge, Conolly 2007; Van der Veen, Livarda, Hill 2008; Zohary, Hopf, Weiss 2012; Chevalier, Marinova, Peña-Chocarro 2014.

archaeobotanists and a limited awareness of the discipline and its potential contribution. During the 20th century only nine sites have published evidence of archaeobotanical remains, with the majority being part of multi-national projects.[2] Since then there has been a greater increase in the recovery of archaeobotanical remains, including recovery within routine rescue excavations. This provides for the first time important information about past human plant economies from a range of archaeological sites and periods across Croatia. How these new discoveries have begun to contribute to Croatian archaeology are summarised here, highlighting the importance of collecting archaeobotanical samples and the potential for future research. This paper does not aim to provide a detailed and comprehensive history of Croatian archaeology and archaeobotany. To aid future research in archaeobotany in Croatia this paper will also outline suggestions for best practice.

PREHISTORY

Neolithic (ca. 6000 to 4500 cal BC)

The Neolithic period has received a great deal of attention over the years, especially in regards to the spread of agriculture and its social and economic consequences.[3] The spread of a 'Neolithic package', which is seen as the introduction of a farming economy, relates to the appearance of specific items of material culture, including polished stone axes, ceramics, a new suite of domestic animals and plants, as well as specific architecture and religious activities.[4] How these items arrived in Europe is still highly debated, with theories ranging from colonising farmers to local hunter gatherer groups adopting farming piecemeal from their neighbours.[5] A key aspect of these debates is the transmission and adoption of certain domesticated plants, which research suggests did not spread as one 'crop package' across Europe.[6] The 'crop package' consisted of einkorn (*Triticum monococcum*), emmer (*Triticum turgidum* ssp. *dicoccum*- formerly *Triticum dicoccum*), barley (*Hordeum vulgare* ssp. *vulgare*), pea (*Pisum sativum*), lentil (*Lens culinaris*), chickpea (*Cicer arietinum*), bitter vetch (*Vicia ervilia*) and flax (*Linum usitatissimum*).[7]

In Croatia, research suggests that farming settlements began to be established ca. 6000 cal BC;[8] however, only a few excavations have yielded early Neolithic archaeobotanical remains (Tab. 1, Map 1). In coastal Croatia, five early Neolithic sites have evidence of carbonised plant macro-remains: Pokrovnik, Crno vrilo, Tinj-Podlivade, Krćina and Kargadur-Ližnjan.[9] While in continental Croatia, only two early Neolithic sites have so far yielded archaeobotanical remains: Sopot and Tomašanci-Palača.[10] All seven sites show evidence of the 'crop package' in varying degrees (all except chickpea and bitter vetch) confirming the establishment of crop agriculture in the early Neolithic. This evidence along with the presence of other Neolithic material culture has been suggested by some to be confirmation of populations moving into Croatia,[11] although evidence of continued hunter gatherer activities suggest a more complex diffusion of farming across the region.[12] At present, the absence of archaeobotanical evidence from Mesolithic sites and the restricted range of early Neolithic evidence in Croatia limit our understanding of how human-plant relationships changed at this time.

2 Gnirs 1925; Hopf 1964; Karg, Müller 1990; Chapman, Shiel, Batović 1996.

3 Harris, Hillman 1989; Harris 1996; Whittle 1996; Perlès 2001; Bogaard 2004; Colledge, Conolly 2007; Hadjikoumis, Robinson, Viner 2011; Zohary, Hopf, Weiss 2012.

4 Çilingiroğlu 2005.

5 Vlachos 2003; Borić 2005; Forenbaher, Miracle 2005.

6 Conolly, Colledge, Shennan 2008.

7 Zohary 1996; Zohary, Hopf, Weiss 2012.

8 Chapman, Müller 1990; Bogucki 1996; Forenbaher, Miracle 2005; Davison *et al.* 2006; Forenbaher, Kaiser, Miracle 2013.

9 Müller 1994; Huntley 1996; Komšo 2006; Legge, Moore 2011; Šoštarić 2009.

10 Reed 2015.

11 Legge, Moore 2011.

12 Chapman, Müller 1990; Biagi 2003; Forenbaher, Miracle 2005; Bass 2008.

Table 1. List of Croatian sites with archaeobotanical remains per period (C = carbonised, IM = impression, M = mineralised, W = waterlogged, P = Pseudo-fresh). *Note: Identifications based on a cumulative table and may not be accurate.

SITE NAME	SITE TYPE	DATE	CEREALS	PULSES	OIL PLANTS	VEGETABLES / HERBS	FRUITS / NUTS	WILD / WEED SEEDS	REFERENCE
Neolithic									
Crno vrilo	Settlement	*(Impresso culture)*	C						Šoštarić 2009.
Kargadur-Ližnjan	Settlement	*(Impresso culture)*	C				C		Komšo 2006, 212–214.
Krčina cave	Cave	*(Impresso culture)*	C						Müller 1994, 64.
Sopot	Settlement	6060 – 5890 cal BC	C	C			C	C	Reed 2015.
Tinj-Podlivade	Settlement	5815 – 5185 cal BC	C					C	Huntley 1996.
Tomašanci-Palača	Settlement	5660 – 5300 cal BC	C	C	C		C	C	Reed 2015.
Pokrovnik	Settlement	5900 – 5100 cal BC	C	C	C		C	C	Karg, Müller 1990; Legge, Moore 2011.
Danilo	Settlement	5300 – 4800 ca BC	C	C	C		C	C	Hopf 1964; Reed 2006; Legge, Moore 2011.
Gromače-Brijuni	Settlement	*(Danilo culture)*	C				C	C	Gnirs 1925, 24–25.
Virovitica-Brekinja	Settlement	5400 – 5200 cal BC	C	C					Reed 2015.
Bapska-Gradac	Tell	4680 – 4460 cal BC	C						Burić 2007, 45–46.
Brezovljani	Settlement	4900 – 4600 cal BC	IM						Reed 2015.
Velištak	Settlement	4900 – 4700 cal BC	C	C			C	C	Reed 2015.
Grapčeva	Cave	5226 – 4167 cal BC	C				C	C	Borojević *et al.* 2008.
Ivandvor-Gaj	Settlement	5050 – 4490 cal BC	C	C					Đukić 2014; Reed 2015.
Otok	Tell	4540 – 4040 cal BC	C						Obelić, Horvatinčić, Krajcar Bronić 2002.
Ravnjaš-Nova Kapela	Tell	*(Sopot culture)*	C	C			C	C	Reed 2015.
Slavća	Tell	ca. 4990 – 4200 cal BC	C	C	C		C	C	Reed 2015.
Sopot	Tell	5050 – 3940 cal BC	C	C	C		C	C	Reed 2015.

SITE NAME	SITE TYPE	DATE	CEREALS	PULSES	OIL PLANTS	VEGETABLES / HERBS	FRUITS / NUTS	WILD / WEED SEEDS	REFERENCE
Tomašanci-Palača	Settlement	4300 – 3900 cal BC					C		Reed 2015.
Turska Peć	Cave	*(Hvar culture)*	C	C			C	C	Reed 2015.
Eneolithic									
Grapčeva	Cave	3637 – 3097 cal BC					C	C	Borojević *et al.* 2008.
Slavća	Tell	ca. 4200 – 2800	C		C		C	C	Reed 2013; 2016
Jurjevac-Stara Vodenica	Settlement	4320 – 3960 cal BC	C				C		Reed 2013; 2016; Đukić 2014.
Pajtenica-Velike Livade	Settlement	4300 – 3900 cal BC	C					C	Reed 2013; 2016; Đukić 2014.
Potočani	Settlement	4203 – 4040 cal BC	C	C				C	Reed 2013; 2016.
Lasinja	Settlement	4040 – 3950 cal BC	C				C	C	Reed 2016.
Barbarsko	Settlement	4320 – 3360 cal BC	C						Reed 2016.
Čeminac-Vakanjac	Settlement	ca. 3750 – 3600 cal BC	C		C		C		Reed 2016.
Čepinski Martinci-Dubrava	Settlement	ca. 4200 – 2900 cal BC	C					C	Reed 2016.
Tomašanci-Palača	Settlement	4340 – 3240 cal BC	C				C	C	Reed 2013; 2016.
Virovitica-Batelije	Settlement	3510 – 3330 cal BC	C						Reed 2013; 2016.
Buković-Lastvine	Settlement	3370 – 2940 cal BC	C					C	Huntley 1996a.
Đakovo-Franjevac	Settlement	3340 – 2830 cal BC	C	C	C		C	C	Reed 2011; 2013; 2016; Đukić 2014.
Vinkovci, 14 Matije Gupca	Settlement	2880 – 2480 cal BC	C		C		C	C	Reed 2013; 2016.
Vučedol	Tell	3490 – 2790 – 2600 cal BC	C	C	C		C	C	Reed 2013; 2016.
Bronze Age									
Grapčeva	Cave	2565 – 2144 cal BC / 1879 – 1529 cal BC	C				C	C	Borojević *et al.* 2008.
Tomašanci-Palača	Settlement	*(early)*	C				C	C	Reed 2013.

SITE NAME	SITE TYPE	DATE	CEREALS	PULSES	OIL PLANTS	VEGETABLES / HERBS	FRUITS / NUTS	WILD / WEED SEEDS	REFERENCE
Monkodonja	Hillfort	ca. 1800 – 1200 cal BC		C			C	C	Hänsel, Mihovilić, Teržan 1997.
Ĉauševica	Settlement	*(late)*					C	C	Huntley 1996b.
Crišnjevi-Oštrov	Necropolis	*(late)*	C					C	Reed 2013.
Mačkovac-Crišnjevi	Settlement	ca. 14th – 12th century BC	C	C			C	C	Reed 2013.
Nova Bukovica-Sjenjak	Settlement	*(late)*		C			C		Šoštarić 2001.
Kalnik-Igrisce	Settlement	*(late)*	C	C			C	C	Mareković 2013; Mareković *et al.* 2015.
Orubica-Veliki Šeš	Settlement	ca. 13th – 12th century BC	C				C	C	Reed 2013.
Okruglo	Settlement	*(late)*						W	Smith *et al.* 2006.
Torčec-Gradić	Settlement	*(late)*						P	Šoštarić 2004.
Iron Age									
Kaptol-Gradci	Tumulus	820 – 410 cal BC	C				C	C	Šoštarić, Potrebica, Brigić 2008; Hršak 2009; Šoštarić *et al.* 2016.
Sisak	Settlement	ca. 6th – 4th century BC	C						Reed, Drnić 2016.
Nadin-Gradina	Hillfort	ca. 5th – 1st century BC	C		C		C	C	Nye 1996.
Roman									
Danilo	Villa		C						Šoštarić 2003; Šoštarić 2005.
Caska, Pag Island	Harbour structure	ca. 1st – 2nd century AD	C	C		W	C,W	W	Tillier *et al.* 2016.
Poreč	Town		C	C					Šoštarić 2015.
Vitrovitica Kiškorija	Settlement	ca. 2nd – mid 5th century AD	C	C			C	C	Šoštarić 2015; Šoštarić *et al.* 2015.
Nadin-Gradina	Hillfort	ca. 1st – 2nd century AD	C		C		C	C	Nye 1996.

SITE NAME	SITE TYPE	DATE	CEREALS	PULSES	OIL PLANTS	VEGETABLES / HERBS	FRUITS / NUTS	WILD / WEED SEEDS	REFERENCE
Sćitarjevo	Cemetery	ca. 1st / early 2nd century AD	M	M	M		M	M	Šoštarić *et al.* 2006.
Illok	Cemetery	ca. 1st / early 2nd century AD	C, M	M	M		M	M	Dizdar, Šoštarić, Jelinčić 2003; Šoštarić *et al.* 2006.
Osijek-Silos	Villa	ca. 1st – 5th century AD	C					C	Starčević 2010.
Port of Aenona / Zaton	Port	ca. 1st – 5th century AD	W		W	W	W	W	Šoštarić 2003; Glušćević *et al.* 2006; Krajačić 2009; Čičak 2015.
Veli Brijun	Villa	ca. 1st – 5th century AD	W		W	W	W	W	Šoštarić, Küster 2001.
Middle Ages									
Vitrovitica Kiškorija	Settlement	ca. 8th – 9th century AD	C				C	C	Šoštarić 2015.
Blaževo Pole 6*	Settlement	ca. 8th / 9th century AD	C					C	Šoštarić, Šegota 2010.
Duga ulica 99, Vinkovci	Cemetery (Slav)	ca. 7th / 8th century AD	C						Sekelj Ivačan, Tkalčec 2006, 200–201.
Nuštar	Cemetery (Avar)	ca. 7th / 8th century AD	C					C	Rapan Papeša, Kenéz, Petö 2015.
Prečno Pole I*	Settlement	ca. 7th / 8th – early 14th century AD	C		C		C	C	Šoštarić, Šegota 2010.
Pod Gucak*	Settlement	ca. 11th / 12th century AD	C					C	Šoštarić, Šegota 2010.
Ledine*	Settlement	ca. 10th / 11th century AD	C		C			C	Šoštarić, Šegota 2010.
Rudičevo*	Settlement	ca. 13th – early 14th century AD	C					C	Šoštarić, Šegota 2010.
Torčec-Gradić	Castle	ca. 13th – 15th century AD	C				C	C	Šoštarić 2004.
Vrbovec	Castle	ca. 12th – 16th century AD	C	C			C	C	Šoštarić, Šegota 2010a.

The recovery of archaeobotanical remains can also provide information about activities associated with the yearly crop cycle, such as preparing the soil, sowing, harvesting and crop processing. Each activity relies on variables such as labour availability, technology, the local environment and any other constraints imposed by the community/society. Recently, these activities have begun to be explored from the analysis of archaeobotanical remains dating to the Neolithic. For example, the recovery of sufficient quantities of carbonised cereal grain, chaff and crop weeds allowed the identification of crop processing activities at six Neolithic sites (one early Neolithic and five late Neolithic): Tomašanci-Palača, Sopot, Čista Mala-Velištak, Turska Peć, Slavča, Ravnjaš.[13] The results suggested that the inhabitants conducted many of the early crop processing stages, such as threshing and winnowing, away from the settlements after harvest. The crops were then brought to the settlement where further crop processing occurred on a more day to day basis in preparation for human consumption. The waste from these final crop processing stages then became carbonised, whether accidentally or deliberately being burnt in the hearth or burnt outside the home, and deposited around the settlement.

During the late Neolithic (ca. 4800 to 4500 cal BC) changes in society are seen in the Carpathian region, where larger more permanent and long-lived tell settlements emerge, along with large scale cattle herding.[14] Whether changes in crop agriculture also occurred at this time is still unclear from the plant record, but recent archaeobotanical research has highlighted its potential to answer these questions. For example, the comparison of plant macroremains collected from late Neolithic tell, cave and flat open-air sites showed a slight increase in the range of crops recovered at the tell sites, potentially indicating differences in crop regimes.[15]

[13] Reed 2015.

[14] Bailey 2000; Tringham 2000; Orton 2012.

[15] Reed 2015.

The identification of burnt dung from plant remains collected from the late Neolithic cave site of Turska Peć has also contributed to our understanding of the possible diet of domestic herds.[16] For example, the large numbers of wild plant and weedy species, such as cicer milkvetch (*Astragalus cicer*), alfalfa (*Medicago sativa*), fat hen (*Chenopodium album*), crabgrass (*Digitaria sanguinalis*) and clover (*Trifolium* sp.), suggests that farmers may have been sowing fields for animals to graze and/or growing fodder crops to feed their livestock. In addition, the identification of animal herds at this site provides valuable information about land use and the seasonal movement of herds around the Croatian landscape during the late Neolithic.

Eneolithic (ca. 4500 to 2400 cal BC)

The Eneolithic (or Copper Age) is an important period of socio-economic change where economic and political complexities began to emerge. However, less research has been directed to understanding the significant changes that occurred to these societies in the Balkans. Generally, the Neolithic/Eneolithic transition in southeast Europe sees a number of communities dispersing from the large centralised Neolithic tells to form smaller settlements with an increased focus on herding and seasonal transhumance.[17] A greater focus on animal products is suggested, where animals were exploited not only for meat but for milk, wool or used as draft animals.[18] This period also sees changes in burial practice and the re-organisation of trade networks, to accommodate the demand for new metallurgical goods.[19] As the Eneolithic progressed, larger more permanent fortified settlements began to develop,[20] along with the emergence of social hierarchy and craft specialisation. The climate too changes dur-

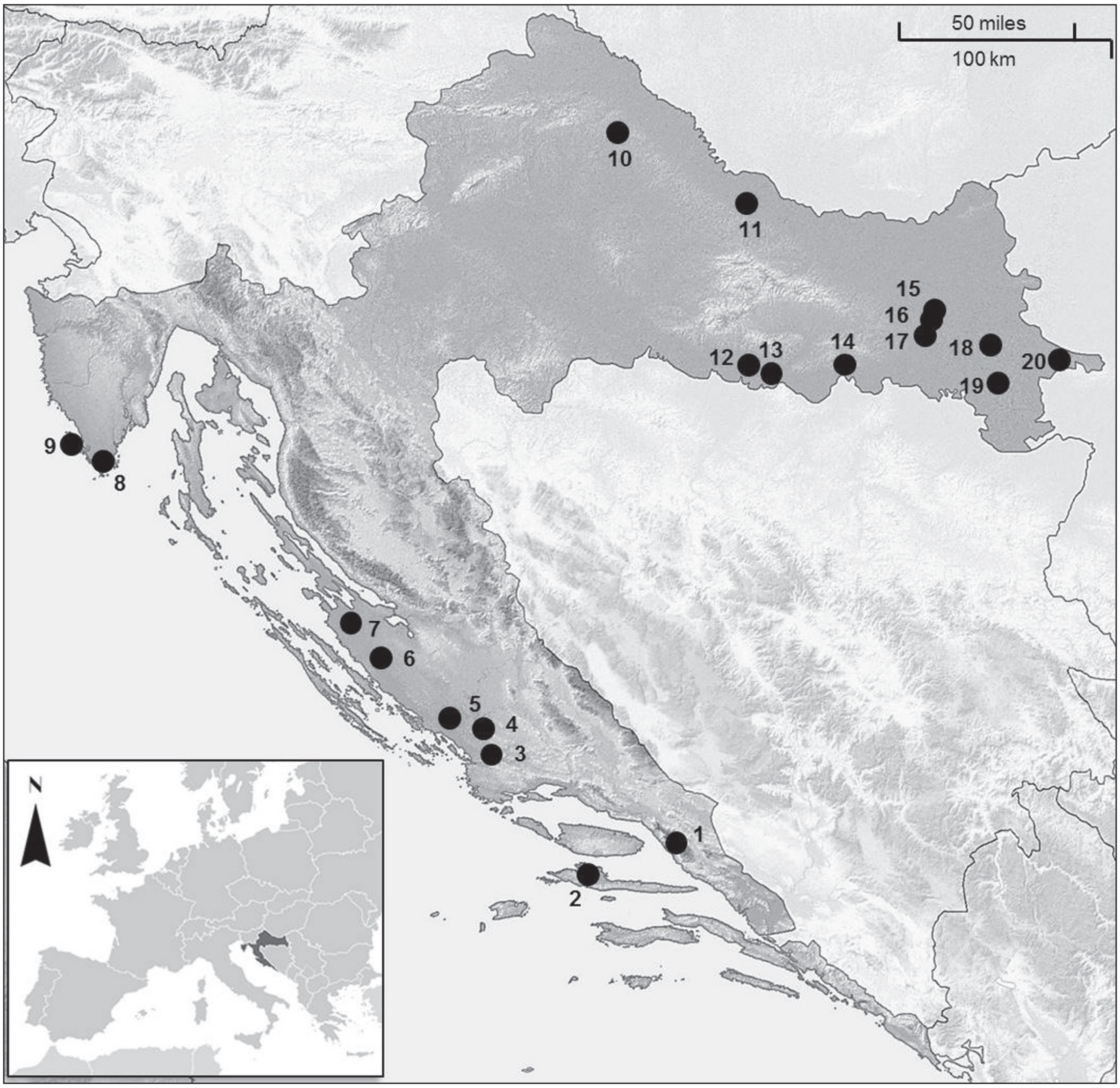
[16] Reed 2015.

[17] Bognar-Kutzian 1972; Parkinson *et al.* 2004.

[18] Sherratt 1981; 1983; Greenfield 2005; Trbojević-Vukičević *et al.* 2011.

[19] Parkinson *et al.* 2010.

[20] Balen 2002; Tasić 2004.



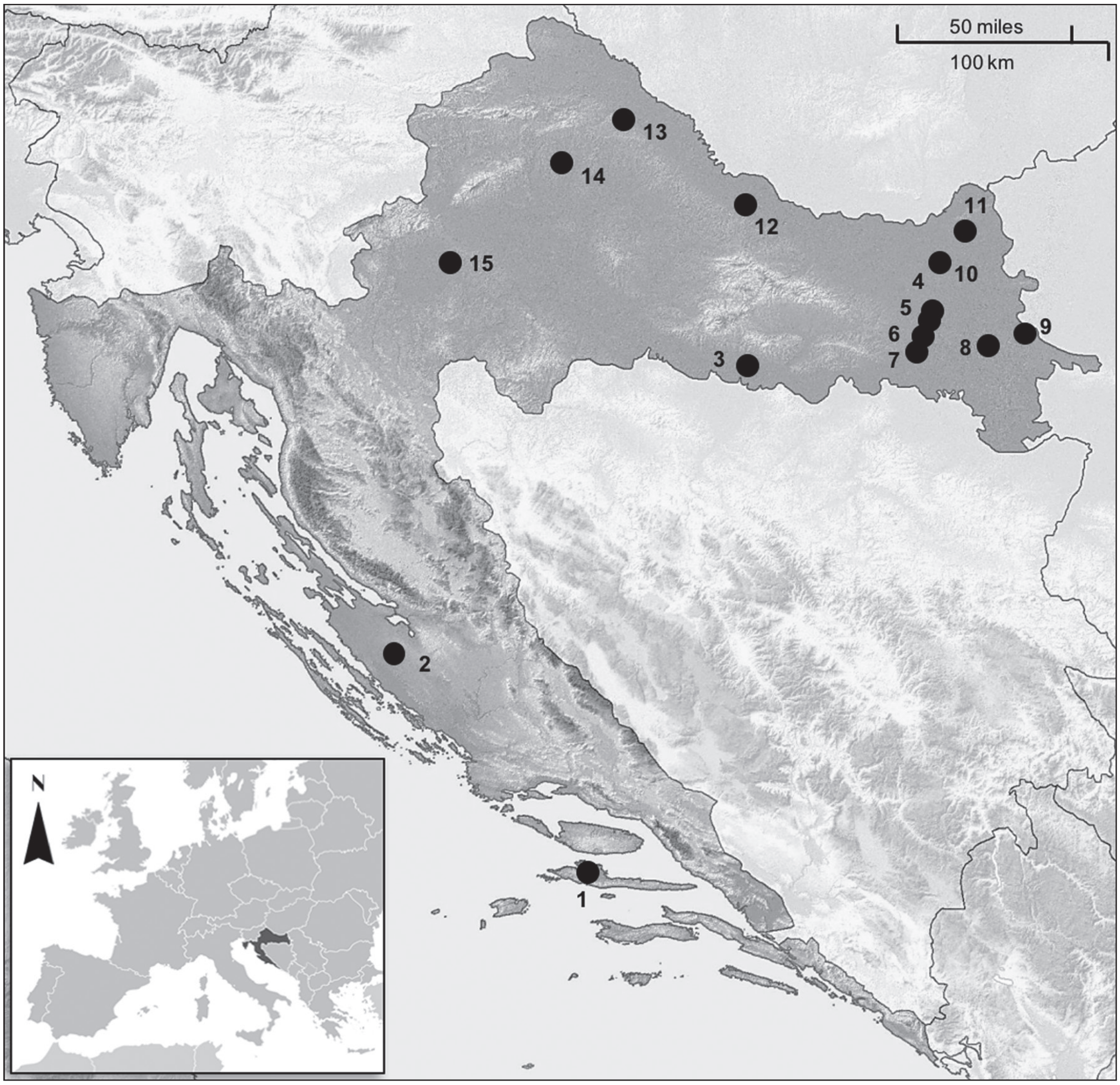
Map 1. Map of Croatia showing the location of Neolithic sites with archaeobotanical remains (1) Krćina and Turska Peć, (2) Grapčeva, (3) Danilo, (4) Pokrovnik, (5) Cista Mala- Velištak, (6) Tinj-Podlivade, (7) Crno Vrilo, (8) Kargadur-Ližnjan, (9) Gromače-Brijuni, (10) Brezovljani, (11) Virovitica-Brekinja, (12) Slavća, (13) Ravnjaš-Nova Kapela, (14) Zadubravlje-Duine, (15) Tomašanci-Palača, (16) Ivandvor-Gaj, (17) Pajtenica-Velike Livade, (18) Sopot, (19) Otok, (20) Bapska.

ing this period from the warm Atlantic period to a cooler Subboreal environment.

Archaeobotanical research for the Eneolithic is limited in the Carpathian Basin and current theories in the region suggest that the change in climate, as well as possible soil deterioration, may have influenced a shift in focus from crop cultivation to animal husbandry, as well as a shift towards hardier crops, such as barley.[21] However, recent archaeobotanical research in Croatia has begun to question this.[22] From the examination of thirteen Eneolithic sites (Tab. 1, Map 2) continuation from the preceding Neolithic is seen in the range of crop species recovered (i.e. the continued cultivation of emmer, einkorn and barley) suggesting crop agriculture did not change significantly during this period. Unfortunately, the limited archaeobotanical data has restricted further interpretation of possible

[21] Kosse 1979; Gyulai 2010.

[22] Reed 2013; 2016.



Map 2. Map of Croatia showing the location of Eneolithic sites with archaeobotanical remains (1) Grapčeva, (2) Buković-Lastvine, (3) Slavća, (4) Pajtenica-Velike Livade, (5) Jurjevac-Stara Vodenica, (6) Tomašanci-Palača, (7) Đakovo-Franjevac, (8) Vinkovci, 14 Matije Gupca, (9) Vučedol, (10) Čepinski Martinci-Dubrava, (11) Čeminac-Vakanjac, (12) Virovitica-Batelije, (13) Potočani (14) Barbarsko, (15) Lasinja.

cultivation methods.[23] Therefore questions regarding the introduction of ploughs and draft animals in agriculture and the relationship between agriculture and changes in society are still unknown.

[23] E.g. Bogaard 2004; Kreuz, Schäfer 2011.

Bronze Age (ca. 2400 to 900 cal BC)

Once again the Bronze Age sees a re-organisation of society with episodes of population migration and transhumance from as far as the Russian steppes, the Aegean and Anatolia.[24] The European Bronze Age (ca. 2500 – 750 BC) is also characterised by the rise of 'élites' and social ranking,[25] which had a direct effect on settlements, resulting in the

[24] Kovács 1977; Todorova 1989; Gerling *et al.* 2012.

[25] Harding 2000; Earle 2002; Kristiansen, Larsson 2005.

appearance of larger more substantial sites located on hilltops or prominent positions which offered strategic control over an area.[26] In the Carpathian Basin, some suggest the emergence of these larger settlements indicate political centres that controlled manufacture, trade and production, while smaller periphery settlements focused on supplying these centres with goods including plant and animal products.[27]

The European Bronze Age also sees distinct changes in crop cultivation where certain species begin to be regularly cultivated as crops in their own right. These include broomcorn millet (*Panicum milliaceum*), spelt (*Triticum aestivum ssp. spelta*) and broad bean (*Vicia faba*).[28] New cultivated species are also seen in the Carpathian Basin, including the oil plant gold of pleasure (*Camelina sativa*) and Safflower (*Carthamus tinctorius*).[29] However, how agriculture developed in the face of changing social organisation is still unclear.

In Croatia, eleven Bronze Age settlements, including a hillfort, cave and necropolis, have so far yielded carbonised archaeobotanical remains (Tab. 1, Map 3). Unfortunately, the majority of these sites had low quantities of plant remains, restricting interpretation. Of particular interest is the increase in presence of broomcorn millet (*Panicum miliaceum*), which may support the theory that it began to be cultivated as a summer crop during this period.[30] At Ĉauševica the recovery of *Olea* fragments may also indicate some of the earliest evidence of wild olives in Dalmatia.[31] Thus, the limited data so far suggests that the choice of crops cultivated changed at this time in the Balkans, but the why and how are still unknown.

The recovery of plant remains from sites can also provide information about the past local environment, which can be particularly important when reconstructing agricultural activities. At Torčec-Gradić, for example, the archaeological recovery of *Alisma plantagoaquatica* from a Bronze Age occupation layer, suggested that the landscape once had areas of standing water, possibly areas of marsh land.[32] Thus, agriculture would have had to be conducted away from these waterlogged areas, or if seasonal, may have restricted the growing and grazing seasons of the crops and livestock in the vicinity of the settlement.

Iron Age (ca.1000 to 100 cal BC)

The Iron Age sees the continuation and emergence of large proto-urban centres, the centralisation of authority and the intensification of trade.[33] Rich burials containing imported luxury items also attest to the transportation of luxury goods at this time.[34] Hillforts persist, but very few have been extensively excavated in Croatia and as such little is known about these settlements. Evidence of archaeobotanical remains from the Iron Age are also rare with only three known sites, Kaptol-Gradci, Nadin-Gradine and Sisak, yielding carbonised plant macro-remains (Tab. 1, Map 3). At Kaptol-Gradci, evidence of cereals, wild fruits and weeds from a cremation grave suggest possible ritual activities where these plants may have been placed on the funeral pyre and later collected and deposited in the tumulus.[35] In Dalmatia, Nadin-Gradine hillfort provides evidence of spelt wheat (*Triticum* cf. *aestivum* ssp. *spelta*), six-row barley (*Hordeum vulgare* ssp. *vulgare*), broomcorn millet (*Panicum miliaceum*) and grape (*Vitis* sp.),[36] but due to the low quantity recovered no additional analyses have been conducted.

[26] Kovács 1977; Dimitrijević, Težak-Gregl, Majnarić-Pandžić 1998; Pavišić 2012.

[27] Gogâltan 2008.

[28] Akeret 2005; Valamoti 2016.

[29] Kroll 1990; Medović 2002; Gyulai 2010, 105.

[30] Reed 2013; Valamoti 2016.

[31] Huntley 1996a.

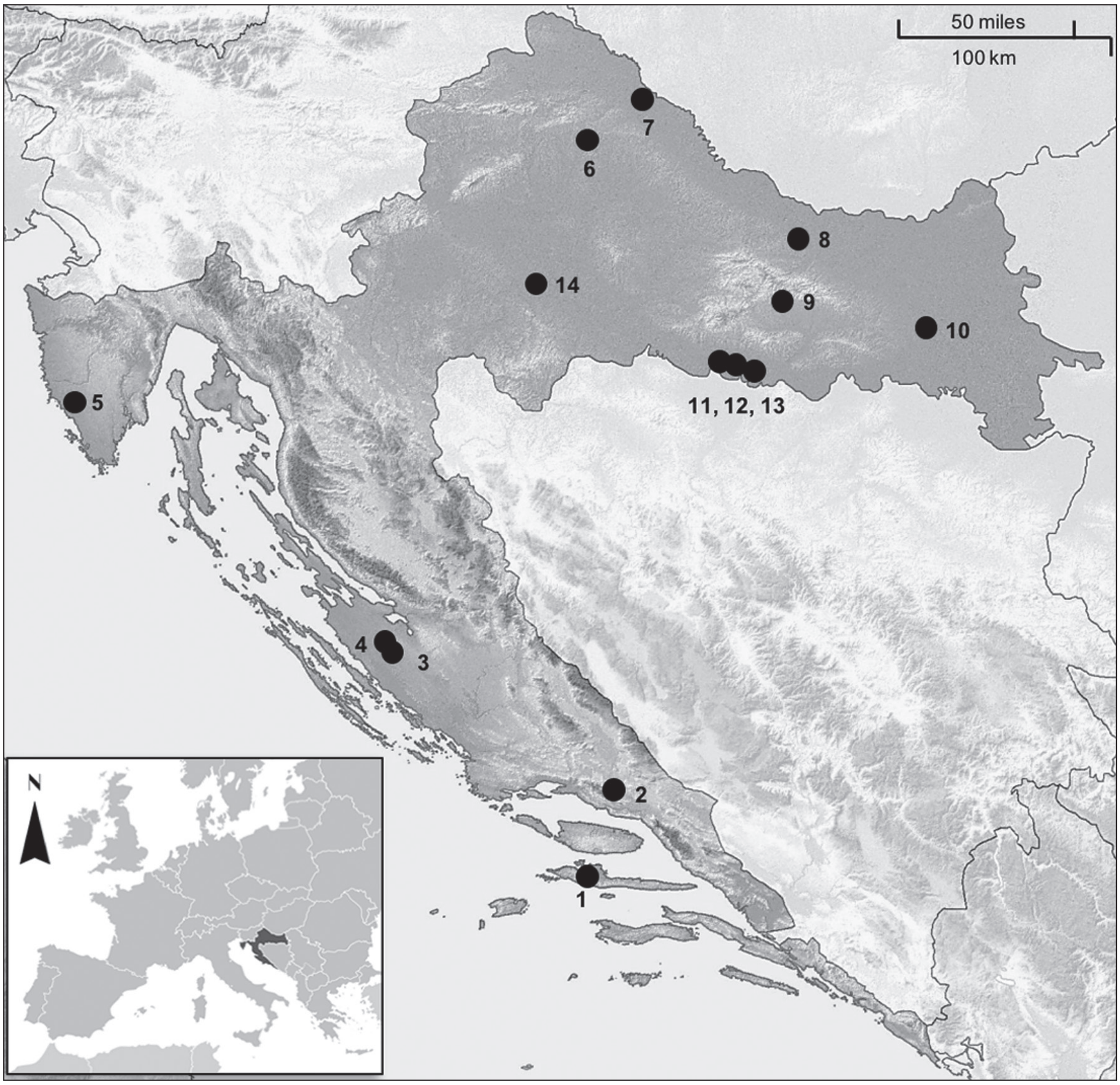
[32] Šoštarić 2004.

[33] Forenbaher 1995.

[34] Potrebica 2013.

[35] Hršak 2009.

[36] Nye 1996.



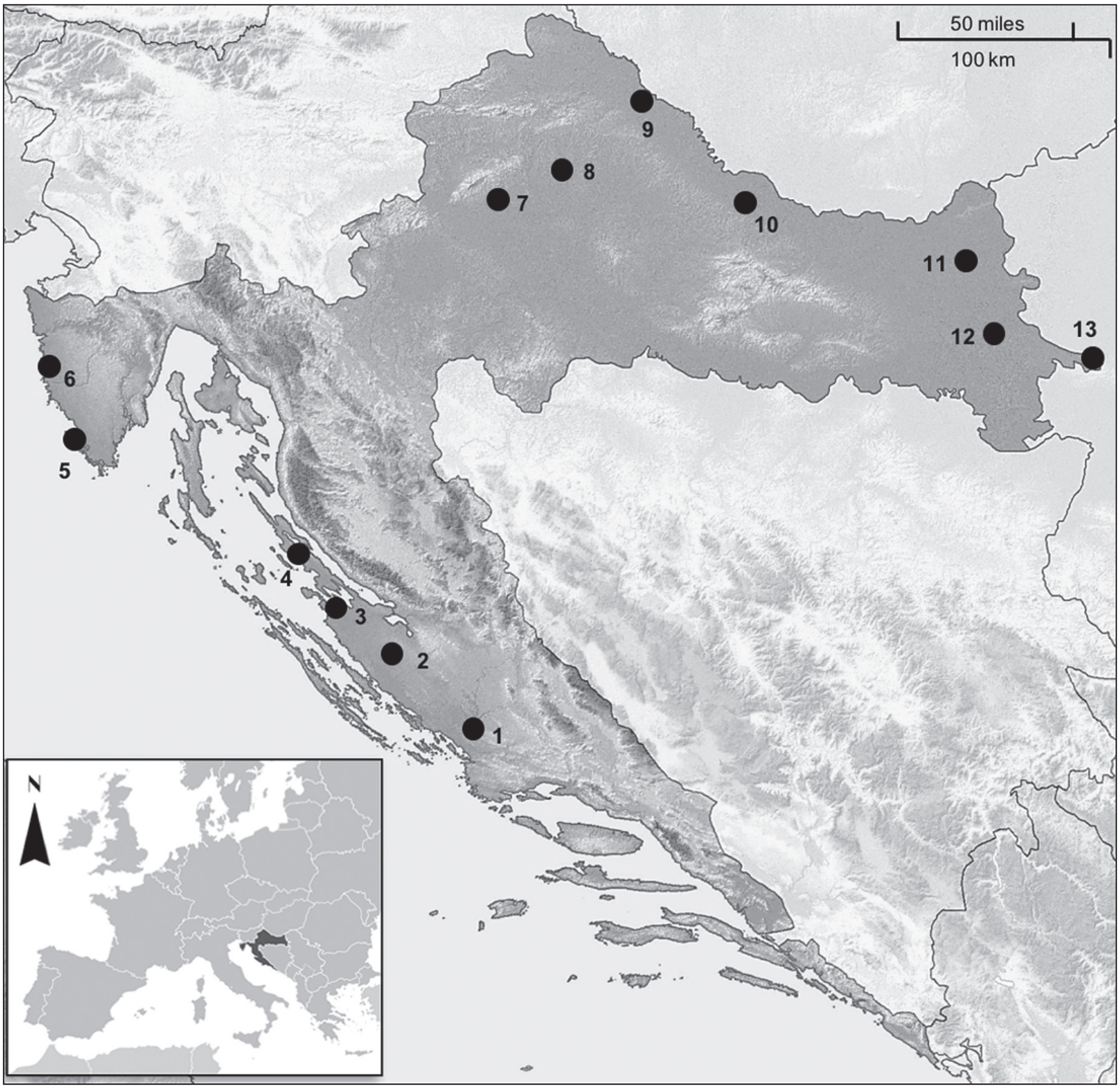
Map 3. Map of Croatia showing the location of Bronze and Iron Age sites with archaeobotanical remains referred (1) Grapčeva, (2) Okruglo, (3) Nadin-Gradina, (4) Ĉauševica, (5) Monkodonja, (6) Kalnik-Igrišče, (7) Torčec-Gradić, (8) Nova Bukovica-Sjenjak, (9) Kaptol-Gradici (10) Tomašanci-Palača, (11) Mačkovac-Crišnjevi, (12) Crišnjevi-Oštrov, (13) Orubica-Veliki Šeš, (14) Sisak.

Recent excavations at Sisak, Croatia, unearthed an early Iron Age pot filled with archaeobotanical remains within the floor of a structure dating to between the 6th and 4th centuries BC.[37] Preliminary results found a high concentration of foxtail millet (*Setaria italica*) within the pot, providing for the first time evidence of millet cultivation in the early Iron Age. This is particularly interesting as an increase in millet consumption in continental Croatia during the Iron Age has been suggested from carbon and nitrogen stable isotope analysis of Bronze Age and Iron Age human bones.[38]

The low recovery of archaeolobotanical remains from Iron Age sites, however, presents a large gap in our understanding of the development of agriculture at this time and how the development of proto-urban centres may have influenced production and consumption in the region.

[37] Reed, Drnić 2016.

[38] Lightfoot *et al*. 2015.



Map 4. Map of Croatia showing the location of Roman and Middle Age sites with archaeobotanical remains (1) Danilo, (2) Nadin-Gradina, (3) Port of Aenona/Zaton, (4) Caska, (5) Veli Brijun, (6) Poreč, (7) Sćitarjevo, (8) Vrbovca, (9) Prečno Pole I, Pod Gucak, Ledine, Rudičevo, Torčec-Gradić, Blaževo Pole 6, (10) Vitrovitica Kiškorija, (11) Osijek-Silos, (12) Nuštar, (13) Ilok.

ROMAN (1ST – 5TH CENTURY AD)

The initial Roman province of Illyricum (Dalmatia) was gradually enlarged during a series of wars that brought much of the Dalmatian coast and continental Croatia within their control by 9 BC.[39] During the 1st to 3rd centuries AD, the region was reorganised into Dalmatia and Upper (Superior) and Lower (Inferior) Pannonia. The Romans ruled the area for five centuries, making Salona (now Solin) their administrative headquarters, while trade prospered through the building of road networks, linking the coast with the Aegean and Black Seas and with the Danube.

In Croatia, ten Roman sites have yielded plant remains, including those preserved through carbonisation, waterlogging and mineralisation (Tab. 1, Map 4). In particular plant remains preserved by waterlogging were recovered from the Roman villa of Veli Brijun and from the ancient harbor at Zaton providing the first evidence of vegetable and spice plants such as cucumber (*Cucumis sativus*), black mustard (*Brassica nigra*), carrot (*Daucus sativus*), radish

[39] Migotti 2012.

(*Raphanus sativus*) and chicory (*Cichorium intybus*).[40] The most frequently recorded plant remains from these sites were of grape (*Vitis vinifera*), olive (*Olea europaea*) fig (*Ficus carica*), walnut (*Juglans regia*) and pine nuts (*Pinus pinea*). These fruits and nuts were all likely grown in Dalmatia and their presence at the Port and at the villa show that they were transported and traded across the region. The growth of olives and grapes would have also supported the production of oil and wine in Dalmatia, seen from the archaeological remains of olive and grape pressing facilities, such as at Škicini.[41]

Plant macro-remains collected from two Roman cemeteries, Illok and Sčitarjevo, have also provided information about Roman ritual activities and in the case of Illok an insight into the process of early Romanization of the Limes.[42] For example, many of the cereal remains were recovered carbonised which suggested that these grains had been placed on the funeral pyre. On the other hand, remains of fruits and lentil (*lens culinaris*), which were not carbonised, were placed in the grave either in a fresh, dried or cooked form and may indicate activities associated with a funerary feast or a sacrifice to the gods.[43] Trade links with the Mediterranean are also seen from the remains of olive and fig.

Written accounts also suggest that agriculture flourished during the Roman period with a reference giving permission to grow vines in Pannonia from the Emperor Probus (276 – 282 AD) and in the 4th century a reference to Pannonia being a land rich in agricultural produce and cattle.[44] Unfortunately, the archaeobotanical remains so far provide little information about the main cereal crops grown during this time and whether agriculture became 'Romanized' during this period, especially in the Limes of the Croatian Danube region.

EARLY AND LATE MIDDLE AGES (7TH TO 12TH CENTURY AD AND 13TH TO 16TH CENTURY AD)

After the fall of the Roman Empire the Carpathian Basin once again filled with migrating nomadic, semi-nomadic and military groups (e.g. Avars, Byzantines, Huns). The Avars in particular began to settle in continental Croatia (ca. 6th/7th century AD) establishing more permanent settlements and cemeteries as part of the Avar Khaganate (Kingdom), which encompassed the Carpathian Basin. The only archaeobotanical evidence directly associated with the Avars is from a Late Avar cemetery near Nuštar.[45] The carbonised remains, although low in quantity, included cereals, such as rye and barley, and a small number of wild plant/weed species, as well as the recovery of 32 burnt fragments interpreted as food mush, possibly from cereals. Unfortunately these remains only hint at the types of ritual activities that may be associated with Avar funerary practices and the types of crops that may have been cultivated.

A series of Middle Age settlements in the region of Torčec (Tab. 1, Map 4), provide the majority of the archaeobotanical evidence for the 7th to 15th century.[46] Carbonised remains of cereals such as naked and spelt wheat (*Triticum aestivum* group, including *T aestivum* ssp. *spelta*) and millet (*Panicum miliaceum*) dominated, while barley (*Hordeum vulgare* ssp. *vulgare*), oat (*Avena* sp.) and foxtail millet (*Setaria italica*) were only identified sporadically. Flax (*Linum usitatissimum*) and fruits such as peach (*Prunus persica*) and grapes (*Vitis vinifera*) were also likely cultivated in the region. However, the limited number of sites and archaeobotanical evidence has restricted our understanding of the development of agriculture at this time, with little understanding of the development of land ownership, differences in consumption between the classes, as well as the relationship between the towns and villages.

40 Šoštarić, Küster 2001; Krajačić 2009.

41 Buršić-Matijašić 1988.

42 Dizdar, Šoštarić, Jelinčić 2003.

43 Šoštarić *et al.* 2006.

44 Oliva 1962, 316–318.

45 Rapan Papeša, Kenéz, Petö 2015.

46 Šoštarić 2004; Šoštarić, Šegota 2010; 2010a.

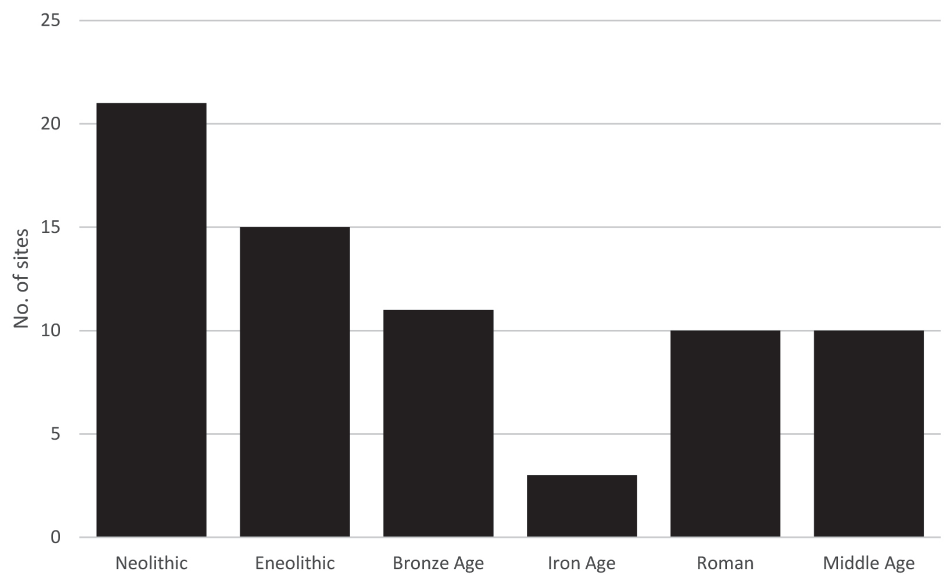


Figure 1. Number of sites with archaeobotanical remains per period.

SUMMARY OF THE ARCHAEOBOTANICAL EVIDENCE FROM CROATIA

A total of 70 sites have yielded plant macro-remains, whether preserved through waterlogging, mineralisation or carbonisation. Despite this the data is heavily biased towards prehistoric sites, particularly the Neolithic (Fig. 1), with periods such as the Iron Age only being represented by a small number of plant remains from three archaeological sites. Datasets are also limited, whether from poor preservation, low volumes of sediment collected or from a small number of samples taken, restricting further interpretation, such as reconstructing crop husbandry regimes (i.e. whether a field is manured, watered or weeded). The potential to explore agricultural activities have begun to be seen in Neolithic research in Croatia, as well as aspects of trade during the Roman period; however, the full potential of archaeobotanical research in Croatia is still to be realised. It is therefore important that archaeobotanical recovery be incorporated within all new excavations within Croatia. The following section highlights some of the key aspects to consider when recovering carbonised plant macro-remains from archaeological sites.

RECOVERING CARBONISED PLANT REMAINS FROM ARCHAEOLOGICAL SITES

The most common form by which plant material is preserved on archaeological sites in Croatia is through carbonisation or charring, although other forms of preservation can also be found including mineralisation and waterlogging. Carbonisation occurs when organic material is exposed to heat either accidentally or deliberately, through activities such as cooking, burning rubbish or using fuel.[47] Therefore the recovery of carbonised remains can provide a direct link to human activities at an archaeological site.

Sampling

The recovery rate of archaeobotanical evidence is dependent on both the strategy of the excavation and the environmental conditions of the site. It is important that a sampling strategy be created prior to excavation and in consultation with an archaeobotanist, although it can always be modified as the project progresses. This ensures sufficient samples are taken for producing

[47] Van der Veen 2007.

statistically significant results, as well as for applying a range of relevant analytical techniques to answer the research questions of the project (e.g. how were the cereals grown and processed).

In order to reconstruct a reasonable and representative picture of agricultural and domestic activities on a site, samples need to be collected from a wide range of structures and features.[48] It is important to not target areas solely on the evidence of charcoal, as many of the plant remains will not be visible to the naked eye. In addition, multiple samples within structures and features should be taken, in order to identify the full range of activities associated with that area. For example, floor levels should be sampled at different places to allow spatial/depositional analyses (sampling each grid or every other grid is a good strategy). Generally, the more samples that are collected the greater the number of species recovered at a site.[49]

Samples also need to be large enough to sufficiently represent the deposited plant remains in that feature. Research suggests that small samples are more likely to over-represent more abundant taxa, while there is a greater probability of encountering rare taxa in larger samples.[50] Large samples also increase the probability that sufficient numbers of seeds are collected to allow certain statistical analyses.

In Croatia, seed density is particularly low at many sites, usually less than one seed per litre, which means that larger samples should be taken.[51] Where practical at least 50 litres should be taken per sample; however, where time/resources are restricted sub-samples can be taken to assess seed density before the rest of the sample is floated. This way samples with few plant remains can be abandoned, while rich samples can be fully processed.

48 Hillman 1981.

49 Reed 2013, Chapter 10, Fig. 10.1.

50 Melzter, Leonard, Stratton 1992.

51 Reed 2013.

Recovery

One of the main methods to recover plant remains is through flotation, where sediment is placed on a sieve in water and gently agitated to allow the organic material, in this case the carbonised plant remains, to float to the surface (light fraction or flot), while the sediment and other heavy materials sink to the bottom (heavy fraction or residue). There are a number of different ways to undertake this, which may depend on the availability of equipment, water and power, as well as, the type of soil and size of samples to be processed. A flotation machine is well suited to large samples and especially to sandy sediments with light carbonised macro-remains, but can require a large amount of water, power and a suitable location to dispose of the sediment. Machine flotation can be less suited to clay-rich soils, as the sample may not disperse easily, which can impede the release of the carbonised material.[52] On the other hand, bucket flotation is useful for small samples, and in some cases can shorten the processing time and decrease the amount of remains that are damaged and lost because of continued submergence and agitation. It is also a more mobile process that can be applied in the field (Fig. 2).

An important aspect of flotation, as well as in sieving, is that recovery efficiency is based heavily on the size of the sieve or mesh used to collect both the light and heavy fraction. For example, if the sieve used for the light fraction is 1mm in size any plant material smaller than this will be lost. This will have a large impact on what species are recovered and will ultimately affect interpretation. It is generally accepted that a sieve of 300 – 500 μm is sufficient for the recovery of most archaeological plant material.[53]

52 Wagner 1988.

53 Pearsall 2000.

Figure 2. Bucket flotation to recover carbonised plant macro-remains, (a) the heavy residue and (b) the flot. Osijek, 2014 (Photo by K. Reed).

Recording

It is essential that all samples are adequately recorded and labelled, especially if they are to be floated or analysed at a later date. Sample records should provide information on:

– Site, context number and any other location information

– Context type (e.g. pit, house floor)

– Sample number

– The volume of the sample (before flotation)

– Date or period of context

It may also be useful to identify how much of a context was sampled, e.g. top or bottom half of a pit (50%). Labelling must also be legible, consistent and permanent. It is best to use plastic or plasticised labels and permanent markers. Samples should have a label inside and outside of the flot or sample to prevent loss of information. In addition, floated samples should be dried thoroughly before storage as when wet they can encourage the growth of fungi or bacteria, which will destroy the plant remains.

CONCLUSION

The study of archaeobotany in Croatia is still relatively young, with few excavations conducting sampling programmes. The majority of plant remains recovered at archaeological sites in Croatia are carbonised and as such provide valuable information about human activities at the sites. To go beyond questions about what plants were present when; planned sampling strategies need to be implemented for all new archaeological excavations. Already archaeobotanical research has begun to show the possible information that can be gained not only on past agricultural strategies, but also on ritual activities and trade networks. As more data is collected more complex questions can be asked and a greater understanding of the role of agriculture in social, cultural, technological and economic changes can be achieved.

BIBLIOGRAPHY

Akeret 2005 – Ö. Akeret, »Plant remains from a Bell Beaker site in Switzerland, and the beginnings of *Triticum spelta* (spelt) cultivation in Europe«, *Vegetation History and Archaeobotany*, Basel, XIV/4, 2005, 279–286.

Bailey 2000 – D. W. Bailey, *Balkan Prehistory: Exclusion, Incorporation and Identity*, London, Routledge, 2000.

Balen 2002 – J. Balen, »Topografija nalazišta kostolačke kulture u sjevernoj Hrvatskoj«, *Vjesnik Arheološkog muzeja u Zagrebu*, Zagreb, 3. s., XXXV, 2002, 35–52.

Bass 2008 – B. Bass, »Early Neolithic communities in Southern Dalmatia: Farming seafarers or seafaring farmers?«, *European Journal of Archaeology*, Praha, XI/2-3, 2008, 245–265.

Biagi 2003 – P. Biagi, »New data on the Early Neolithic of the upper Adriatic region«, in Nikolova, L. (ed.), *Early Symbolic Systems for Communication in Southeast Europe*, BAR International Series 1139, Oxford, Archaeopress, 2003, 337–346.

Bogaard 2004 – A. Bogaard, *Neolithic Farming in Central Europe: An Archaeobotanical Study of Crop Husbandry Practices*, London, Routledge, 2004.

Bognar-Kutzian 1972 – I. Bognar-Kutzian, *The Early Copper Age Tiszapolgar Culture in the Carpathian Basin*, Budapest, Archaeologica Hungarica Akademiai Kaido, 1972.

Bogucki 1996 – P. Bogucki, »The spread of early farming in Europe«, *American Scientist*, Chapel Hill, LXXXIV, 1996, 242–253.

Borić 2005 – D. Borić, »Fuzzy horizons of change: orientalism and the frontier model in the Mesolithic-Neolithic transition«, in Milner, N., Woodman, P. (eds.), *Mesolithic Studies at the Beginning of the 21st Century,* Oxford, Oxbow Books, 2005, 81–105.

Borojević et al. 2008 – K. Borojević et al., »Plant use at Grapčeva cave and in the eastern Adriatic Neolithic«, *Journal of Field Archaeology*, Boston, XXXIII/3, 2008, 279–303.

Burić 2008 – M. Burić, »Bapska-Gradac«, *Hrvatski arheološki godišnjak*, Zagreb, IV, 2007 [2008], 45–46.

Buršić-Matijašić 1988 – K. Buršić-Matijašić, »Tragovi prethistorije Mutvorana i okolice«, *Prilozi o zavičaju*, Pula, V, 1988, 95–104.

Chapman, Müller 1990 – J. C. Chapman, J. Müller, »Early Farmers in the Mediterranean Basin: The Dalmatian Evidence«, *Antiquity*, Durham, LXIV, 1990, 127–134.

Chapman, Shiel, Batović 1996 – J. C. Chapman, R. Shiel, Š. Batović, *The Changing Face of Dalmatia*, Leicester, Leicester University Press, 1996.

Chevalier, Marinova, Peña-Chocarro 2014 – A. Chevalier, E. Marinova, L. Peña-Chocarro (eds.), *Plants and People: Choices and Diversity through Time*, Earth Series 1, Oxford, Oxbow, 2014.

Çilingiroğlu 2005 – Ç. Çilingiroğlu, »The concept of 'Neolithic package': considering its meaning and applicability«, *Documenta Praehistorica*, Ljubljana, XXXII, 2005, 1–13.

Colledge, Conolly 2007 – S. Colledge, J. Conolly (eds.), *The Origins and Spread of Domestic Crops in Southwest Asia and Europe*, Walnut Creek, Left Coast Press, 2007.

Conolly, Colledge, Shennan 2008 – J. Conolly, S. Colledge, S. Shennan, »Founder effect, drift, and adaptive change in domestic crop use in early Neolithic Europe«, *Journal of Archaeological Science*, Amsterdam, XXXV/10, 2008, 2797–2804.

Čičak 2015 – M. Čičak, *Arheobotaničko istraživanje antičke luke u Zatonu kraj Nina*, master's thesis, Zagreb, Sveučilište u Zagrebu, Prirodoslovno-matematički fakultet, 2015.

Davison *et al.* 2006 – K. Davison *et al.*, »The role of waterways in the spread of the Neolithic«, *Journal of Archaeological Science*, Amsterdam, XXXIII/5, 2006, 641–652.

Dimitrijević, Težak-Gregl, Majnarić-Pandžić 1998 – S. Dimitrijević, T. Težak-Gregl, N. Majnarić-Pandžić, *Prapovijest*, Zagreb, Naprijed, 1998.

Dizdar, Šoštarić, Jelinčić 2003 – M. Dizdar, R. Šoštarić, K. Jelinčić, »Ranorimski grob iz Iloka kao prilog poznavanju romanizacije zapadnoga Srijema«, *Prilozi Instituta za arheologiju u Zagrebu*, Zagreb, XX, 2003, 57–77.

Đukić 2014 – A. Đukić, »Biljni ostaci s četiri novoistraživana lokaliteta Đakovštine / Plant remains from four newly excavated sites in the Đakovo region«, *Vjesnik Arheološkog muzeja u Zagrebu*, Zagreb, 3. s., XLVII, 2014, 7–37.

Earle 2002 – T. Earle, *Bronze Age Economies: The Beginnings of Political Economies*, Oxford, Westview Press, 2002.

Forenbaher 1995 – S. Forenbaher, »Trade and Exchange in Late Bronze and Early Iron Age Croatia«, in Hänsel, B. (ed.), *Handel, Tausch und Verkehr im bronze- und früheisenzeitlichen Südosteuropa*, Südosteuropa-Schriften 17, Prähistorische Archäologie in Südosteuropa 11, München etc., Südosteuropa-Gesellschaft, 1995, 269–282.

Forenbaher, Kaiser, Miracle 2013 – S. Forenbaher, T. Kaiser, P. Miracle, »Dating the East Adriatic Neolithic«, *European Journal of Archaeology*, Praha, XVI/4, 2013, 589–609.

Forenbaher, Miracle 2005 – S. Forenbaher, P. Miracle, »The spread of farming in the eastern Adriatic«, *Antiquity*, Durham, LXXIX/305, 2005, 514–528.

Gerling *et al.* 2012 – C. Gerling *et al.*, »Immigration and transhumance in the Early Bronze Age Carpathian Basin: the occupants of a kurgan«, *Antiquity*, Durham, LXXXVI/334, 2012, 1097–1111.

Gluščević *et al.* 2006 – S. Gluščević *et al.*, »Evidence for the Nutrition of Sailors from the Roman Harbour at Zaton near Zadar«, *Archaeologia Maritima Mediterranea*, Pisa etc., III, 2006, 147–161.

Gnirs 1925 – A. Gnirs, *Istria Praeromana*, Karsbad, Verlag von Walther Heimisch 1925.

Gogâltan 2008 – F. Gogâltan, »Fortificaţiile tellurilor epocii bronzului din Bazinul Carpatic. O privire«. *Analele Banatului*, Timişoara, XVI, 2008, 81–100.

Greenfield 2005 – H. Greenfield, »A reconstruction of the secondary products revolution in South-eastern Europe: on the origins and the use of domestic animals for milk, wool, and traction in central Balkans«, in Mulville, J., Outram, A. (eds.), *The Zooarchaeology of Fats, Oils, Milk and Dairying, Proceedings of the 9th ICAZ Conference*, Oxford, Oxbow, 2005, 14–31.

Gyulai 2010 – F. Gyulai, *Archaeobotany in Hungary: Seed, Fruit, Food and Beverage Remains in the Carpathian Basin from the Neolithic to the Late Middle Ages*, Budapest, Archaeolingua, 2010.

Hadjikoumis, Robinson, Viner 2011 – A. Hadjikoumis, E. Robinson, S. Viner (eds.), *The Dynamics of Neolithisation in Europe: Studies in honour of Andrew Sherratt*, Oxford, Oxbow books, 2011.

Hänsel, Mihovilić, Teržan 1997 – B. Hänsel, K. Mihovilić, B. Teržan, »Monkodonja: utvrđeno protourbano naselje starijeg i srednjeg brončanog doba kod Rovinja u Istri«, *Histria Archaeologica*, Pula, XXVIII, 1997, 37–107.

Harding 2000 – A. Harding, *European Societies in the Bronze Age*, Cambridge, Cambridge University Press, 2000.

Harris 1996 – D. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia*, London, University College London Press, 1996.

Harris, Hillman 1989 – D. Harris, G. Hillman (eds.), *Foraging and farming: The evolution of plant exploitation*, One World Archaeology 13, London, Unwin Hyman, 1989.

Hillman 1981 – G. Hillman, »Reconstructing crop husbandry practices from charred remains of crops«, in Mercer, R. (ed.), *Farming Practices in British Prehistory*, Edinburgh, Edinburgh University Press, 1981, 123–162.

Hopf 1964 – M. Hopf, »Untersuchung der Getreidereste im Hüttenlehm aus Danilo«, in Korošec, J. (ed.), *Danilo in danilska kultura*, Ljubljana, Univerzitetna založba, 1964, 107–108.

Hršak 2009 – J. Hršak, *Karbonizirani makrofosili s prapovijesnog lokaliteta Kaptol-Gradci kraj Požege*, master's thesis, Zagreb, Sveučilište u Zagrebu, Prirodoslovno-matematički fakultet, 2009.

Huntley 1996 – J. Huntley, »The plant remains«, in Chapman, J., Shiel, R., Batović, Š. (eds.), *The Changing Face of Dalmatia*, Leicester, Leicester University Press, 1996, 187–189.

Huntley 1996a – J. Huntley, »The plant remains«, in Chapman, J., Shiel, R., Batović, Š. (eds.), *The Changing Face of Dalmatia*, Leicester, Leicester University Press, 1996, 204–205

Huntley 1996b – J. Huntley, »The plant remains«, in Chapman, J., Shiel, R., Batović, Š. (eds.), *The Changing Face of Dalmatia*, Leicester, Leicester University Press, 1996, 225.

Karg, Müller 1990 – S. Karg, J. Müller, »Neolithische Getreidefunde aus Pokrovnik, Dalmatien«, *Archäologisches Korrespondenzblatt*, Mainz, XX, 1990, 373–386.

Komšo 2006 – D. Komšo, »Kargadur«, *Hrvatski arheološki godišnjak*, Zagreb, II, 2005 [2006], 212–214.

Kosse 1979 – K. Kosse, *Settlement ecology of the Early and Middle Neolithic Körös and linear pottery cultures in Hungary*, BAR International Series 64, Oxford, Archaeopress, 1979.

Kovács 1977 – T. Kovács, *The Bronze Age in Hungary*, Budapest, Hereditas, 1977.

Krajačić 2009 – M. Krajačić, *Biljni makrofosili iz Antičke Luke u Zatonu kraj Nina*, master's thesis, Zagreb, Sveučilište u Zagrebu, Prirodoslovno-matematički fakultet, 2009.

Kreuz, Schäfer 2011 – A. Kreuz, E. Schäfer, »Weed finds as indicators for the cultivation regime of the early Neolithic Bandkeramik culture?«, *Vegetation History and Archaeobotany*, Basel, XX/5, 2011, 333–348.

Kristiansen, Larsson 2005 – K. Kristiansen, T. Larsson, *The Rise of Bronze Age Society: Travel, Transmissions and Transformations*, Cambridge, Cambridge University Press, 2005.

Kroll 1990 – H. Kroll, »Ein Fruchtfund von *Carthamus tinctorius* belegt diese Färbepflanze für die Bronzezeit Jugoslaviens«, *Archäologisches Korrespondenzblatt*, Mainz, XX, 1990, 41–46.

Legge, Moore 2011 – T. Legge, A. Moore, »Clutching at straw: the Early Neolithic and the dispersal of agriculture«, in Hadjikoumis, A., Robinson, E., Viner, S. (eds.), *The Dynamics of Neolithisation in Europe: Studies in honour of Andrew Sherratt*, Oxford, Oxbow books, 2011, 176–195.

Lightfoot *et al.* 2015 – E. Lightfoot *et al.*, »Metals and millets: Bronze and Iron Age diet in inland and coastal Croatia seen through stable isotope analysis«, *Archaeological and Anthropological Sciences*, Cham, VII/3, 375–386.

Mareković 2013 – S. Mareković, *Karbonizirani biljni ostaci kasnobrončanodobnog lokaliteta Kalnik-Igrišče*, doctoral thesis, Zagreb, Sveučilište u Zagrebu, Prirodoslovno-Matematički Fakultet, 2013.

Mareković *et al.* 2015 – S. Mareković *et al.*, »The botanical macroremains from the prehistoric settlement Kalnik-Igrišče (NW Croatia) in the context of current knowledge about cultivation and plant consumption in Croatia and neighboring countries during the Bronze Age«, *Acta Societatis Botanicorum Poloniae*, Wrocław, LXXXIV/2, 2015, 227–235.

Medović 2002 – A. Medović, »Archäobotanische Untersuchungen in der metallzeitlichen Siedlung Židovar, Vojvodina/Jugoslawien. Ein Vorbericht«, Старинар, Beograd, LII, 2002, 181–190.

Melzter, Leonard, Stratton 1992 – D. Meltzer, R. Leonard, S. Stratton, »The relationship between sample size and diversity in archaeological assemblages«, *Journal of Archaeological Science*, Amsterdam, XIX/4, 1992, 375–387.

Migotti 2012 – B. Migotti (ed.), *The Archaeology of Roman southern Pannonia: the state of research and selected problems in the Croatian part of the Roman province of Pannonia*, BAR International Series 2393, Oxford, Archaeopress, 2012.

Müller 1994 – J. Müller, *Das ostadriatische Frühneolithikum: Die Impresso-Kultur und die Neolithisierung des Adriaraumes*, Prähistorische Archäologie in Südosteuropa 9, Berlin, Wissenschaftsverlag Volker Spiess, 1994.

Nye 1996 – S. Nye, »The plant remains«, in Chapman, J., Shiel, R., Batović, Š. (eds.), *The Changing Face of Dalmatia*, Leicester, Leicester University Press, 1996, 240–242.

Obelić, Horvatinčić, Krajcar Bronić 2002 – B. Obelić, N. Horvatinčić, I. Krajcar Bronić, »Rudjer Boškovic Institute Radiocarbon Measurements XV«, *Radiocarbon*, Tucson, XLIV/2, 2002, 601–630.

Oliva 1962 – P. Oliva, *Pannonia and the onset of crisis in the Roman Empire*, Praha, Nakladatelství Československé akademie věd, 1962.

Orton 2012 – D. Orton, »Herding, Settlement, and Chronology in the Balkan Neolithic«, *European Journal of Archaeology*, Praha, XV/1, 2012, 5–40.

Parkinson *et al.* 2004 – W. Parkinson *et al.*, »Settlement reorganization at the end of the Neolithic in Central Europe: Recent research in the Körös River Valley, southeastern Hungary«, *Eurasian Prehistory*, Cambridge, II/2, 2004, 57–73.

Parkinson *et al.* 2010 – W. Parkinson *et al.*, »Early copper age settlements in the Körös region of the Great Hungarian Plain«, *Journal of Field Archaeology*, Boston, XXXV/2, 2010, 164–183.

Pavišić 2012 – I. Pavišić, »Putovi i komunikacije kroz sjeverozapadnu Hrvatsku tijekom kasnog brončanog doba«, *Histria Antiqua*, Zagreb, XXI, 2012, 263–277.

Pearsall 2000 – D. Pearsall, *Paleoethnobotany: A Handbook of Procedures*, Second Edition, San Diego, Academic Press, 2000.

Perlès 2001 – C. Perlès, *The Early Neolithic in Greece: The First Farming Communities in Europe*, Cambridge, Cambridge University Press, 2001.

Potrebica 2013 – H. Potrebica, *Kneževi* željeznoga *doba*, Zagreb, Meridijani, 2013.

Rapan Papeša, Kenéz, Petö 2015 – A. Rapan Papeša, Á. Kenéz, Á. Petö, »Arheobotanička analiza uzoraka iz kasnoavarodobnih grobova iz Nuštra (istočna Hrvatska) / The Archaeobotanical Assessment of Grave Samples from the Avar Age Cemetery of Nuštar (Eastern Croatia)«, *Prilozi Instituta za arheologiju u Zagrebu*, Zagreb, XXXII, 2015, 261–288.

Reed 2006 – K. Reed, *Early Farming in Dalmatia: Preliminary Archaeobotanical Report on the Middle Neolithic site of Danilo*, MSc thesis, London, University College London, Institute of Archaeology, 2006.

Reed 2011 – K. Reed, »Biljni ostaci / Plant macro-remains«, in Balen, J. (ed.), *Đakovo-Franjevac: kasno bakrenodobno naselje / Đakovo-Franjevac: Late Eneolithic Settlement*, Katalozi i monografije Arheološkog muzeja u Zagrebu VII, Zagreb, Arheološki muzej u Zagrebu, 2011, 126–127.

Reed 2013 – K. Reed, *Farmers in Transition: The archaeobotanical analysis of the Carpathian Basin from the Late Neolithic to the Late Bronze Age (5000 – 900 BC)*, Volume 1-2, doctoral thesis, Leicester, University of Leicester, School of Archaeology and Ancient history, 2013.

Reed 2015 – K. Reed, »From the field to the hearth: Plant remains from Neolithic Croatia«, *Vegetation History and Archaeobotany*, Basel, XXIV/5, 2015, 601–619.

Reed 2016 – K. Reed, »Agricultural Change in Copper Age Croatia (ca. 4500 – 2500 cal B.C)?«, *Archaeological and Anthropological Science*, Cham, 2016, http://link.springer.com/article/10.1007/s12520-016-0330-3 (1.11.2016.).

Reed, Drnić 2016 – K. Reed, I. Drnić, »Iron Age diet at Sisak, Croatia: archaeobotancial evidence of foxtail millet (*Setaria italica* [L.] P. Beauv.)«, *Oxford Journal of Archaeology*, Oxford, XXXV/4, 2016, 359–368.

Sekelj Ivačan, Tkalčec 2006 – Sekelj Ivačan, T., Tkalčec, T., »Slavensko paljevinsko groblje na položaju Duga ulica 99 u Vinkovcima/ Slawisches Brandgräberfeld am Standort Duga ulica 99 in Vinkovci«, *Prilozi Instituta za arheologiju u Zagrebu*, Zagreb, XXIII, 141–212.

Sherratt 1981 – A. Sherratt, »Plough and pastoralism: aspects of the secondary products revolution«, in Hodder, I., Isaac, G., Hammond, N. (eds.), *Pattern of the Past*, Cambridge, Cambridge University Press, 1981, 261–301.

Sherratt 1983 – A. Sherratt, »The development of Neolithic and Copper Age settlement in the Great Hungarian Plain. Part II: site survey and settlement dynamics«, *Oxford Journal of Archaeology*, Oxford, II/1, 1983, 13–41.

Smith *et al.* 2006 – D. Smith *et al.*, »Assessing the later prehistoric environmental archaeology and landscape development of the Cetina Valley, Croatia«, *Environmental Archaeology*, Abingdon, XI/2, 2006, 171–186.

Starčević 2010 – S. Starčević, *Karbonizirani biljni ostaci antičkog lokaliteta Osijek-Silos*, master's thesis, Zagreb, Sveučilište u Zagrebu, Prirodoslovno-matematički fakultet, 2010.

Šoštarić 2001 – R. Šoštarić, »Karbonizirani biljni ostaci iz prapovijesnog lokaliteta u Novoj Bukovici na položaju Sjenjak«, *Prilozi Instituta za arheologiju u Zagrebu*, Zagreb, XVIII, 2001, 79–82.

Šoštarić 2003 – R. Šoštarić, *Vegetacijske promjene u postglacijalu u Hrvatskoj*, doctoral thesis, Zagreb, Sveučilište u Zagrebu, Prirodoslovno-matematički fakultet, 2003.

Šoštarić 2004 – R. Šoštarić, »Arheobotanička analiza uzoraka s lokaliteta Torčec-Gradić«, *Podravina*, Koprivnica III/6, 2004, 107–115.

Šoštarić 2005 – R. Šoštarić, »The development of postglacial vegetation in coastal Croatia«, *Acta Botanica Croatica*, Zagreb, LXIV/2, 2005, 383–390.

Šoštarić 2009 – R. Šoštarić, »Karbonizirani ostaci žitarica, tragovi poljodijelstva«, in Marijanović, M. (ed.), *Crno vrilo 2*, Zadar, Sveučilište u Zadru, Odjel za arheologiju, 2009, 49–52.

Šoštarić 2015 – R. Šoštarić, »Biljni ostaci iz antičkog i srednjovjekovnog naselja na lokalitetu Virovitica Kiškorija Jug / Plant remains from the Roman and early medieval settlement at the site Virovitica Kiškorija South«, in Jelinčić Vučković, K. (ed.), *Rimsko selo u provinciji Gornjoj Panoniji: Virovitica Kiškorija Jug / Roman Village in the Province of Upper Pannonia: Virovitica Kiškorija South*, Monographiae Instituti archaeologici 7, Zagreb, Institut za arheologiju, 2015, 311–326.

Šoštarić, Küster 2001 – R. Šoštarić, H. Küster, »Roman plant remains from Veli Brijun (island of Brioni), Croatia«, *Vegetation History and Archaeobotany*, Basel, X/4, 2001, 227–233.

Šoštarić *et al.* 2006 – R. Šoštarić *et al.*, »Comparative Analysis of Plant Finds from Early Roman Graves in Ilok (*Cuccium*) and Šćitarjevo (*Andautonia*), Croatia – A Contribution to Understanding Burial Rites in Southern Pannonia«, *Collegium Antropologicum*, Zagreb, XXX/2, 2006, 429–436.

Šoštarić, Potrebica, Brigić 2008 – R. Šoštarić H, Potrebica, A. Brigić, »Direct Dating of Botanical Samples in an Archaeological Context – Plant Remains from the Prehistoric Site of Kaptol-Gradci near Požega (Croatia)«, *Prilozi Instituta za arheologiju u Zagrebu*, Zagreb, XXIV, 2008, 79–88.

Šoštarić, Šegota 2010 – R. Šoštarić, V. Šegota, »Analiza biljnih ostataka sa srednjevjekovnog lokaliteta Torčec kraj Koprivnice / The analysis of plant remains from the medieval site Torčec near Koprivnica«, in Sekelj Ivančan, T. (ed.), *Podravina u ranom srednjem vijeku* , Monographiae Instituti archaeologici 2, Zagreb, Institut za arheologiju, 2010, 373–388.

Šoštarić, Šegota 2010a – R. Šoštarić, V. Šegota, »Analiza biljnih ostataka iz srednjovjekovnog burga Vrbovca u Klenovcu Humskome / Analysis of Plant Remains from the Vrbovec Medieval Fortified Town in Klenovec Humski«, in Tkalčec, T. (ed.), *Burg Vrbovec u Klenovcu Humskome: Deset sezona arheoloških istraživanja*, Zagreb, Muzeji Hrvatskog Zagorja, Institut za arheologiju, 2010, 247–253.

Šoštarić *et al.* 2015 – R. Šoštarić *et al.,* »Diet at the Roman Village of Virovitica Kiškorija South, Croatia«, *Collegium* Antropologicum, Zagreb, XXXIX/4, 2015, 829–842.

Šoštarić *et al.* 2016 – R. Šoštarić *et al.*, »Prilog poznavanju halštatskih pogrebnih običaja – arheobotanički nalazi tumula 13 i 14 iz Kaptola kraj Požege / A Contribution to the Understanding of Hallstatt Burial Customs – Archaeobotanical evidence from Tumuli 13 and 14 at the Site of Kaptol, near Požega«, *Prilozi Instituta za arheologiju u Zagrebu*, Zagreb, XXXIII, 2016, 307–315.

Tasić 2004 – N. Tasić, »Historical picture of development of Bronze Age cultures in Vojvodina«, Старинар, Beograd, LIII-LIV, 2003-2004 [2004], 23–34.

Tillier *et al.* 2016 – M. Tillier *et al.* »Carpologie en contexte portuaire romain: Economie végétale et environnement des sites de Caska (île de Pag, Croatie), du Castélou-Mandirac (Narbonne) et d'Arles Rhône 3«, in Sanchez, C., Jézégou, M.-P. (eds.), *Les ports dans l'espace Méditerranéen antique. Narbonne et les systèmes portuaires fluvio-lagunaires, Actes du colloque de Montpellier des 22 – 24 mai 2014*, Supplément à la Revue Archéologique de Narbonnaise, Montpellier, Presses universitaires de la Méditerrannée, 2016, 381–396.

Todorova 1989 – H. Todorova, »The transition from the Late Neolithic to the Bronze Age in Bulgaria«, in Maniatis, Y. (ed.), *Archaeometry. Proceedings of the 25th International Symposium, Athens, 1986*, Amsterdam, Elsevier, 1989, 697–703.

Trbojević-Vukičević *et al.* 2011 – T. Trbojević-Vukičević *et al.*, »Arheological and archaeozoological evidence of milk as a food in the territory of Croatia«, *Mljekarstvo*, Zagreb, LXI/4, 2011, 319–325.

Tringham 2000 – R. Tringham, »Southeastern Europe in the Transition to Agriculture in Europe: Bridge, Buffer or Mosaic«, in Price, T. (ed.), *Europe's First Farmers*, Cambridge, Cambridge University Press, 2000, 19–56.

Valamoti 2016 – S. Valamoti, »Millet, the late comer: on the tracks of *Panicum miliaceum* in prehistoric Greece«, *Archaeological and Anthropological Sciences*, Cham, VIII/1, 51–63.

Van der Veen 2007 – M. van der Veen, »Formation processes of desiccated and carbonized plant remains – the identification of routine practice«, *Journal of Archaeological Science*, Amsterdam, XXXIV/6, 2007, 968–990.

Van der Veen, Livarda, Hill 2008 – M. Van der Veen, A. Livarda, A. Hill, »New food plants in Roman Britain – dispersal and social access«, *Environmental Archaeology*, Abingdon XIII/1, 2008, 11–36.

Van Zeist, Wasylikowsa, Behre 1991 – W. van Zeist, K. Wasylikowsa, K.-E. Behre (eds.), *Progress in Old World Palaeoethnobotany*, Rotterdam, Balkema, 1991.

Vlachos 2003 – D. Vlachos, »Who did it? Perspectives on the beginning of the Neolithic in Greece«, *Documenta Praehistorica*, Ljubljana, XXX, 2003,131–137.

Wagner 1988 – G. Wagner, »Comparability among recovery techniques«, in Hastorf, C., Popper, V. (eds.), *Current Paleoethnobotany*, Chicago, The University of Chicago Press, 1988, 17–35.

Whittle 1996 – A. Whittle, *Europe in the Neolithic: the creation of new worlds*, Cambridge, Cambridge University Press, 1996.

Zohary 1996 – D. Zohary, »The mode of domestication of the founder crops of Southwest Asian agriculture«, in Harris, D. (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia*, London, University College London Press, 1996, 142–158.

Zohary, Hopf, Weiss 2012 – D. Zohary, M. Hopf, E. Weiss, *Domestication of plants in the Old World: the origin and spread of domesticated plants in south-west Asia, Europe, and the Mediterranean Basin*, Oxford, Oxford University Press, 2012.