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

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. 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. 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. 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. 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. 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).

In Croatia, research suggests that farming settlements began to be established ca. 6000 cal BC; 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. While in continental Croatia, only two early Neolithic sites have so far yielded archaeobotanical remains: Sopot and Tomašanci-Palača. 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, although evidence of continued hunter gatherer activities suggest a more complex diffusion of farming across the region. 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.
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.

<table>
<thead>
<tr>
<th>SITE NAME</th>
<th>SITE TYPE</th>
<th>DATE</th>
<th>CEREALS</th>
<th>PULSES</th>
<th>OIL PLANTS</th>
<th>VEGETABLES / HERBS</th>
<th>FRUITS / NUTS</th>
<th>WILD / WEED SEEDS</th>
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<tr>
<td>Neolithic</td>
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<tr>
<td>Krčina cave Cave</td>
<td></td>
<td>(Impresso culture)</td>
<td>C</td>
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<td>C</td>
<td></td>
<td>C</td>
<td>Müller 1994, 64.</td>
</tr>
<tr>
<td>Tomašanci-Palača Settlement</td>
<td>5660 – 5300 cal BC</td>
<td></td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>Reed 2015.</td>
</tr>
<tr>
<td>Danilo Settlement 5300 – 4800 cal BC</td>
<td></td>
<td></td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>Hopf 1964; Reed 2006; Legge, Moore 2011.</td>
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<tr>
<td>Brezovljani Settlement 4900 – 4600 cal BC</td>
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<td>C</td>
<td></td>
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<td>IM</td>
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<td>C</td>
<td>Reed 2015.</td>
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<tr>
<td>Ivandvor-Gaj Settlement</td>
<td>5050 – 4490 cal BC</td>
<td></td>
<td>C</td>
<td>C</td>
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<td>C</td>
<td></td>
<td>C</td>
<td>Dukić 2014; Reed 2015.</td>
</tr>
<tr>
<td>Ravnjaš-Nova Kapela Tell</td>
<td>(Sopot culture)</td>
<td></td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>Reed 2015.</td>
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<tr>
<td>Slavča Tell</td>
<td></td>
<td>ca. 4990 – 4200 cal BC</td>
<td>C</td>
<td>C</td>
<td>C</td>
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<td>C</td>
<td>C</td>
<td>Reed 2015.</td>
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<tr>
<td>Sopot Tell</td>
<td></td>
<td>5050 – 3940 cal BC</td>
<td>C</td>
<td>C</td>
<td>C</td>
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<td>C</td>
<td>Reed 2015.</td>
</tr>
<tr>
<td>SITE NAME</td>
<td>SITE TYPE</td>
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<td>CEREALS</td>
<td>PULSES</td>
<td>OIL PLANTS</td>
<td>VEGETABLES / HERBS</td>
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<tr>
<td>Tomašinci-Palača</td>
<td>Settlement</td>
<td>4300 – 3900 cal BC</td>
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<td>Reed 2015.</td>
</tr>
<tr>
<td>Turska Peć</td>
<td>Cave</td>
<td>(Hvar culture)</td>
<td>C</td>
<td>C</td>
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<td>Reed 2015.</td>
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<tr>
<td><strong>Eneolithic</strong></td>
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<tr>
<td>Lasinja</td>
<td>Settlement</td>
<td>4040 – 3950 cal BC</td>
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<td>Reed 2016.</td>
</tr>
<tr>
<td>Čeminac-Vakanjac</td>
<td>Settlement</td>
<td>ca. 3750 – 3600 cal BC</td>
<td></td>
<td></td>
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<td></td>
<td>Reed 2016.</td>
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<tr>
<td><strong>Bronze Age</strong></td>
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<td></td>
</tr>
<tr>
<td>Tomašinci-Palača</td>
<td>Settlement</td>
<td>(early)</td>
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<td></td>
<td></td>
<td>Reed 2013.</td>
</tr>
<tr>
<td>SITE NAME</td>
<td>SITE TYPE</td>
<td>DATE</td>
<td>CEREALS</td>
<td>PULSES</td>
<td>OIL PLANTS</td>
<td>VEGETABLES / HERBS</td>
<td>FRUITS / NUTS</td>
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<tr>
<td>Crišnjevi-Oštrov Necropolis</td>
<td>(late)</td>
<td>C</td>
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<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reed 2013.</td>
</tr>
<tr>
<td>Mačkovac-Crišnjevi Settlement</td>
<td>ca. 14th – 12th century BC</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td></td>
<td></td>
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<td>Reed 2013.</td>
</tr>
<tr>
<td>Kalnik-Igrisce Settlement</td>
<td>(late)</td>
<td>C</td>
<td>C</td>
<td>C</td>
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<td></td>
<td></td>
<td>Mareković 2013; Mareković et al. 2015.</td>
</tr>
<tr>
<td>Orubica-Veliki Šeš Settlement</td>
<td>ca. 13th – 12th century BC</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td>Reed 2013.</td>
</tr>
<tr>
<td>Okruglo Settlement</td>
<td>(late)</td>
<td>W</td>
<td></td>
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<td></td>
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<td>Smith et al. 2006.</td>
</tr>
</tbody>
</table>

**Iron Age**

<table>
<thead>
<tr>
<th>SITE NAME</th>
<th>SITE TYPE</th>
<th>DATE</th>
<th>CEREALS</th>
<th>PULSES</th>
<th>OIL PLANTS</th>
<th>VEGETABLES / HERBS</th>
<th>FRUITS / NUTS</th>
<th>WILD / WEED SEEDS</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sisak Settlement</td>
<td>ca. 6th – 4th century BC</td>
<td>C</td>
<td></td>
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<td>Reed, Dmić 2016.</td>
</tr>
<tr>
<td>Nadin-Gradina Hillfort</td>
<td>ca. 5th – 1st century BC</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td>Nye 1996.</td>
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</tbody>
</table>

**Roman**

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<th>SITE NAME</th>
<th>SITE TYPE</th>
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<th>CEREALS</th>
<th>PULSES</th>
<th>OIL PLANTS</th>
<th>VEGETABLES / HERBS</th>
<th>FRUITS / NUTS</th>
<th>WILD / WEED SEEDS</th>
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<tbody>
<tr>
<td>Poreč Town</td>
<td>Town</td>
<td>C</td>
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<td>Šoštarić 2015.</td>
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<tr>
<td>Vitrovitica Kiškoria Settlement</td>
<td>ca. 2nd – mid 5th century AD</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
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<td>Šoštarić 2015; Šoštarić et al. 2015.</td>
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<tr>
<td>SITE NAME</td>
<td>SITE TYPE</td>
<td>DATE</td>
<td>CEREALS</td>
<td>PULSES</td>
<td>OIL PLANTS / HERBS</td>
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<tr>
<td><strong>Middle Ages</strong></td>
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<tr>
<td>Vitrovitica Kiškorića</td>
<td>Settlement</td>
<td>ca. 8th – 9th century AD</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>Šoštarić 2015.</td>
<td></td>
</tr>
<tr>
<td>Blaževo Pole 6*</td>
<td>Settlement</td>
<td>ca. 8th / 9th century AD</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>Šoštarić, Šegota 2010.</td>
<td></td>
</tr>
<tr>
<td>Duga ulica 99, Vinkovci</td>
<td>Cemetery (Slav)</td>
<td>ca. 7th / 8th century AD</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>Sekelj Ivačan, Tkalčec 2006, 200–201.</td>
<td></td>
</tr>
<tr>
<td>Nuštar</td>
<td>Cemetery (Avar)</td>
<td>ca. 7th / 8th century AD</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>Rapan Papeša, Kenéz, Pető 2015.</td>
<td></td>
</tr>
<tr>
<td>Prečno Pole 1*</td>
<td>Settlement</td>
<td>ca. 7th / 8th – early 14th century AD</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>Šoštarić, Šegota 2010.</td>
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<tr>
<td>Pod Gučak*</td>
<td>Settlement</td>
<td>ca. 11th / 12th century AD</td>
<td>C</td>
<td>C</td>
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<td>C</td>
<td>C</td>
<td>Šoštarić, Šegota 2010.</td>
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<tr>
<td>Ledine*</td>
<td>Settlement</td>
<td>ca. 10th / 11th century AD</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>Šoštarić, Šegota 2010.</td>
<td></td>
</tr>
<tr>
<td>Rudičevo*</td>
<td>Settlement</td>
<td>ca. 13th – early 14th century AD</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>Šoštarić, Šegota 2010.</td>
<td></td>
</tr>
<tr>
<td>Vrbovec</td>
<td>Castle</td>
<td>ca. 12th – 16th century AD</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>Šoštarić, Šegota 2010a.</td>
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</tbody>
</table>
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. 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. 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 macro-remains 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.

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. 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 dover (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. 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. This period also sees changes in burial practice and the re-organisation of trade networks, to accommodate the demand for new metallurgical goods. As the Eneolithic progressed, larger more permanent fortified settlements began to develop, along with the emergence of social hierarchy and craft specialisation. The climate too changes dur-

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13 Reed 2015.
15 Reed 2015.
16 Reed 2015.
19 Parkinson et al. 2010.

...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. However, recent archaeobotanical research in Croatia has begun to question this. 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 changes...

Kosse 1979; Gyulai 2010.

Reed 2013; 2016.
cultivation methods. Therefore questions regarding the introduction of ploughs and draft animals in agriculture and the relationship between agriculture and changes in society are still unknown.


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. The European Bronze Age (ca. 2500 – 750 BC) is also characterised by the rise of ‘élites’ and social ranking, which had a direct effect on settlements, resulting in the
appearance of larger more substantial sites located on hilltops or prominent positions which offered strategic control over an area. 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.

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 miliaceum*), spelt (*Triticum aestivum* ssp. *spelta*) and broad bean (*Vicia faba*). New cultivated species are also seen in the Carpathian Basin, including the oil plant gold of pleasure (*Camelina sativa*) and Safflower (*Carthamus tinctorius*). 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. At Čauševica the recovery of *Olea* fragments may also indicate some of the earliest evidence of wild olives in Dalmatia. 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.

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. Rich burials containing imported luxury items also attest to the transportation of luxury goods at this time. 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. 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.), but due to the low quantity recovered no additional analyses have been conducted.

27 Gogļitan 2008.
29 Kroll 1990; Medović 2002; Gyulai 2010, 105.
30 Reed 2013; Valamoti 2016.
31 Huntley 1996a.
33 Forenbaher 1995.
34 Potrebica 2013.
35 Hršak 2009.
36 Nye 1996.
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. 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. The low recovery of archaeobotanical 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.
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. 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

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39 Migotti 2012.
(Raphanus sativus) and chicory (Cichorium intybus). 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.

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. 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. 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. 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. 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. 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.
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

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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. 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.

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 overrepresent more abundant taxa, while there is a greater probability of encountering rare taxa in larger samples. 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. 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.

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. 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.

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48 Hillman 1981.
49 Reed 2013, Chapter 10, Fig. 10.1.
51 Reed 2013.
52 Wagner 1988.
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.
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