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THE ARCHAEOBOTANY OF MIKULČICE

Food Supply to the Early Medieval Stronghold

Michaela Látková

ARCHEOLOGICKÝ ÚSTAV AV ČR, BRNO

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This paper is dedicated to the memory of Renáta Látková

EDITORS' FOREWORD

The 11th volume in the SBM – Studien zum Burgwall von Mikulčice – series returns to archaeobotanical issues. This volume draws on the nowadays classic research by Emanuel Opravil, published in SBM volumes 3 through 5. Unlike the "original" stage of Mikulčice archaeobotany associated with E. Opravil, which evaluates finds from a closed stage of large-scale open area excavations in Mikulčice from 1954–1992, the "new" stage, represented in this book by Michaela Látková, is based on the results of modern excavations conducted in Mikulčice in recent years. Geographically, this work includes the whole territory of the early medieval agglomeration including the Slovak (Kopčany) part of the monument area, which is in line with the modern concept of the Mikulčice research.

Thanks to a thorough stratification of the finds, and in particular to the new unified methodology of sampling and the separation and evaluation of samples, the results of our new archaeobotanical research are key elements in the reconstruction of the economic conditions in the early medieval agglomeration. The presented results are groundbreaking in a way – in some respects even contradictory to the archaeological findings so far – which is why a valuable specialised discussion concerning the newly presented subsistence models can be expected. The present work asks specific questions relevant to today's interdisciplinary research into Mikulčice, particularly its economic and environmental activities. At the same time, it contributes to the highly topical subject of the current Moravian and Central European medieval studies: the knowledge of the economic foundations of Great Moravia and its power centres.

Thanks to the erudition of the author, we have a useful archaeobotanical analysis of the latest archaeological excavations in Mikulčice and Kopčany. Thus, Mikulčice is once again at the forefront of archaeobotanical research in Moravia. This volume is the first tangible output of the newly established archaeobotanical workplace in Mikulčice, part of the Institute of Archaeology of the Academy of Sciences of the Czech Republic, Brno.

The 11th volume opens a new phase of the publishing series Studien zum Burgwall von Mikulčice. First of all, it has a new graphic style. There is a trend set by volumes 9 and 10: the content of the individual publications is becoming more independent – apart from several contributions with similar topics, the SBM books will be in the form of monographs. The basic principle – the publication in a language accessible to the international community – remains; it will always be adapted to the specific focus of the future publications (German, English and so on).

This book is published thanks to the financial support of the Editorial Board of the Academy of Sciences of the Czech Republic, to whom we would like to express our gratitude.

Lumír Poláček, Pavel Kouřil — Brno, April 2017

AUTHOR'S FOREWORD

This study began as a dissertation thesis, which was defended in 2015 at the Department of Archaeology, Faculty of Arts, Constantine the Philosopher University in Nitra (Slovakia), which is why my greatest appreciation goes to my consultant, Doc. Mária Hajnalová, PhD. I am grateful for her invaluable assistance, expert advice and critical remarks during the writing process. Without her support and initiative, this paper would have never come into being.

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Michaela Látková

Mikulčice, May 2017

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1 Introduction

One of the most frequently discussed questions concerning research into Early-Medieval central settlements in Central Europe is regarding (paleo)economy – the supply of crop-based food and the level of the centres' dependency on smaller neighbouring communities.[1] The question of the exploitation and the economic use of river floodplains is a fundamental issue raised by archaeological research into the Great Moravian lowland strongholds (Poláček 2001, 363–364).[2]

The food supply at one of the most important Early-Medieval centres is evaluated in this study along with a more detailed localising and characterisation of its economic and agricultural hinterland. The purpose of this study is to reconstruct the centre's subsistence strategy using identification crop husbandry regimes and how the landscape was used as an economic hinterland. Research into such a broad issue should be based on various methodological approaches to the reconstruction of a living culture, where archaeobotany – which evaluates direct evidence of economic activities – holds an undisputed position.

The main tool to fulfil the aim of the present study is an archaeological analysis of the plant macroremains (PMR) retrieved from archaeological sediments at the Mikulčice and Kopčany sites. Plant macroremains from the time horizon of the 9th to the 10th centuries were evaluated and interpreted. These were obtained over the past few years during the excavation of 16 sites located in both parts of the agglomerations, both on the Slovak (Baxa 2010; Baxa et al. 2008; Kraskovská 1965, 1969) and Czech banks of the River Morava (Poláček et al. 2013, 2014; Hladík/Poláček 2014; Mazuch 2013b; Poláček/Škojec 2011; Poláček/Škojec 2012; Hladík 2009).

The Mikulčice-Kopčany settlement agglomeration is currently one of the most important Great Moravian centres. The Mikulčice agglomeration consists of two fortified areas (the acropolis and the fortified outer bailey) and a larger non-fortified area, marked as a suburbium/extramural settlement. Smaller villages are concentrated in the neighbourhoods of the agglomeration, which are better archaeologically excavated, particularly on the left bank of the Morava River although they are also present on the Slovak side. In the past, the stream and the character of the river have been changing and today it is still unknown exactly where the main water course flowed. However, it is likely that the Mikulčice and Kopčany sites were agglomerated during the Great Moravia period. Situated in this area of the agglomeration are the remains of the 12 sacral structures with bricked walls; however, the existence of the three churches (1, 11 and 12) is only on a hypothetical level. On the right river bank is the still standing so-called "13th church of Mikulčice" – the Church of St Margaret of Antioch in Kopčany. All these churches are located in a fortified area (acropolis) and also in non-fortified parts of the suburbium. With the exception of the numerous sacral structures, there is also a secular mural building – a palace. The extremely high concentration of mural structures and the numerous collections of findings (created during the 1960s when there were intensive archaeological excavations) point to the significant character of Mikulčice being mainly in the Church sphere and its organization during the Great Moravia period, as well as to the great political authority concentrated there (Poláček 2006).

1 Klanica 1987; Poláček 2008a; Dresler/Macháček 2008; Mařík 2009; Hladík 2014; Dreslerová et al. 2013.

2 The main project worked on in Mikulčice in the years 1996–2001 was the "Sídelní aglomerace velkomoravských mocenských center v proměnách údolní nivy" (Settlement Agglomeration of Great Moravian Power Centres and the Changes of the Valley Meadow) funded by the Czech Science Foundation.

The central parts (e.g. Mikulčice-Valy, the acropolis, the outer bailey and extramural settlement) are considered to be super-community areas where there could be further significant, functional and organisational differences (cf. Neustupný 2007, 13). In general, it is assumed that the Great Moravian central settlements were not autarkic, i.e. self-sufficient (Dresler/Macháček 2008, Hladík 2014, 172). Supplying Early Medieval centres with food and other commodities and services indispensable for their operation was arranged and carried out by the so-called economic hinterland, which was comprised of small rural settlements situated further away from the centre of the agglomeration (cf. Vignatiová 1992, 98).

The first to consider the existence of an economic hinterland of the Mikulčice centre (acropolis), by taking into account the settlement structure to define the hinterland (there were activities mentioned above), was Z. Klanica (1987, 127–133). He defines the hinterland as 10-km circle centred on the acropolis containing the smaller villages that supplied the centre.

In more recent studies, L. Poláček (2008a, 265–266) works with a hinterland of a similar size but defines two zones – a circle with its centre in the acropolis with a radius of 7 km (closer economic hinterland) and a maximum radius of 10 km (further economic hinterland). These models exclude the area of the floodplains, which overreaches into the area determined for research. The area of the economic hinterland of the Mikulčice agglomeration can be further divided into three main settlement zones, which are linked to the course of the River Morava and are on the Czech and the Slovak banks. The zones are defined in descending order depending on the distance from the acropolis. The first zone is situated within one kilometre and includes the settlement of the suburbium terrain elevations within the river floodplain. The second zone has a radius of 3.5 km and includes the settlement of the Morava River terraces. The third and final zone is situated in the valley of the Prušánka stream, which is 7.5 km from the acropolis (Poláček 2008a, 257; Poláček 2008b, 27).

For the purpose of defining the hinterland, L. Poláček draws on estimates of the area of arable land needed to sustain 1,000–2,000 inhabitants.[3] The study of the function and division of the economic hinterland presented by L. Poláček (2008a) is based on the assumption of certain socio-economic settlement structures showing different characteristics (and means of construction) of residential buildings. The model is based on the assumption that there is a link between the quality/characteristics of a built-up area and the type of community that inhabited it. So far, only the remains of the above-ground constructions have been recorded in the fortified Mikulčice central seat complex – probably log houses or other constructions made entirely of wood. Sunken-floor residential buildings were excavated as far as zone one (Mikulčice-Trapíkov and Kopčany-Kačenáreň). According to L. Poláček, they accommodated the inhabitants of the closest hinterland who actively participated in the production and supply of plant foodstuffs for the centre. It is assumed that the inhabitants of the central seat were not involved in such activities very much – or even at all.

The most recent assessment of the settlement structure and the nature of the economic hinterland was conducted by M. Hladík (2014). The results of his study confirmed the assumed extent of Mikulčice's economic hinterland (Poláček 2008a, 257; Poláček 2008b, 27). Marek Hladík supports the theory that defines the economic hinterland as a circle with a 7km radius centred on the acropolis (Hladík 2014, 159–160). Based on the settlement structure and the material culture, M. Hladík (2014, 165–166) interprets the settlements at Mikulčice-Trapíkov and Kopčany-Kačenáreň as peripheries of the Mikulčice agglomeration. He considers the rampart to be the only clearly defined border that separated the elite, who lived behind it, from the immediate hinterland, i.e. the farming community (Hladík 2014, 166). He, therefore, expects that the area of the floodplain belonged to and served the purposes of the agglomeration. The closest area he considers to be exploited as arable land is that starting on the terraces of the River Morava. This is where the cultivation, processing and storage of crops are assumed to have taken place and where crafts were performed (Hladík 2014, 166).

Up to today, all estimations about the size and localization of the hinterland (hinterland in the context of the assemblage of arable lands, pastures and meadows, or where were the labour force produced for the centre) are solely based on the assumptions of the number of inhabitants and their food demands, specifically that the lands in the alluvial flat were not fertile and were unsuitable for agricultural crop production. In the best case scenario, the flatlands might have been used in the same way as they were used in the recent past as lowlands pastures. None of the

3 For estimates of the population of the Mikulčice centre and its agglomeration see Klanica 1987, 128; Poláček 2008a, 265–266; Poláček 2008b, 24–25; Poulík 1975, 151; Stloukal/Vyhnánek 1976, 40–42.

models mentioned have used palaeobotanical data yet. This is because this was not available.

Several archaeobotanists had previously analysed and evaluated the assemblages of the plant macroremains from Mikulčice.[4] The most complex study to date is the publications of E. Opravil. This researcher assembled a rich and diverse set of plant remains. The vast assemblage of 44,367 items was comprised of the remains of charred cereals, pulses and waterlogged seeds and pips from different types of cultivated fruits (plums, cherries, peaches and grapes), vegetables (cucumbers) and diverse wild species. Unfortunately, most of his findings are published without the contextual information and quantitative information. Furthermore, a substantial part of the Mikulčice plant remains analysed by E. Opravil was destroyed by a tragic fire in the autumn of 2007. It is thus impossible to revise the older material or to use published data for more detailed archaeological analyses. This is also the reason why his results are used only as a comparative dataset in this study. In his work, E. Opravil dealt with the questions of the cultivated and gathered crops, and the reconstruction of the natural environment of Mikulčice including the vegetation cover of the floodplain of the River Morava during the Early Middle Ages (Opravil 1972, 1983, 2000, 2003). These studies provided information on the consumption of a wide range of crops, only that Opravil did not assess them in a wider (paleo)economic context. He concentrated on hypothesising on specific questions, such as the origin and local cultivation of fruit trees and the reconstruction of the immediate – primarily forest and water – vegetation (cf. Opravil 2003, 1978). Neither did he address the question of the origin of foodstuffs, the methods of the centre's food supply or the size and situation of the agricultural hinterland of the Mikulčice agglomeration. Most likely, this is due to the fact that in the period where he and his fellow archaeobotanists were active, such questions were very rarely considered in Eastern European archaeology. In addition, the samples he studied were collected not systematically but purposefully from very specific contexts in the Valy excavation area and in the adjacent riverbed. It is, therefore, not surprising, that they are dominated by the remains of fruits and wild species while findings of staple crops – cereals and pulses – were only sporadic.

Current archaeobotanical knowledge about crops and their cultivation in early medieval Slovakia and Moravia comes from both open agricultural villages – smaller farmsteads e.g. Kostice-Zadní hrúd (Dreslerová et al. 2013), Brankovice, Boskovice, Slavonín (M. Hajnalová, unpublished data)[5], and central fortified settlements (e.g. Prague – Čulíková 1998, 2001a, 2001b, 2005, Nitra – Hajnalová/Hajnalová 2008, Devín – M. Hajnalová, unpublished data and Olomouc – Opravil 1985). A significant change is documented in early medieval times in the range of cultivated plants compared with the protohistorical period (Hajnalová 1993; Kočár/Dreslerová 2010). Unfortunately, in Slovakia, archaeobotanical finds from the period of the Migration Period are absent to date, and in the Czech Republic, only one site is known – Březno u Loun (Tempír 1982).[6] When considering the crops cultivated there, millet and rye are represented to a smaller extent; cereals, such as hulled barley and hexaploid bread wheat dominate. What is remarkable is the relatively high proportion of glume wheat: emmer (*Triticum dicoccum*) and einkorn (*Triticum monococcum*, Tempír 1982). According to E. Hajnalová (1993), in the early Middle Ages, free-threshing cereals, such as bread wheat (*Triticum aestivum*) and rye (*Secale cereale*), became more common at the expense of glume wheat as cereals used for making bread. Free-threshing wheat had been known from prehistoric settlements, although it is usually unclear whether it was tetraploid wheat (*T. durum/T. turgidum*), or hexaploid wheat (*T. aestivum*). Such discrimination is only possible when based on finds of chaff – rachis internodes, which are scarce in archaeobotanical assemblages. Still, it is assumed that in the early Middle Ages it was the latter – *Triticum aestivum* (Hajnalová 1993, 54). Rye began to be cultivated in Central Europe as early as the La Tène and Roman period (Kočár/Dreslerová 2010, 210; Hajnalová/Varsík 2010; Hajnalová 2000), but it became fully established in the Early Middle Ages (Kočár et al. 2010; Hajnalová 1993). Hulled barley (*Hordeum vulgare*) is an important crop from prehistoric times, in particular, due to its ability to adapt to various environmental conditions and also its various uses in food for humans (porridge, flatbread, beer…) or as animal fodder (Šálková et al. 2012). Millet (*Panicum miliaceum*) is another crop where its past occurrence dates

4 Tempír 1973; Kühn 1981; Opravil 1962, 1972, 1978, 1983, 1998, 2000, 2003.

5 I would like to thank to M. Hajnalová for providing me with the unpublished data that she obtained from the excavations of UAPP Brno, v. v. i.

6 The Paprotki Kolonia in Poland (settled in Roman times and during the Great Migration) unearthed evidence of the use of wheat that still had chaffs (Wacnik et al. 2014, 448).

back to the middle Bronze Age (Hajnalová/Barta pers. comm., Kočár/Dreslerová 2010, 210). Once introduced, millet became a very popular crop over the course of the whole prehistoric period and was firmly established in the Early Medieval range of crops (Hajnalová 1993, 91–92; Kočár et al. 2010). Oat, similar to rye, is a so-called secondary domesticate (i.e. at first it was a weed in the fields). It began to be grown as an independent crop in Central Europe in the La Tène or Roman period (Kočár/Dreslerová 2010, 210). The cultivation of oat (*Avena sativa*) as a separate crop is highly probable in the early Middle Ages, despite the relatively frequent absence of chaff – lemma bases, which can indicate whether it is a cultivated or wild form of oat (Hajnalová 1993, 85). While these basic staple cereal crops are known from both rural and other types of settlements in this time horizon, larger amounts of cultivated fruits and vegetables were only found to date in Mikulčice. There were mostly in the natural sediments of the River Morava (Opravil 1972, 2000), in different locations at Prague Castle (Čulíková 1998, 2001a, 2001b, 2005, 2008) and to a lesser extent, also in the Early Medieval settlement agglomeration in Žatec (Kočár et al. 2010). The number of seeds and variety of arable weeds is higher in the early medieval (Great Moravian) period than in previous times – Certain species of field weeds occur together with certain groups of cultivated crops, which is interpreted as a higher level of farming specialisation (Hajnalová 1989, 100).

The aim of the present study is thus to analyse and interpret the latest archaeobotanical data from recent years of excavations at Mikulčice and Kopčany, to improve the understanding of the economic activities of different parts of the Mikulčice-Kopčany settlement agglomeration and to determine to what extent archaeobotany can verify the validity of the archaeological hypothesis of the non-autarkic character of this Great Moravian central site.

2 Natural conditions

2.1 GEOGRAPHICAL CONDITIONS

The Mikulčice-Kopčany agglomeration is situated in what is nowadays an irregularly flooded part of the River Morava floodplain. On the Moravian bank of the river, the site is situated three kilometres to the south-east of the residential area of today's village of Mikulčice (Hodonín district) and on the Slovak bank, one kilometre from the centre of the town of Kopčany (Holíč district). These two archaeological sites are now divided by the regulated channel of the River Morava, which currently constitutes a state border. In the past, they probably formed one cultural-geographical entity although it is still not clear whether they used to be connected or divided by the River Morava (Hladík 2014; Poláček 2008a; Janšák 1962).

2.2 GEOLOGY, GEOMORPHOLOGY AND PEDOLOGY

The area is constituted of sediments from the early-Tertiary Vienna Basin with a thickness of 4,000 to 5,000 m (Valachovič 1992, 7). The basin is filled with marls, conglomerates and sandstones. In the following period, the depression of the continental crust continued and was covered by a continuous layer of Quaternary deposits. The Holocene is represented by eolic sands, river gravels and silts, and locally by loess (Valachovič 1992, 7).

The river floodplain, in which the archaeological sites are located, is one of the earliest geological and geomorphological formations. Its development took place throughout the whole Holocene period – and is possibly still ongoing in areas of unregulated water streams. The dynamic development of the river valleys in the past was characterised by alternating processes of accumulation and erosion (Poláček 1999, 25). The landscape around it is formed of a continuous complex of sand dunes with a river network. The relief of the area in question has the character of a plane or mound. The area is formed by three basic types of landscape. Along the River Morava are flat river planes that are – from the point of view of landscape creation – the earliest geographical formations. Terrace-like plains created by the previous meandering of the river rise from the river planes, above which rises on a loess substrate, gently rolling land that eventually becomes hilly (Poláček 1999; Hladík 2014).

Within the Morava River valley are two main types of soils. Soils developed on sandy substrates on higher elevated dunes and sand islands and soils developed in the depressions within inundation. The soils based on sands have a significant lack of organic and mineral colloids (Valachovič 1992, 8). Their cohesiveness is low; when dry they are powdery and easily become subject to wind erosion. They are also incapable of containing precipitation, which leaks quickly, except where there are plant roots present. Such soils are sensitive and react strongly to the removal of surface vegetation or any lowering of the underground water. As a result, the surface humus mineralises; the sand dries up and is carried away by the wind. The alluvial soils of the River Morava are very different to the sandy soils. Their sorption complex is saturated; the humus content is up to 5 % and they have a favourable soil structure and a nearly neutral pH (Valachovič 1992, 9). They originated from deposits of humus substances that have created a thick layer; their moisturisation is caused by mineral-rich groundwater.

At present, the soils in the River Morava floodplain can be divided, based on function, into two categories: agricultural land (12,900 ha) and meadows/pastures (3,500 ha). Forest soil takes up 11,900 ha of which 735 ha is floodplain forests inundated by the River Morava. Water areas take up 1,150 ha and the built-up area is currently 248 ha (Valachovič 1992).

2.3 CLIMATIC AND HYDROLOGICAL CONDITIONS

The area that was researched falls within the temperate climate zone with an Atlantic-continental climate. South Moravia and Záhorie are areas with a warm and dry climate. The overall climate is influenced by the vicinity of the Little Carpathians, which prevents the entry of north-westerly winds with clouds as these would bring moisture into the area. The average annual rainfall ranges from 650 to 580 mm and the average annual temperature from 9.4 °C to 10.2 °C (Vachek et al. 1997, 10; Valachovič 1992, 3). There are also other differences in the area of the Záhorská nížina lowlands and South Moravia: the winters are colder and harsher and the summers are warmer. Greater temperature variations can also be observed during the day as well as a more pronounced formation of dew (Valachovič 1992, 3).

2.4 PALAEOCLIMATOLOGY

Unfortunately, in the specialised literature, there is no local palaeoclimate model of the area under research (South Moravia and Záhorie) that would help its palaeoclimatic reconstruction. So far, the climate in this region has been reconstructed based on dendrochronological data, which indicates a decrease in rainfall in the second half of the first millennium – and a relatively dry climate (Macháček et al. 2007, 306–307). Aside from this approach, there are also many other models that attempt to reconstruct the climate of the Early Medieval period, although some of the claims are conflicting (Lamb 1989, 181–191; Wiethold 2002, 32; Svoboda et al. 2003, 60).

2.5 CURRENT VEGETATION

At present, the South Moravian landscape has the character of warm and dry lowland with a continental forest-steppe (Chytrý 2010). Phytogeographically, the vegetation of the Záhorská Nížina lowland and South Moravia is denoted as the Carpathian flora district (Dostál/Červenka 1991), within which the plants create different communities depending on the type of landscape.

Among the classes of permanent grasslands present in South Moravia is *Crypsietum aculeatae*. The species of this class of low open stands with annual grasses occur on exposed banks, pond beds and on the banks of salt marshes (Chytrý 2010, 103), which even tolerate soils with an alkaline reaction. Salt-marsh vegetation is enriched by the species of the *Thero-Salicornietea* class (Chytrý 2010, 117). Moist flooded continental meadows are evidenced by such classes as *Lathyro palustris-Gratioletum officinalis*. This vegetation is found in temporarily flooded floodplains along rivers and streams. From the point of view of the composition of such meadows, various types of grasses grow there together with broad-leaved plants (Chytrý 2010, 185). The *Vulpietum myuri* classes frequently form archaeophytic communities of dry meadows and semi – natural habitats on sandy soils. These are annual herbs with a strong presence of *Achillea millefolium* (Chytrý 2010, 267). The third class, characterised by thermophilic ephemeral spring plants and acidophilic species, is *Festuco-Veronicetum dillenii* (Chytrý 2010, 280).

The *Caucalido platycarpi – Conringietum orientalis* ruderal and weed vegetation species currently grow in South Moravia. This is a basiphilous weed vegetation of grain fields. The species of this class prefer desiccative soil rich in bases (Chytrý 2009, 80). Other types of rather rich vegetation are the species of the *Setario pumilae – Echinochloëtum cruris-galli* class, which occur on desiccative soils with thermophile grasses (Chytrý 2009, 111). Typical ruderal grasses are represented by the species of the *Hordeo murini – Brometum sterilis* class. The thermophilous forest community can be found at the sunny southern sites (Chytrý 2009, 139).

Forest vegetation in the South Moravian Region is represented by types such as *Prunetum fruticosae* – steppe shrubs with frequent occurrence of the dwarf cherry. This community occurs mostly in lowlands and on warm hills, usually in soils rich in nutrients (Chytrý 2013, 83). Moist floodplain sloe-plum shrubs currently growing in the researched area evidence species of the *Rhamno catharticae-Cornetum sanguineae* class, which occurs at the edge of the forest. This is a community occurring in the valleys of floodplain forests, and in the surroundings of unfarmed, mostly wet meadows. The land where they grow is usually wet, rich in nutrients and in the past was periodically inundated with spring floods (Chytrý 2013, 106).

The most common alliance that occurs in the South Moravian Region is the ash-alder – *Alnion incanae* – a hard floodplain forest in river valleys. This alliance is, to a large extent, influenced by groundwater levels and often takes the form of narrow strips along streams and rivers directly neighbouring other mesophilic communities (Chytrý 2013, 199). Central European hardwood riparian forests of lowland rivers are more varied due to the species from the *Ficario vernae-Ulmetum campestris* community. This community includes species with a high diversity of wood types (*Quercus robur, Fraxinus excelsior, Ulmus laevis, Acer campestre, Prunus padus* and *Sambucus nigra*). The species of this class occur on acidic or slightly neutral soils (pH 4.5–7.2) with relatively high groundwater levels (Chytrý 2013, 214).

Xerophilous pine-oak forests growing on sand are the most widespread type in the Borská Nížina lowland (Valachovič 1992, 9). Stands of Scotch pine (*Pinus sylvestris*) with an admixture of oaks (*Quercus sp.*) growing on sand dunes grow on shallow soils that are very poor in ranker type minerals. In the Borská nížina lowlands, the occurrence of several communities, phytocenotically belonging to acidophilous oak woods of *Pino-Quercion* alliances, are reported or assumed (Chytrý 2013, 233). In the herb layer, oligotrophic to acidophilous species prevail while in the shrub layer, a gradual decrease in indigenous species, such as *Crataegus laevigata* and *Frangula alnus* can be observed. These are mostly soil-protecting forests and are not for economic use because the production of wood is very low.

Soft floodplain forests are characteristically linked with fresh moist soil types, which restrict the spread of other woody plants because of regular long-term flooding. Another feature typical of soft floodplain forests is the fluctuation of groundwater. Regular floods significantly enrich the soil with nutrients. The following species are typical of the *Aegopodium podagraria, Anthriscus nitida, Lysimachia vulgaris, Galium aparine, Phalaris arundinacea, Glechoma hederacea* and *Poa palustris* habitat. From among the water and mud species that have their biotopes in soft floodplain forests, there are *Alisma plantago-aquatica, Caltha palustris, Carex acuta, Carex riparia, Galium palustre, Iris pseudacorus* and *Phragmites australis*. What is also typical of these stands is the occurrence of various types of lianas, such as *Calystegia sepium, Humulus lupulus* and *Solanum dulcamara* (Chytrý 2001, 64–66).

2.6 PALAEOVEGETATION

Recent palaeoecological, in particular palynological, research conducted at Hodonínská doubrava in the near vicinity of Mikulčice, evidence for the Early Medieval period a rather open landscape with species requiring sunshine (Jamrichová et al. 2013, 4). Species of trees and shrubs indicate relatively open woodland dominated by hazel (*Coryllus avellana*) while the presence of common juniper (*Juniperus communis*) has also been documented. The composition of pollen from the herbaceous spectrum indicates intensively farmed land (Jamrichová et al. 2013, 4).[7]

Older archaeobotanical reconstructions show the surroundings of the Mikulčice stronghold as relatively open and light (Opravil 1972). Based on PMR, E. Opravil (1972, 16) located periodically flooded stands of so-called hard floodplain forests in the floodplain area. He assumed the occurrence of soft riparian forest in the areas of overgrowing cut-off lakes as they are inundated more frequently. Finds of PMR from the herb and shrub forest layers tend to indicate the existence of forest openings in the landscape surrounding the Mikulčice stronghold (Opravil 1972, 16).

7 In earlier historical periods, the results of pollen analyses show that the Hodonín region underwent various significant landscape changes, in particular in the 14th century, when oak (*Quercus sp.*) began to spread to the detriment of shrub vegetation (*Quercus sp*.). The onset of oak in the 14th century in the researched area can indicate climate changes. There was probably a temperature drop and the environment became more humid (Jamrichová et al. 2013, 12). At the beginning of the 18th century, mesophilic species start to appear in the researched area – and the process has continued up to the present (Jamrichová et al. 2013, 11). Pollen profiles of 19th-century layers show a significant decline of oak in favour of birch and pine, which are still present in the area today (Jamrichová et al. 2013, 11).

3 Cultural and historical situation

The beginnings of Great Moravia overlap with the end of the Avar Khaganate (803), which fell apart after the military intervention of Charlemagne (Wihoda 2014, 46). The Slavs also contributed to the downfall of the Avar Empire by their frequent military attacks (Wihoda 2014, 46). After the end of the Avar Khaganate, there was a cultural vacuum in the area of the Carpathian Basin that enabled the independent development of Great Moravia. In general terms, Great Moravia can be characterised as a political unit with a rich archaeological material culture.

The name Great Moravia (μεγάλη Μοραβία, *megalé Morabia*) was used for the first time by Konstantinos Porphyrogennetos (Havlík 1967, 13, 383–384, albeit several decades after its downfall). The interpretation of this term (famous, extinct, remote and others) is yet another issue, as well as its location (Wihoda 2014, 46). Despite various efforts to locate Great Moravia in the Region of the Serbian River Morava (Boba 1971), it is clear that Great Moravia was the first state formation of the Western Slavs (833–907), situated north of the Middle Danube, i.e. in the area of what is today Moravia, south-western Slovakia and adjacent northern Austria (Havlík 1967, Třeštík 2001, Wihoda 2014). This political and power unit was formed in the first half of the 9th century and ceased to exist in the early 10th century. Apart from internal economic and political crises, the disintegration of the Great Moravian Empire was primarily caused by the invasion of the Old Hungarians.

The periodisation scheme of the early Middle Ages, which is used in this work, comprises five chronological phases/periods (Lutovský 2001, 235; 2009, 5):

- RS1: Early Slavic, 6th century
- RS2: Old Hillfort, 7th–8th century
- RS3: Middle Hillfort, 9th – first half of the 10th century
- RS4: Young Hillfort, second half of the 10th–12th century
- RS/VS: Late Hillfort, end of the 12th – first half of the 13th century

What is characteristic of the entire Great Moravian period are the dramatic political and cultural changes associated with the power wrangling of the Great Moravian rulers (Třeštík 2001; Wihoda 2014, 46–47). Apart from historical events (despite the fact that they had an obvious impact on overall developments in Great Moravia)[8], there was a new phenomenon that began to gain importance in the second half of the 9th century – the so-called central fortified settlements – hillforts/strongholds (Šalkovský 2012, 55; Lutovský 2001, 89). Great Moravian central agglomerations were characterised by the division of the fortified area (an acropolis and a fortified outer bailey – sometimes even several such outer baileys) and the existence of related unfortified areas referred to as extramural settlements/*suburbs* (Lutovský 2001, 241; Poláček 2008a, 257; Poláček 2008b, 27).

The terms "fortified central settlement" and "agglomeration" first appeared in literature in the 1960s. The area of the complex (agglomeration) includes the fortified settlement itself as well as adjacent open settlements and burial sites. These centres are not typical rural settlements: they consist of both fortified and unfortified parts, which must be considered a functionally connected whole (Mařík 2009b, 12). Centrally and strategically, it is usually the acropolis that has the most advantageous position and the best

8 The beginnings and history of Great Moravia are influenced by dramatic changes in the rulers of this national formation; these political events are commented on mainly in Frankish written sources (Třeštík 2001; Wihoda 2014, 46-47; Štefanovičová, 1988, 85-87).

fortification (various fortification techniques have been recorded). The acropolis is considered the seat of the highest authority in the stronghold. The acropolis has at least one fortified outer bailey, where crafts and the seats of the officials and spiritual dignitaries were usually concentrated (Mařík 2009b, 12). Similar functions are attributed to the extra-mural settlement, which, unlike the outer bailey, is not fortified and the size of it is different. The last area that is considered part of the Great Moravian fortified seats is the hinterland. It was this area that was assumed to significantly contribute to the supply of commodities and services to the central areas. The economic hinterland was not fortified and there were typical open rural settlements and burial sites in it. To denote a locality as a central site, it must comply with the following basic functions: administrative/political, military/defence, craft, commercial and cultic (Dostál 1975, 1979, 1988; Macháček 2005; Vignatiová 1992). An even representation of all said components in a single settlement enables us to presume it was a controlled, central, Early Medieval settlement.

From the point of view of social structure, it can be assumed that the Great Moravian central settlements were strictly structured and that social hierarchy was a substantial factor in the differentiation of the Early Medieval population. There has been extensive discussion on whether Great Moravian society shows the traits of an Early Medieval state – or not (Macháček 2012; Profantová/Profant 2014; Kalhous 2014; Štefan 2014; Macháček 2015). We can mention at this point that this case study contributes to the debate on the economic base of Great Moravia.

In early medieval times, Mikulčice was one of the main Great Moravian centres. Unfortunately, there are no written sources that could inform us of the names and definitions of the functions of this central settlement. From the point of view of topography, the Mikulčice-Kopčany settlement agglomeration was a rather indented landscape. The fortified part itself covered an area of 10 ha (acropolis and the outer bailey) and around the fortified centre were 30 ha of different unfortified areas. These areas can be denoted as an extra-mural settlement (Poláček/Marek 2005, 33–36). Clearly, the landscape had a different character in the 9th century than now. The most important geomorphological element in this floodplain environment is the sand dunes and aggradation walls (Poláček 1997, 33–37; Havlíček et al. 2003, 14–16; Šošulová et al. 2014). These rises were surrounded by river channels and its tributaries. Such protected areas with optimum living conditions were naturally sought after as settlement areas. In some places, the assumed difference in height between the populated dunes and the riverbed is significant – 5 to 6 metres. When adding the height of the fortification, approximately 4 metres (Procházka 2009, 173), the range would be 6 to 8 metres (Poláček 2012, 26). The development of the valley floodplain was considerable over time and it is obvious that the floodplain used to have a different character from what it does today. The youngest and the most widespread sediments are clayey or clayey-sandy flood loams (Poláček 1997, 39–40; Havlíček et al. 2003, 16). These cover almost all the terrain depressions. These sediments are assumed to have started being deposited in the course of the 13th century and the sedimentation finished with the artificial regulation of the River Morava in the 1970s (Opravil 1983).

The settlement of the Mikulčice stronghold started to gradually decrease with the downfall of Great Moravia. It is likely that the members of the higher ruling classes, and also ordinary inhabitants, were physically eliminated (Poláček 2014b, 177; Hladík 2012). Some of those who managed to escape left for the nearby surroundings where they established new settlements. A small group of people stayed in the stronghold area and survived there until the 13th century when the floodplain meadow began to be a hostile environment. Regularly recurring floods drove the last inhabitants out of the Mikulčice stronghold (Poláček 2014b, 177).

4 Methodology

The archaeobotanical material analysed in this work comes from 16 excavation areas examined within the Mikulčice-Kopčany settlement agglomeration between 2005 and 2013. The sediment samples from which the PMR were extracted come from various types of archaeological excavations (rescue, systematic) and contexts (settlements, burials, river bed). The nature of the archaeobotanical material was significantly influenced by the natural conditions and excavation methods – to which the sampling methods had to be adapted – and the methods of extracting plant material from the sediments. Two excavation areas underwent archaeobotanical research in Kopčany – the Church of St Margaret and Kačenáreň. In Mikulčice there were 14 positions – excavation areas, number 85, 86, 88, 89, 90, 91, 93, 95, 96, 97, 98, 100, 103 and M17.

4.1 ON-SITE SAMPLING METHODOLOGY

The methodology for taking samples for archaeobotanical analysis primarily depended on the method applied to the archaeological excavation (see the chapter 5 Characteristics of find contexts of archaeobotanical samples). The technique of total sampling (sensu Jones, M. K. 1991; Pearsall 2000) was used exclusively at the only one of the 16 positions that were excavated – at the Kopčany-Kačenáreň site. The point sampling strategy (Jones, M. K. 1991) was applied in Mikulčice, at three excavation areas (No 93, 96 and 103). Column sampling (Jones, M. K. 1991) of finished excavations, where samples were not taken across the whole area, was conducted at three excavation areas (No 91, 95 and 100) in Mikulčice. In the other areas (Kopčany – Church of St Margaret, Mikulčice – No 85 86, 88, 89, 90, 97, 98, 99 and M17), judgment sampling strategy for exceptional contexts (Jones, M. K. 1991) was employed.

Differences in the methodology of the archaeobotanical sampling may result in overestimating or underestimating certain finds or contexts. This is why it is not appropriate to compare them directly. Sampling methodology also has a significant impact on the identification of the taphonomic processes and the subsequent interpretation of the samples from the point of view of their origin. The systematic archaeobotanical sampling of sediments began to be employed in Mikulčice only after the active involvement of an archaeobotanist in the research and excavation activities in 2011. From this point on, the documentation for each sample was introduced and logbooks were created for archaeobotanical samples. We began to take large samples of sediments as a standard: 10 to 12 litres per sample of dry and one litre of wet sediments. Smaller samples were taken whenever the context prevented this.

4.2 THE METHODOLOGY FOR EXTRACTING FINDS FROM SEDIMENTS

Flotation equipment was usually positioned near the excavated site – in Kopčany it was in the local parish office and in Mikulčice it was within the excavated area or in the research base [fig. 1]. Our aim was to perform flotation even during archaeological excavations. This, however, was not always possible in view of the weather and the technical conditions of the excavations and the equipment.

The PMR were extracted from the sediments of the archaeobotanical samples by flotation in a flotation tank (modified Siraf type, Williams 1973, 288–292). This method was combined with wash-over (sensu Steiner et al. 2015; Badham/Jones 1985; Hajnalová/Hajnalová 1998, [fig. 2 and 3]). Due to the combination of these extraction methods, we managed to obtain PMR that had remained in the heavier residues on the mesh in the tank. Some mineralised, waterlogged – but also charred – PMR still remained in the heavy residue even after this step. Therefore, they had to be collected manually. PMR, together

FIG. 1 | Mikulčice-Valy Flotation station Mikulčice 2014 (Photo by D. Krčová).

FIG. 2 | Mikulčice-Valy. The wash-over method (Photo by D. Krčová).

with other findings (artefacts and ecofacts) were collected immediately after flotation in the field. The reason why charred PMR would stay in the heavy residue (HR) and not float was due to the natural saturation of the Mikulčice deposits and sediments with minerals and salts of different metals (in particular, iron and manganese),

which penetrated (in particular) the charred PMR to a large extent.

Both potable, treated water from a well (Kopčany, Mikulčice 2014) and water from a local probe (Mikulčice 2008–2013) were used for flotation. For collecting light ecofacts and artefacts, which floated or rose up the water column, sieves were used with a mesh size of 0.25 mm. In Kopčany, larger square uncalibrated sieves were used, which did, however, meet the criteria for standard laboratory sieves. In Mikulčice, calibrated standard circular laboratory sieves were used. The flotation procedure in the flotation tank was as follows:

1) Measuring out the sediments intended for flotation in calibrated containers, recording this information together with other archaeological information concerning the sample in the flotation logbook.
2) Immersing the sample into a flotation tank lined with “mosquito mesh” (1 mm mesh size). The water flowing from the rosette located beneath the mesh stirred the sample, releasing the organic remains from the sediment and letting them float up to the surface to be washed away from the tank through an outlet and caught in a sieve.
3) From the sediment left on the mesh, plant macroremains that did not float (charcoal, seeds of plants), other ecofacts (bones, malacofauna) and artefacts (pottery, metal, glass, daub, mortar) were collected with surgical tweezers.

FIG. 3 | Mikulčice-Valy. PMR in a tank after wash-over (Photo by D. Krčová).

FIG. 4 | Mikulčice-Valy. The drying of flot fractions in nylon "bags" (Photo by M. Látková).

4) The method of washing the heavy residue was then used – wash-over. Sediment, which was left after the washing process on the mosquito net, was extracted into the bucket. It was then filled with water and mixed and poured through the sieve during the torque moment. The use of this method allowed us to also catch the macroremains, which although not floating were raised after the movement due to the capillary action.
5) Light residuum – i.e. objects that floated and were captured in the sieve (in particular plant macroremains and small animal bones) – was washed with clean water.
6) Floating residuum and the finds from the heavy residuum (pottery, metal, glass, animal and human bones) were dried in "nylon bags" [FIG. 4] and wrapped individually after drying [FIG. 5].
7) At the request of PhDr. P. Baxa, all the remaining sediment left after flotation was separately dried, packed and left in its entirety in Kopčany for any further analyses.

4.3 THE LABORATORY ANALYSIS METHOD

As the first step, to pre-analyse and evaluate the "capacity" of the material, samples from Kopčany were analysed; only 100 samples were selected based on the visual assessment of volumes and PMR presence in the samples. During the

FIG. 5 | Mikulčice-Valy. Finds of pottery and small animal bones, manually sorted from the fraction of heavy residues in archaeobotanical samples (Photo by M. Látková).

selection, the composition of the residuum after flotation was taken into account. When plant macroremains were present, the sample was included in the selection, even if it was smaller in volume. When the volume or nature of certain flotation residua did not allow for analysis of the whole sample, the sample was sub-sampled (1/2). The objective method of random sampling (only half of the flotated sample was taken) was chosen, which ensured that a representative (non-subjectively selected) part of the residuum was analysed. In the following step, all the other samples were analysed and processed, i.e. those that did not contain PMR according to visual assessment. In the following steps, samples from the areas in Mikulčice were gradually added. The following method of laboratory processing of the samples was identical for all the samples. The method of laboratory sample processing:

1) Information concerning the sample that was acquired during the excavations was copied into the laboratory logbook.
2) Both the residua were sieved together through sieves with grid sizes of 4 mm, 1 mm and 0.25 mm.
3) The volumes of the flotation residua from different sieves were measured out in calibrated graduated cylinders and recorded in the laboratory logbook.
4) The presence and nature of other finds and possible contamination (artefacts, roots, other sediment and the like – see point 5) was assessed and recorded.
5) The PMR were separated from the flot under a stereomicroscope at a maximum magnification of 40 and 75. Apart from charred seeds and charcoal, non-charred diaspores were selected in some cases. The presence of other findings, such as the shells of molluscs, human and animal bones, metals, mortar and others, were recorded in the logbook.
6) Charcoal with a diameter exceeding 3 mm from both the fractions was picked out and packed. These were counted and the volume measured.
7) The PMR were botanically (taxonomically) determined and the number of items was recorded. Selected taxa were documented in drawings or photographs.
8) Selected PMR were packed and labelled. The extracted residue samples were also kept and packed individually.
9) The PMR were documented using the imaging software in the Zeiss Discovery V8 stereomicroscope. Photographic documentation was taken using a Nikon SMZ 18 magnifying glass.

4.4 IDENTIFYING PLANT MACROREMAINS

After sorting, seeds and other plant parts were studied and taxonomically determined under the Zeiss Discovery V8 stereomicroscope at a maximum magnification of 40 and also using the Nikon SMZ 18 magnifying glass with a maximum magnification of 75. To identify the seeds of cultivated plants, a combination of a wide range of verbal guides and seed atlases were used; the final determination was based on comparison with modern materials – the comparative collection of modern seeds of M. Hajnalová. The botanical nomenclature was adopted from J. Dostál/M. Červenka (1991, 1992).

4.4.1 Criteria for determining the grains of cultivated crops

4.4.1.1 Cereal grains

The basic criterion for the determination of cereal grains is the grain shape. A combination of views from the dorsal (back), ventral (front) and lateral (side) direction together with a cross-section of the grain beyond the embryo are evaluated. Other diagnostic features include: the shape of the ventral furrow, the position and shape of the embryo and the surface structure (cf. Jacomet 2006).

Despite a number of diagnostic features, a precise determination of different species of naked wheat (*Triticum sp.*), such as *Triticum aestivum*, *Triticum durum* and *Triticum compactum*, is rather demanding, if not impossible. This is because the species are exceedingly similar. Even within a single species, there can be a large variability among seeds depending on the position of the grain in the spike. The appearance of charred seeds may undergo considerable change in the combustion process. In fact, the determination of wheat species is only possible when the nodes of the rachises are present (Jacomet 2006).

Common barley (*Hordeum vulgare*) differs significantly from wheat in that its grains are generally convex in shape, particularly on the ventral and dorsal side, with a narrowing apex and base. Among other diagnostic features is the fairly broad and shallow ventral furrow (Jacomet 2006). Depending on the number of fertile grains on the rachis and how they are organised, barley (*Hordeum sp.*) can be divided into several types: 2-row, 4-row and 6-row. In 2-row barley (*Hordeum distichon*) only one spikelet/grain is developed on one node of the rachis; other side spikelets are "dwarfed". For 4-row and 6-row barley (*Hordeum vulgare-vulgare*), all three grains are fully developed. While the central grain is completely straight and similar to those of 2-row barley (*Hordeum distichon*), the lateral grains are twisted. By counting the ratio of straight and twisted grains 1 : 2 it can be assumed that the sample contains 2-row or 6-row barley or both the subspecies (Jacomet 2006).

Naked and hulled forms can be distinguished in both types of barley. Hulled barley is characterised by significantly pointed ends, both at the apex and the base, and protruding longitudinal nerves at the ventral and dorsal side of the grain. The transverse cross-section of the grain is angular. In contrast to hulled types, naked types are more rounded and lack the protruding nerves. The cross-section of naked barley grain is round and the apex is notably blunt. There are horizontal wavy lines in the surface structure (Jacomet 2006).

The shape of the grains of millet (*Panicum miliaceum*) range from oval to round; the embryo has a specific shape and is sometimes absent – in such a case a specific dip occurs. The embryo of millet (*Panicum miliaceum*) is very wide and reaches almost to the middle of the grain (Jacomet 2006).

Grains of rye (*Secale cereale*) are easily distinguished from other cereal grains, in particular, because of the tilted angle of the basal part and the shape of the embryo. The embryo of rye grains reaches up to a third, sometimes even half the total length of the grain, i.e. the angle of the base of the grain is more or less in conjunction with the flat ventral side of the grain (Jacomet 2006, 49–50; Hajnalová 1993, 62–71). Also characteristic of this species is the shape of the apex, which is blunt both from the dorsal and the lateral view. The apex of this part of the grain has a triangular shape, unlike any other cereal grain (M. Hajnalová pers. comm.).

The cereal grain of oat (*Avena sp.*) differs from other cereals by its elongated shape and is relatively narrow and subtle. It is dorsoventrally flattened with an oval cross-section and a shallow central furrow while the dorsal side is slightly concave. This cereal is characterised by an oval embryo, which becomes a narrow dip at the topmost point (Jacomet 2006, 55; van der Veen 1992, 23). Grains of oat (*Avena sp.*) are very similar to the seeds of other wild oats (e.g. *Avena fatua, A. strigosa*). These species cannot be distinguished without the presence of the chaff remains – the lemma base. In some cases, only fragments of grains were preserved in our material. Sometimes, it was not possible to distinguish whether they were seeds of oat (*Avena sp.*) or brome grass (*Bromus sp.*). Such finds were denoted as *Avena/Bromus*.

When only fragments of cereal grains were preserved, without the fragments having any diagnostic features, they were classified as indeterminable cereal grains, *Cerealia Indet*.

4.4.1.2 Cereal chaff

In charred material, the lighter chaff remains of free-threshing cereals is usually found in much

smaller quantities than in the tougher chaff remains of glume wheat (Boardman/Jones 1990).
If preserved chaff remains of free-threshing wheat and barley, these represent only fragments of rachis internodes. Based on the morphological features of the rachis, we can distinguish tetraploid (*Triticum durum and Triticum turgidum*) and hexaploid wheat (*Triticum aestivum* and *Triticum aestivum-compactum*) as well as varieties of 2-row, 4-row and 6-row barley (Jacomet 2006).

Rachis internodes of tetraploid wheat are characterised by the straight sides, the absence of lateral groove, the presence of bulges under the connection of the glume bases and, quite frequently, the preserved glume bases themselves. The rachis reaches its maximum width at the level of the nodus. Rachis internodes of hexaploid wheat have slightly bent sides and are widest in the middle part. There are prominent grooves on the dorsal side, the bulges are lacking, and the glume bases are usually broken off (Jacomet 2006; Hillman et al. 1996).

In the whole assemblage from Mikulčice and Kopčany, there are only three rachis internode fragments present, which are all determined as hexaploid wheat, *Triticum aestivum* s.s. (*sensu stricto*). Rachis internodes of rye and barley have not so far been found in the assemblage.

4.4.1.3 Legumes

For the classification of legumes (*Fabaceae*), the size and shape of the seed are diagnostic features although the fundamental classification criterion is the length and shape of the *hillum* (Anderberg 1994; Berggren 1981, 1996). The seed of the common pea (*Pisum sativum*) is circular or slightly angular in outline and has a short, round to cylindrical *hillum*. The lentil (*Lens culinaris, son. L. esculenta*) is also round, but dorso-ventrally flattened. The bitter vetch seed (*Vicia ervilia*) is triangular in shape and has a short *hillum*. Seeds that were oval from the lateral view, round in the cross-section, with a *hillum* were categorised as types of Celtic bean (*Vicia faba*).

Fragments of otherwise damaged diasporas were categorised as *Leguminosae sativae* (cultivated *Fabaceae*).

4.4.1.4 Oil and fibre plants

Among the finds of oil and fibre crops are hemp seeds (*Cannabis sativa*). These taxa were determined based on the overall shape, size, and in particular, the surface structure. Concerning the poppy family (*Papaveraceae*) only one find of charred poppy seed was found, probably the opium poppy (*cf. Papaver somniferum*). This seed was determined based on the size and number of cells in its incomplete preserved surface structure.

4.4.2 Criteria for the identification and determination of wild species

The identification of seeds of wild species directly depends on the condition and fragmentation of the material and on the quality of the comparative collection. There is only a limited number of seeds of each species in seed atlases (while there is a large variability among seeds within each species), which is why they can be confused. Another problem is the use of foreign atlases that do not contain the species from a given territory, which also makes the determination of finds difficult. The risk of incorrect determination was minimised through working with a comparative collection of recent seeds. Unfortunately, it is not exhaustive either. For these reasons, some diasporas were determined only up to the genus or the family. The number of wild taxa from Mikulčice and Kopčany sites is over 200, so the listing of the description and identification criteria for each taxon would be disproportionately extensive, which is why it is not part of this work.

4.5 EVALUATION METHODS

Only those charred, mineralised and waterlogged seeds of plants, which can be considered "archaeologised", i.e. dating back to the early-medieval period were evaluated. Recent or modern diaspores – e.g. non-charred and well-preserved finds recovered from otherwise "charred" samples – were considered irrelevant in terms of archaeological events or contexts. These are thought to represent later contamination and were excluded from the analyses, as were atypically mineralised foxtail seeds (*Setaria viridis/verticillata*). Some finds of this taxa were preserved in a highly specific manner. Based on a visual assessment of the surface structure of the skin, they appeared to be non-charred (the skin of the seeds was white) although in the places where they had been disturbed, the endosperm actually appeared to be charred (black). Based on their excellent preservation and because no other taxa were preserved in such a way, we considered them to be of recent origin.

4.5.1 Quantification

For identification and quantification of the finds, a completely preserved seed was considered an individual ("*specimen*"). In the case of fragments of seeds, the preserved part was first recorded and then the minimum number of individuals (MNI) was calculated for each sample. The procedure for the calculation of the MNI was as follows. It was determined in the cereal grains whether there were further apexes or bases in the sample during sorting; the larger number was considered the MNI. When it was possible to determine that an apex or a base was not part of the same individual, they were counted as one grain. When only half or a quarter of a grain was preserved, the number of finds was obtained by adding the finds in the given category, which was then divided by two or four depending on the category. For rachis internodes of naked wheat, each fragment was counted as one. Finds of whole legume seeds were also counted as one. Fragments belonging to the same individual were counted as one. Otherwise, each fragment was counted separately.

When quantifying the seeds of wild species all determinable fragments were counted as one. If it was not clear whether they came from the same individual then they were also counted as one (cf. van der Veen 1992).

4.5.2 Statistical analysis methods

4.5.2.1 Description of the method

"Nature is very complicated and there are a number of factors that influence ecosystems and that change them over time and in space. The number and properties of organisms are influenced by various biotic and abiotic factors. The immense diversity of relationships and the multidimensionality of nature itself mean that a "linear", or better, a one- or two-dimensional analysis of ecological systems is almost impossible" (ter Braak 1996). It is usual that a set of plants can be understood as different variables that influence each other, and, what is more, they have their own specific relationship among themselves (Haruštiaková et al. 2012). Special methods of multidimensional analysis were developed that emphasise the overall analysis of the whole set of variables, and which put the emphasis on a comprehensive analysis of the set of variables instead of focusing on the individual variables (Jongman et al. 1995; Haruštiaková et al. 2012, ter Braak 1996).

Multivariate statistics methods are used when each sample (object, context) is characterised by several variables and when the relationship between these variables requires a joint analysis. Multivariate statistics methods assess not only the mutual positions of the objects but also the relationship between the variables that describe the samples (objects, contexts) in an n-dimensional space. Each sample is a point in a multi-dimensional space whose parameters are its coordinates (cf. Hajnalová 2012). The fundamental step in the analysis is the search for characteristic patterns of the structure of data in the whole matrix. Multivariate statistics methods are employed to discover the trends, dependences and arrangement of data. The use of these methods is (more) objective: the data arranges itself in the ordination space without the subjective attitude of the researcher, who can manipulate the data based on subjective views (Haruštiaková et al. 2012).

For processing the archaeobotanical data from Mikulčice and Kopčany, a multivariate statistic method was used – detrended correspondence analysis (DCA) and a two-step discriminant analysis [tab. 39].

4.5.2.2 Selection and end-processing of data

Different procedures of taphonomic analysis address different questions. One such question is the determination of the origin of the samples from the point of view of the post-harvest processing of the crops. At this point, it is necessary to determine which samples can be included in taphonomic analyses – also by means of multivariate analyses. The samples from Mikulčice and Kopčany can be divided into three basic categories based on how the plant macroremains were preserved. DCA analysis was used to determine whether these three categories of PMR reflect the same or different activities, and in particular, to find out whether the samples come from the processing of cereals.

Given that several samples in the dataset were not rich in PMR (did not have more than 50 seeds), all the samples were included in the analysis. As the sampling of different types of contexts (settlement constructions, graves, the river bed) in which the number of PMR significantly differed, absolute numbers of the finds in different samples were not used in the DCA analysis – the density of species was used instead.[9] In an analysis where the number of finds

9 See the chapter 7.2 Density of PMR.

TAB. 1 | The DCA analyses performed for ecological examination of the samples.

Analysis	Variable	Preservation	Standardization
DCA1	Cereal / chaff / wild species	Charred / mineralized / waterlogged	Average value
DCA2	Cereal / chaff / wild species	Charred / mineralized / waterlogged	Presence / absence
DCA3	Wild species	Charred	Presence / absence
DCA4	Wild species	Charred	Presence / absence
DCA5	Wild species	Charred	Average value
DCA6	Wild species	Charred	Average value
DCA7	Cereals	Charred	Average value
DCA8	Wild species	Charred	Average value
DCA9	Wild species	Charred	Average value

or the density is considered, this variable is one of the discriminants.[10] The samples are assessed and grouped based on such information. In the second step, the presence-absence (P-A) method was used. In this method, the values that represent the species (variables) are replaced by the symbol – 1 or 0. When using this approach, one of the discriminants is eliminated and all the species are "equivalent". The advantage of this method is in the grouping of samples based on the composition of species, not the "richness" – i.e. the amount/density – of PMR. Both these approaches were applied to all types of multivariate analysis.

4.5.2.3 Detrended correspondence analysis (DCA)

This method is an indirect gradient analysis. Detrended correspondence analysis (DCA) is basically an analysis of contingency tables. Most importantly, it examines the relationship between two (newly generated) variables. A contingency table is a table containing data frequency, where the position of one variable (in rows) is compared with the characteristics of another variable (in columns). It employs the method of weighted average values. This method assumes nonlinear single-peak data distribution, i.e. so-called unimodal distribution (JONGMAN et al. 1995; TER BRAAK 1996).

To better understand the taphonomic processes that contribute to the formation of the archaeobotanical assemblage, it was necessary to create nine DCA analyses [TAB. 1].

4.5.3 Wilcoxon two-sample test method

Wilcoxon two-sample test is one of the most widely used non-parametrical methods in mathematical statistics (MARKECHOVÁ et al. 2011, 123) and is used as a non-parametric alternative to the parametric t-test for two independent samples. Several assumptions must be fulfilled for the use of parametric methods (the assumptions of normal distribution, equal variability and others). These assumptions should be verified before the test is employed. Should one of the assumptions for the use of this statistical method be violated, the use of the statistical method is ineligible and any conclusions drawn based on employing this method on experimental data may not be valid. Very often, the data available does not allow to verify whether the assumptions required for the use of a parametric method apply to it or not. In such cases, it is better to use one of the non-parametric methods where the fulfilment of such strict conditions is not required. As non-parametric methods are less sensitive and accurate than parametric ones, there is a rule that when the assumptions for the use of a parametric method are fulfilled then it is preferred to a non-parametric one.

4.5.3.1 Description of the method

Wilcoxon two-sample[11] test is a non-parametric analogy to a two-sample t-test. If $(X_1, X_2, ..., X_m)$ and $(Y_1, Y_2, ..., Y_n)$ are two independent random selections from two continuous distributions, it is possible to verify by the null hypothesis H_0, that both the selections are derived from the same

10 In this context, discriminants can be seen as distinguishing elements or principles.

11 In literature and in some statistical programmes, Wilcoxon paired difference test can be encountered under the name Mann-Whitney's test.

basic set, i.e. the hypothesis that the distribution functions of both the distributions are identical. The alternative hypothesis states that the distribution functions of both the distributions are different.

During testing, it is necessary to proceed as follows: arrange all $m + n$ selection values into a non-decreasing progression, which will become an associated selection set. Each value in this set is given an order number. The sum of the order of values $x_1, x_2, ..., x_m$ will be denoted as T_1. Analogically, *T2* will be the denotation of the sum of the order of values $y_1, y_2, ..., n_y$. The calculation of the value of the characteristics follows.

$$U_1 = m \cdot n + \frac{m(m+1)}{2} - T_1$$

$$U_2 = m \cdot n + \frac{n(n+1)}{2} - T_2$$

The following relationship is valid and can be used as a calculation check: $U_1 + U_2 = m \cdot n$

The following statistic will be used as a test criterion: $U_0 = min\ (U_1, U_2)$. The hypothesis H_0 can be rejected on the level of the significance of α, if $U_0 \leq U_\alpha$, where U_α are the critical values of Wilcoxon two-sample test. The given *m, n* ranges of the selection sets and the level of significance, $\alpha = 0.05$ and $\alpha = 0.01$, respectively, appear in the table (Markechová et al. 2011, 375 Tab. 12.9).

If the *m, n* ranges are large numbers ($m > 30$, $n > 20$), the statistic is used as a test criterion;

$$U = \frac{U_1 - \frac{1}{2} - m \cdot n}{\sqrt{\frac{m \cdot n}{12}(m+n+1)}}$$

if the hypothesis tested is valid, this statistic has the following asymptotically normally normed distribution: $N(0, 1)$. The hypothesis tested H_0 can be rejected on the level of significance α and the alternative hypothesis accepted, if $|U| \geq u_\alpha$.

4.5.4 Chi-squared goodness of fit test x²

The so-called goodness of fit tests enables to verify whether the data measured is a selection from a distribution. The most frequently used goodness of fit test is Pearson's chi-squared test. The chi-squared goodness of fit test is based on a frequency table of data and tests the null hypothesis H_0. It can be used to test the hypothesis of the correspondence between the empirical and theoretical distribution of a set. The following criteria must be fulfilled before this method can be used:

- total number of frequencies observed: $n \geq 10$
- number of categories: $c \geq 3$
- all the expected values $e_{ij} \geq 0.25$

All the above assumptions must be verified prior to using the test. If any of the assumptions are violated, it is appropriate to revise the use of the method since the conclusions may not be valid. This test was aimed at the identification of the fit or the difference between two basic data sets (several matrices were tested) and the influence of the dependence of the test units on a given set.

4.5.4.1 *Description of the method*

The chi-squared goodness of fit test is usually used to test the null hypothesis that the value of the distribution of sets tested is even at all levels of the relevant factors.

There is the assumption that the results of the observation are arranged into k classes with frequencies $fe_1, fe_2, ..., fe, k$. The frequencies $fe, j, j = 1, 2, ..., k$ are called empirical because they provide information about results based on empirical data. Using a certain distribution that can be considered a model for the selection, it is possible to determine the expected (theoretical) frequencies, which are denoted fo, j. In the goodness of fit test, we compare the differences between the empirical and the expected frequencies i.e. $fe, j - fo, j$. The null hypothesis tested H_0 shall be the hypothesis of fit between the empirical and theoretical distribution of the basic set. The statistic will be used as the test criterion:[12]

$$x^2 = \sum_{j=1}^{k} \frac{(fe, j - fe, j)^2}{fo, j}$$

If the validity of hypothesis $H_0 x^2$ is confirmed, a distribution with k-1 degrees of freedom will have the resulting values $-x^2$. The hypothesis H_0 that is tested is rejected at level α if the x^2 value generated by the statistic exceeds the value x_a^2 (k-1, Markechová et al. 2011, 123).

12 The test was conducted using the calculation tool at <http://www.quantpsy.org/>.

4.5.5 Method using the ratio of the indexes of grain length and thickness

The main objective of this analysis was to identify cereal grains that are not products and can be classified as waste based on measurable indices of length and thickness. In the process of the post-harvesting processing of crops, larger grains find their way into the final reserves; at the same time, cereal grains whose shape resembles wild species can also be released.

4.5.5.1 Description of the method

The dimensions of the seeds are basic quantitative, objective, measurable values. The morphology of cereal grains allows for the measurement of three basic dimensions – length, width and thickness. This measurement was taken using a standard metal caliper with a measurement accuracy to one decimal place. Two evaluation indices – length and thickness index – were then calculated from the dimensions measured:

$$Id = \frac{lenght \times 100}{width} \qquad Ih = \frac{thickness \times 100}{width}$$

The ratio of the measurable indexes of cereal grains was also calculated to determine whether there are differences in seed size in individual excavation areas, or better, in the areas of the researched agglomeration. The assemblage of finds from Mikulčice and Kopčany is also compared with the results from other contemporaneous sites.

5 Characteristics of find contexts of archaeobotanical samples

This part of the work introduces some basic information about the research methods employed and the character of the areas researched, or, to be more precise, the excavation areas. It provides more detailed characteristics of the contexts that were subjected to archaeobotanical analysis. In the 16 researched excavation areas [FIG. 6 and 7] an assemblage of 946 archaeobotanical samples was collected [TAB. 29–31]. The number of positive samples, i.e. those containing PMR, was 580, which is 62.43 % of the total. While in Mikulčice the number of sterile samples was 7.38 %, in Kopčany it was 63 %. The high number of "sterile" samples in Kopčany is likely due to the total sampling of all sediments (see the chapter 4.1 On-site sampling methodology).

5.1 KOPČANY

In the part of the site on the Slovak bank of the River Morava – in Kopčany – two excavation areas, 300 metres from each other, were examined. The main subjects of the archaeological research were inhumations, in particular, the relationship between the graves and their relationship to the Church of St Margaret of Antioch. The character of the researched deposits (dry, sandy) affected the way the PMRs were preserved. Only charred and mineralised PMR are present there. Overall, 528 samples come from Kopčany. The total volume of deposits is 3,547.05 litres, from which 2,824 seeds and plant diaspores have been extracted. The average density of seeds in this excavation area is 0.72 per litre of sediments.

5.1.1 The Church of St Margaret of Antioch

In the excavation area around the Church of St Margaret of Antioch, we examined graves dating from the 9th to the middle of the 18th century and features dating to the middle of the 15th century. The archaeobotanical samples probably come from the graves outside the church of St Margaret of Antioch, not from its interior.[13] Samples of sediment for archaeobotanical analysis were taken by the researcher exclusively from grave units dating back to the 9th to 10th century (BAXA et al. 2008, 261). The sampling strategy was systematic in the sense that the samples were taken from all the graves thus dated and were taken based on the contexts (see Kačenáreň excavation area). The number of samples taken from individual graves varies – it depends on the find situation; a larger number of samples, for instance, come from graves undisturbed by later interventions. The volume of individual samples also varies depending on the size of the sampled context; for instance, a sample from the cleaning of a skull was generally smaller than a sample from the upper layer of the filling of the grave pit.

Eleven samples with a total volume of 106 litres were examined archaeobotanically. There are 236 PMRs and the average density of finds is relatively low: 2.22 seeds per litre of flotated sediment [CAT. 1].

5.1.2 Kačenáreň

This position is situated approximately 250 m to the north-east of the church of St Margaret of Antioch. In the Kopčany-Kačenáreň context, ten inhumations [FIG. 8] and two sunken settlement features have been examined to date. The director of the excavation, P. Baxa, drew on the works initiated by Ľ. KRASKOVSKÁ (1965, 1969) with the same assumption – based on the artefacts – that

13 Unfortunately, there is no further detailed documentation available concerning the samples taken from this position.

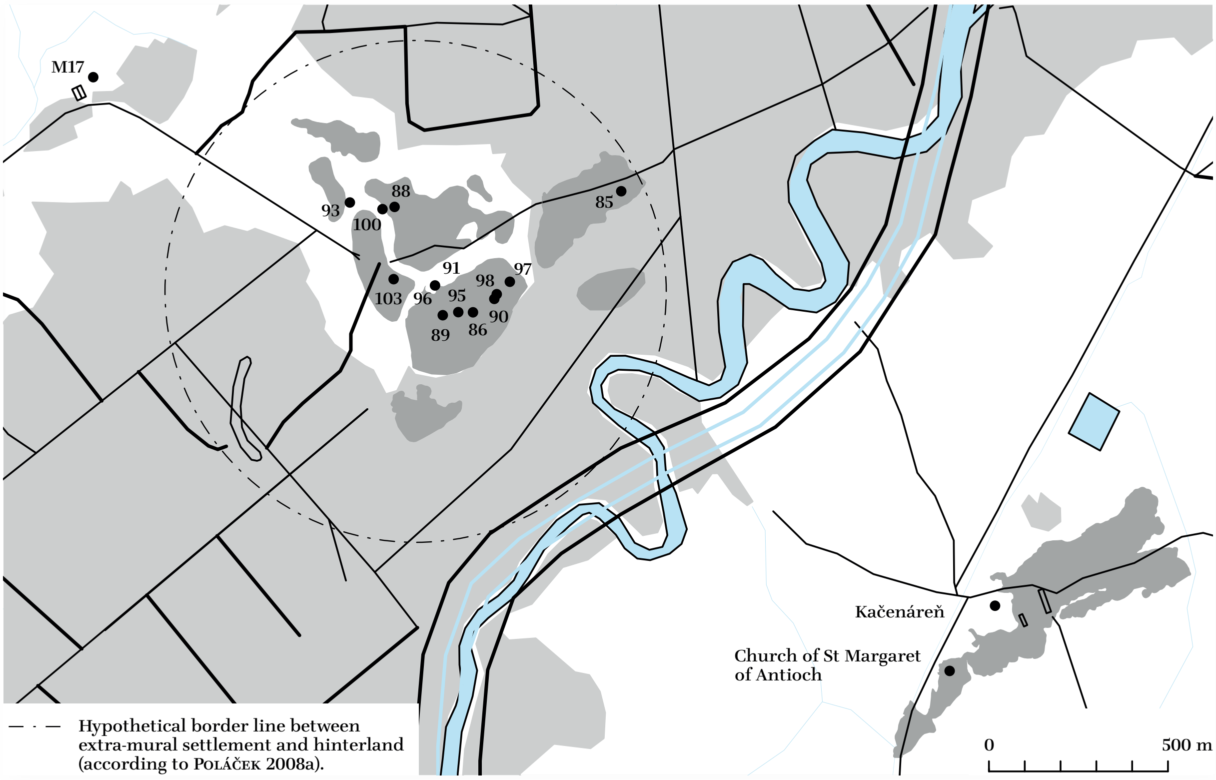


FIG. 6 | Mikulčice-Valy. Map of the agglomeration with excavation areas from which samples were taken for archaeobotanical analysis (Layout after Poláček 2016)

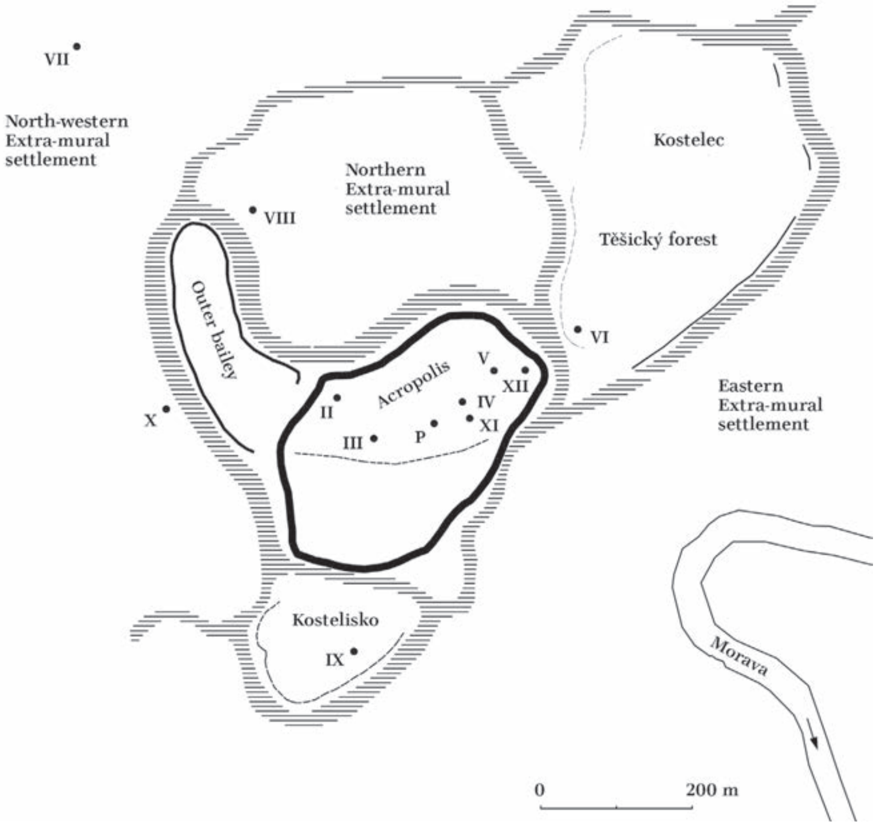


FIG. 7 | Mikulčice-Valy. Map with details of excavation areas from which archaeobotanical samples were taken for analysis Mikulčice-Valy (By O. Marek).

FIG. 8 | Kopčany-Kačenáreň. View of a partly excavated grave (Photo by M. Látková).

the dating of the settlement horizon and the burial site falls within the 9th and the first half of the 10th century (Baxa et al. 2008, 261). All features were sampled, with the exception of grave 1, which had been significantly disturbed by ploughing, with parts of its skeleton on the ploughed-up surface.

The method of total sampling was used when taking samples, i.e. the complete fill of the grave pits was flotated while the emphasis was placed on the spatial distribution of samples within the grave. Separate sampling was conducted on several areas around the skeleton – e.g. the vicinity of the skull, the rib cage and the upper and lower limbs. Sediments above and below the skeleton were also sampled separately. Using this method, 517 samples were retrieved from the excavation area of Kopčany-Kačenáreň of which 157 were positive. The total volume of flotated deposits from this excavation area is 3,441.05 litres. The plant finds retrieved from the filling of the features and graves comprise 2,588 seeds and diaspores. Intensive sampling of all the sediments resulted in a very low average density of finds – 0.75 seeds per litre. The number of samples with a high density of finds (e.g. over 2) is very low [CAT. 2].

5.2 MIKULČICE

Richer and more varied plant material was obtained from the excavation areas in Mikulčice, where 14 positions were examined archaeobotanically. Samples were taken from a wide range of archaeological situations and contexts, such as the rampart, the river bed, churches, cultural layers and sunken settlement features. Equally varied is the spatial distribution of areas sampled within the agglomeration. Samples were taken from the acropolis, the outer bailey, the extra-mural settlement as well as from the peripheral parts of the agglomerations (Mikulčice-Trapíkov). The diversity of the archaeological contexts from which they were taken has resulted in the presence of not only charred and mineralised seeds but also waterlogged seeds and other plant diaspores.

An assemblage of 418 samples with a total original volume of 6,297.45 litres was processed by water flotation. The number of PMR extracted is 24,405. The average density of PMR per litre of sediment is 3.87 pieces, which although more than in Kopčany, is still classified as low in archaeobotanical literature (cf. Jones 1984). The number of samples with a high density of finds, i.e. more than three, is 85.

5.2.1 Area 85 (T 2009)

Area 85 is located in the extra-mural settlement in the locality called “Těšický les” (Těšice Forest), in what is nowadays part of the forested area to the north-east of the acropolis. The central part, as in other populated areas, is a sand dune with an area of 4.4 hectares (Poláček/Marek 2005, 35). The excavated area is in the internal perimeter

FIG. 9 | Mikulčice-Palace. A sunken feature/pit No 346 under the foundations of the palace (Photo by J. Škojec).

FIG. 10 | Mikulčice-Basilica. Sunken feature/pit No 103 under the foundations of Church III – the basilica (Photo by J. Škojec).

of an extensive burial site that was on the highest point of the dune. Typical of this area is the alternation of settlement and burial functions in the 9th and the first half of the 10th century AD. The presence of settlement features from the pre-Great-Moravian period cannot be ruled out (Poláček et al. 2007, 130–133). The function and status of this area within the Mikulčice agglomerations have been connected with jewellery production because of a significant concentration of crucibles (Klanica 1974; 1986, 191). The excavations in 2009 focused on a review of the earlier excavations in Kostelec. The main aim was the reconstruction and documentation of different situations and the determination of the relative chronology of the early medieval settlement in this area (Hladík 2009, 446).

Only a single sample was deliberately taken from this area; the volume was 44 litres and it was flotated in 2009 by the technician P. Čáp. The sample comes from a grey sandy layer. This context was below the upper cultural layer, which formed a backfill of the settlement features (Hladík 2009, 448). A rich assemblage of charred and mineralised PMRs was recorded in the sample. A total of 192 seeds were present there. The average density is 4.4 finds per litre of sediment [CAT. 3].

5.2.2 Area 86 (Palace 2010)

In 2010, as a part of an ESF project focusing on the presentation of the ground plans of what were originally stone constructions in Mikulčice by building replicas above ground (Poláček/Škojec 2011), excavations were conducted that aimed to revise earlier findings concerning stratigraphy, chronology and construction/technological issues.

The review excavations mainly addressed the remains of the stone wall palace discovered in 1958 (Poulík 1975; Poláček/Marek 2005, 68–80). Apart from the remains of the stone palace building, different kinds of sunken settlement features (pits) were excavated in the area [FIG. 9]. Stratigraphically, these pits of various irregular shapes are not functionally related to the “palace” and are older than the stone building itself. As with the palace building, these features were examined as far back as in the 1960s; however, (and fortunately) not all of them were fully excavated to the very bottom. The samples for archaeobotanical analysis were taken from these intact, unexamined parts. The archaeological material taken from the filling of the settlement pits situated under the “palace” can be dated back to the late second half of the 9th century (Poláček/Škojec 2011). Based on the material from the backfill of the pits stratigraphically situated below the palace, it can be assumed that they come from an earlier phase of the Great Moravian period and probably also partly from the pre-Great Moravian period (Poláček/Škojec pers. comm.).

A total of 19 samples were taken for archaeobotany. As the excavation was conducted in 2010, before the arrival of an archaeobotanist at the site, the sampling was not systematic. The exact procedure of flotation in the tank is not known as the samples from this area were flotated by

P. Čáp, a technician. The volume of the flotated sediment from this area was 1,083 litres, from which 2,480 PMRs were extracted. The mean density of the macroremains in this area is relatively low: 2.28 seeds per litre of sediment. Apart from finds of charred seeds, mineralised specimens were also found [CAT. 4].

5.2.3 Area 88 (Church III 2011)

As the aforementioned ESF project continued, in 2011 revision excavations were conducted at the third Mikulčice church, the so-called three-nave basilica, discovered in 1956 (Poulík 1975, 73–88; Poláček/Marek 2005, 56–67). The aims of the archaeological research were similar to those for the "palace" (see the chapter 5.2.2 Area 86, Poláček/Škojec 2012). Similarly, partially excavated sunken settlement features were unearthed including the disturbed foundation masonry of a church, which were purposefully sampled and flotated again by P. Čáp [FIG. 10].

Six samples were taken from the excavation area of the basilica with a total volume of 203 litres. Altogether, 821 charred and mineralised PMRs were retrieved from the sediment. The average density of seeds per litre of sediment is 4.04 [CAT. 5]. Apart from seeds and mineralised fruits, the unique find of a charred gall was also made in this area (see the chapter 6.2.3. Woody plants and shrubs).

5.2.4 Area 89 (Church VIII 2011)

In the north-west part of the settlement area, in literature denoted as the northern extra-mural settlement (Hladík 2012; Mazuch 2013a; Poláček/Marek 2005, 117–120), there is only one sacral building – Church VIII. The revision research in 2011 focused on the remains of the church and the settlement structures situated stratigraphically under this building (Poláček/Škojec 2012, 151). What presents a potential problem is the interpretation of the function of this extra-mural settlement. In view of the densely built-up area, and also the significant presence of crucibles and iron slag, a non-agricultural function or role is presumed. On the other hand, there are extremely high numbers of finds of (grass?) scythes, which may be linked with animal herding and husbandry (Poláček 2003b, 634–644). The archaeobotanical samples come from the settlement structures, backfilled prior to the construction of the church, probably at the very end of the 9th or at the beginning of the 10th century (Poláček/Škojec 2012, 151).

During the revision excavations of Church VIII, only two judgement samples of sediment (139 litres) for archaeobotanical analysis were taken. The samples rendered 471 charred and mineralised diaspores. The average density of plant seeds per litre of sediment is 3.38 [CAT. 6].

5.2.5 Area 90 (Church IV 2012)

Area 90 is linked with the review excavation of Mikulčice church No IV situated on the acropolis. The church was discovered in 1958 in this location and, considering the assumed masonry tombs inside the nave, it was designated as a "mausoleum" (Poulík 1975, 92–94; Poláček/Marek 2005, 81–86). The new research unearthed evidence of a relatively later origin for the church – in the late second half of the 9th century (Poláček/Škojec 2013, 232–233). The archaeobotanical samples come from layers older than the church itself, i.e. from an earlier phase of the 9th or from the 8th century (Poláček/Škojec pers. comm.). The aims and questions of revision excavations and the methodology used to obtain environmental samples were similar to previous (Area 86 and Area 88).

Three archaeobotanical samples from two features were taken from Area 90. The total volume of the samples was 76 litres, which produced 1,336 charred and mineralised diaspores of wild and cultivated species. The average density of finds was relatively high compared to the other areas: 17.57 finds per litre of sediment [CAT. 7].

FIG. 11 | Mikulčice – Area 93. The excavated area (Photo by L. Poláček).

5.2.6 Area 91 (R 2012-I)

Area 91 and the neighbouring Area 96 were a relatively wide perpendicular cross-section through the fortification of the acropolis in the close vicinity of Church II (Mazuch 2013b, 2014; Poláček et al. 2013, 233–234). At the site where the trench has been laid out, the previous excavations had been conducted as early as the 1950s (Poulík 1975) and were unfinished at the time. The samples from Area 91 were collected directly from clearly stratified layers/contexts from the western profile of the fortification rampart and the ditch. The complexity of the situation of the archaeological finds in this excavation area does not currently allow us to date the time of its foundation and the decline of the fortification. Based on pottery and other artefacts, however, the material in individual layers of the fortification can be dated by means of relative chronology to the second half of the 9th and the beginning of the 10th century (Mazuch 2013b). A total of seven samples from different cultural layers were retrieved. As the samples were taken from the profile, their volume had to be adapted to the context size – they are thus smaller in volume. The total volume of floated deposits is 58.5 litres and 72 charred diaspores were found in the flotated residuum. The overall average density of finds per litre of sediment is 1.23 [CAT. 8].

5.2.7 Area 93 (B 2012)

Archaeological excavations of the riverbed in Area 93 focused on the revision of earlier findings from the 1960s and 1970s (Klanica 1968; Poláček/Marek 2005). The research was aimed at locating the cut bank of the riverbed and the continuation of a bridge (Hladík/Poláček 2014; Poláček/Hladík 2014; [FIG. 11]). As a great deal of organic material studied by E. Opravil (1972, 2000) comes from the riverbed but lacks more precise contextual information, then the intensive systematic sampling of sediments and deposits was conducted.[14]

14 A complex interdisciplinary evaluation of the findings is available (Poláček 2014a).

Intensive interval sampling was conducted at the excavation area. Samples were taken spatially from the surface of the lower layers and from a control block that had been left in the middle of the trench. During the excavations, 62 samples were taken from sediment layers of different nature (clay and sand). The volume of the floated samples was 677.9 litres, which produced 8,506 mainly waterlogged, but also charred, seeds and other plant remains (flower buds, leaves and twigs), with an average density of finds of 12.54/litre (Látková/Hajnalová 2014). Most of the PMR from recent excavations at Mikulčice come from this area [cat. 9].

5.2.8 Area 95 (Z 2012 II)

The rescue excavations in Area 95 were conducted in 2012. It was a development-led excavation prior to the construction of a tourist trail across the acropolis. The excavation was aimed at the verification of selected archaeological situations and contexts at the acropolis. The main focus of the excavation was the ditch between the basilica and the palace (Poláček et al. 2013, 235–236).

The archaeobotanical samples were taken from the infill of this ditch. The composition and nature of artefacts and ecofacts indicate that the fill comprises the usual settlement waste. The excavations produced four samples rich in charred and mineralised plant material. The volume of floated sediment is 104.5 litres from which 1,287 PMRs were extracted. The average density of macroremains is 12.31 finds per litre of sediment, which is relatively high [cat. 10].

5.2.9 Area 96 (R 2012-II)

Area 96 covers the eastern part of the cross-section of the acropolis fortification and is situated behind Church II. This excavation is related to and draws on findings from Area 91 (western part [fig. 12]). The excavated layers have brought a rich assemblage of archaeological material, which helps to date the period of the construction and use of the fortification wall to the second half of the 9th and the beginning of the 10th century (Mazuch 2013b; Poláček et al. 2013, 233–234).

Unlike in Area 91, these excavations employed extensive, systematic, interval sampling of all the layers/contexts. Eighty-five samples with a volume of 927.5 litres of sediment were collected while 2,295 charred, mineralised and waterlogged

fig. 12 | Mikulčice – Area 96. View of the excavated area – cross-section through a rampart (Photo by L. Kalčík).

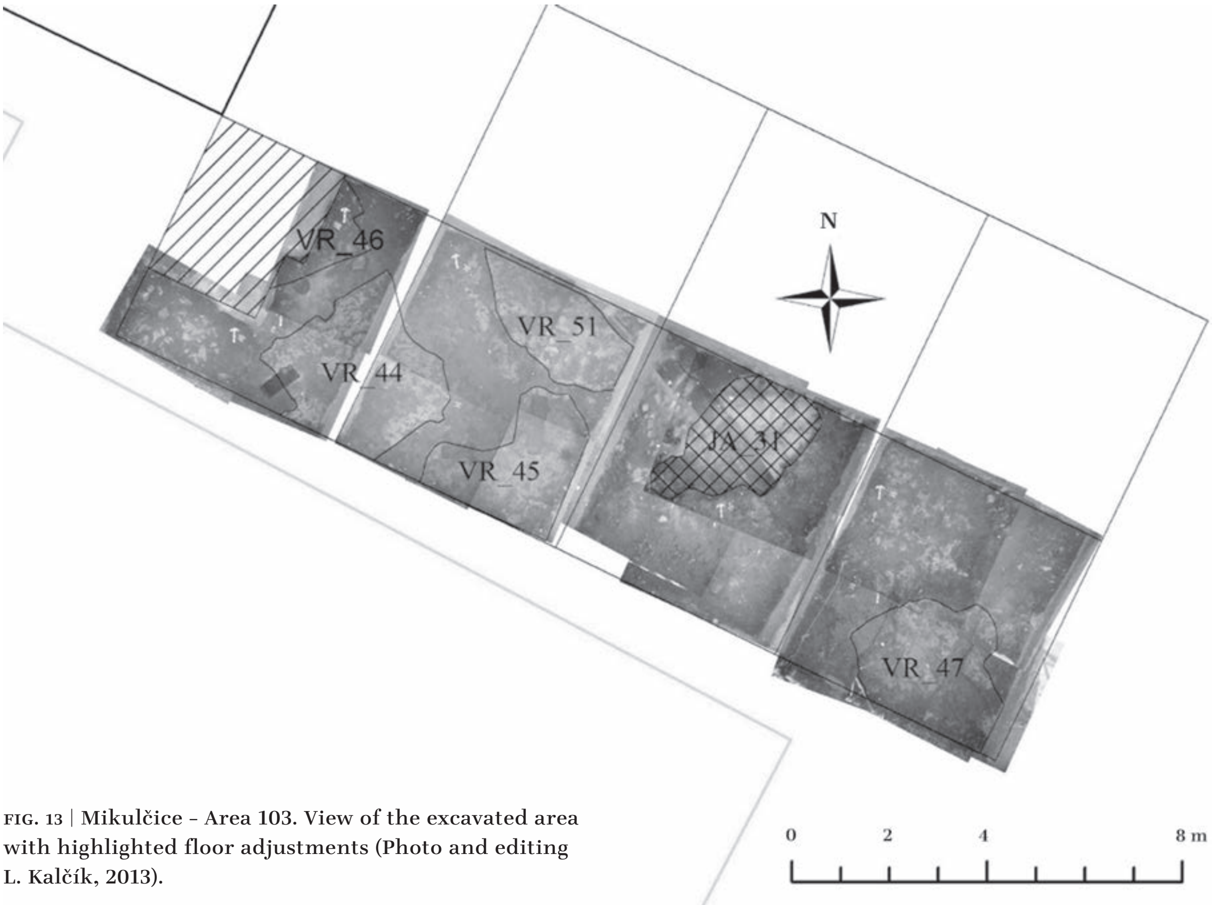


FIG. 13 | Mikulčice – Area 103. View of the excavated area with highlighted floor adjustments (Photo and editing L. Kalčík, 2013).

plant remains were extracted by flotation. On average, there were 2.4 finds per litre of sediment [CAT. 11].

5.2.10 Area 97 (Church V 2012)

As part of the restoration and revision of the findings made earlier in the 1950s, an excavation in Area 97 – at Church V – was conducted in 2012 (POLÁČEK et al. 2013, 236–237). The archaeological situation was similar to those of other sacral buildings (see Areas 88, 90 and 86). Apart from the preserved and past unexcavated lower parts of the fill for the settlements pits, archaeobotanical samples were taken from context 22 – the backfill for the original church wall foundations. Most of the sampled deposits date to the period before the foundation of the church, i.e. to the early 9th or the 8th century (POLÁČEK et al. 2013, 236–237).

The excavations produced nine judgement samples. To extract plant remains, a combination of flotation and wash-over was used in order to obtain the highest possible number of PMRs. The original volume of floated samples was 160.5 litres, from which 535 charred and mineralised plant diaspores were extracted. The average density of finds per litre of sediment was 3.33. Interestingly abundant plant material was also recorded in context 22, which closely resampled the finds from the settlement pits situated around the church [CAT. 12].

5.2.11 Area 98 (Z 2012-III)

The excavations in Area 98 were of a rescue nature and were meant to prevent damage to the layers during the construction of a tourist path across the acropolis. The excavations focused on a review of earlier findings regarding the situation around the main road through the acropolis to the north from Church IV (POLÁČEK et al. 2013, 237). The archaeobotanical samples were only taken from some of the contexts visible in the profile as the sampling was not supervised by the archaeobotanist.

Eighteen samples with a volume of 157.5 litres were collected, which produced 754 charred and mineralised plant seeds and fruits. The average density of the finds was 4.78 per litre of sediment [CAT. 13].

5.2.12 Area 100 (R 2012-III)

Area 100 represents a cross-section through a rampart in the outer bailey that was excavated in 2012. The excavations focused on the nature of the construction and dating of the fortification. Archaeological material dates the stratified layers to the period between the second half of the 9th to the first half of the 10th century (Hladík et al. 2014).

The samples taken for archaeobotanical analysis were only collected from the profile of the cross-section of the rampart. A total of 10 samples with a volume of 95 litres were taken with an average density of PMR per litre of sediment of 1.52 [cat. 14]. By combining flotation and wash-over methods, the samples produced 145 charred and waterlogged seeds (Látková 2014b).

5.2.13 Area 103 (P 2013-I)

Area 103 is located within the area enclosed by the outer bailey. Here, the rescue excavations were conducted there because of the reconstruction of the museum building in 2013–2014. The archaeological excavations uncovered part of a rather intensively inhabited area of the settlement. The complicated stratigraphic situation, typical of the area of an outer bailey, was documented comprising a system of interconnected, overlapping layers, interpreted as the floors of consequently built aboveground structures – probably houses with a wooden timber construction. In addition, several settlements pit – dug from the level of the floor(s) or under it – were recorded and sampled. Stratigraphically, there is a clay layer with charcoal on the subsoil, which used to be denoted to the horizon of the Pre-Great-Moravian period. Above it is a sequence of aluminous interlayers between the “floors”, which contain large amounts of settlement waste mainly comprised of animal bones and pottery. The described group of strata probably represents the period of the end of the 8th and the whole of the 9th century. Although, in general, these artefacts were rather scarce in Area 103; the original interpretation of the outer bailey as a residential area of the power centre has not been challenged (Poláček et al. 2014, 231–236; Hladík et al. 2015, 281–284; [fig. 13]).

Area 103 yielded the largest assemblage of 418 systematically obtained archaeobotanical samples. Despite the rescue character of the excavations, the sampling strategy was systematic and intensive. Samples were taken from a 1 × 1 m square network in a chessboard manner – every second square metre was sampled in each stratigraphic context and/or mechanical layer. All the samples were floated, but for reasons of time, not all of them could be included in this study. The samples included were selected so that they represent and illustrate the individual contexts in the best possible way. The analysis includes 163 samples from this area (40 % of the whole assemblage), with 5,053 charred, mineralised and – surprisingly – non-charred waterlogged PMRs. Groundwater was not recorded in the excavated area, which is why the presence of waterlogged PMR was not expected. The probable reason why they were present is that the clayey layers, documented during the excavations, maintained sufficient humidity in the deposits above and below them. The average density of the finds was 2.86 per litre of sediment [cat. 15].

5.2.14 Area M17

Archaeological excavations in Area M17 Mikulčice-Trapíkov were conducted as development-led rescue excavations before the construction of the new building for the archaeological base of the Institute of Archaeology Czech Academy of Sciences [fig. 14]. Area M17 is located on the periphery of the early medieval Mikulčice settlement agglomeration. It is assumed that inhabitants of the settlement in this area were actively involved in the production of (plant) foodstuffs and their supply to the centre (Poláček 2008a). The excavations were conducted over three excavation seasons from 2010 to 2012. During the excavations, several sunken settlement features of a different nature and function were unearthed (Hladík 2014). The dating of the pits, sunken houses and ovens, based on archaeological finds, dates them to the period of the second half of the 9th to the mid-10th century (Hladík 2014, 131). Haphazard and unsystematic sampling was applied for collecting the majority of the samples of deposits for archaeobotanical analysis. Usually, the middle or bottom part of the fill was taken. In some cases, the complete fill of a feature was removed as one unstratified sample. During the excavation seasons of 2010 and 2011, the samples were processed by water flotation by P. Čáp who was not supervised by a specialist. In 2012, the ground plan of one sunken house was discovered and its fill was sampled by systematic interval sampling. Apart from the fill of the settlement features, the fill of all complete ceramic vessels discovered in the interior of the houses was also sampled and floated. Overall, the assemblage of this area included 30 samples with a volume of 901.1 litres. Extracted and identified were 488 charred seeds. The average density of finds per litre is 0.3 ([cat. 16], Látková 2014c).

5.3 DATING

Based on the evaluation of the types and the archaeological chronology of various types of artefacts, it is possible to date the sampled contexts by using relative chronology to the period from the end of the 8th to the first half of the 10th century. Using conventional archaeological periodisation, it represents the end of the Pre-Great-Moravian (Old Hillfort) period and the following Great-Moravian (Middle Hillfort, 800–950 CE) period (Lutovský 2001, 235, Bialeková 1980). Unfortunately, due to the "weak" dating potential of the accompanying ceramic material and the extremely preliminary evaluation of the excavated features, it was not possible to date the contexts from which the PMR come from in any further detail.

In addition, attempts were made in the past to use methods of absolute chronology for dating in the occupation phases of the Mikulčice site. The results of dendrochronological and radiocarbon analysis approximately correspond with the conventional archaeological dating described above. They indicate the occupation of the site during the period from the end of the 8th through the whole of the 9th century (Dvorská/Boháčová 1999, Dvorská et al. 1999). Dendrochronological dating was limited by imperfectly preserved wood, a generally low number of annual rings in the studied samples and the absence of sapwood - the last annual rings (Dvorská et al. 1999, Rybníček et al. 2014). In the case of the radiocarbon dating method, the period when Mikulčice was mainly inhabited coincides with the plateau on the calibration curve [fig. 15]. As a result, there is quite a broad interval of the standard deviation of the data obtained, which reduces the possibility of more precise dating of archaeological events (Reimer et al. 2013).

Despite the existence of a relatively precise relative chronology of the Mikulčice area, which is based on an analysis of an extensive pottery assemblage (latest: Mazuch 2013a), unambiguous dating of the contexts is very rare, in particular, because of the absence of chronologically sensitive material. This is why it is impossible to ascertain the time difference between clearly stratified contexts (for example, between masonry structures and the pits underneath them), let alone between contexts without a clear spatial relationship (e.g. the neighbouring sunken houses).

Plant seeds represent one of the so-called short-lived samples. If they come from well-stratified contexts that have not been contaminated with younger or older intrusions/residues, then

FIG. 14 | Mikulčice-Trapíkov. View of the excavated area(HLADÍK 2014, 338).

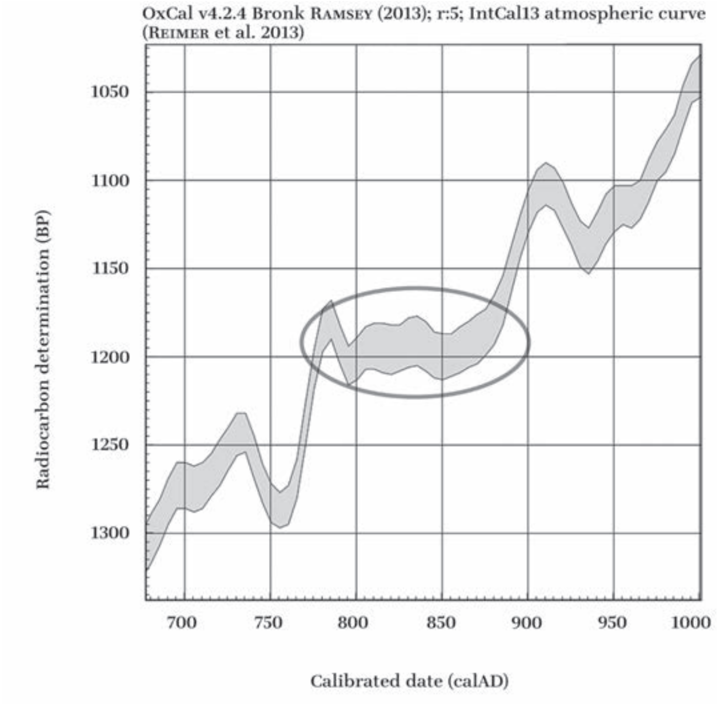


FIG. 15 | Radiocarbon calibration curve, IntCal 13 between 700 and 1000 cal AD. Plateau between 750–870 cal AD.

they represent samples of high chronometric hygiene, which are suitable for answering questions on absolute chronology (BARTA 2009). Data measured from a series of short-lived samples (plant seeds and chaff, year-old branches, woody-plant buds etc.) reduce the difference between the time in which a given organism lived – or ceased to live – and an archaeological event (e.g. the formation of a pit filling). This is why so-called long-lived samples (animal bones, human bones, annual rings of woody plants without a clear relation to sapwood and others) are less appropriate as suitable data (BARTA 2009).

For these reasons, a series of seeds was selected for radiocarbon dating in Mikulčice. Due to the low weight of the samples (up to a few milligrams) the AMS (*Accelerated Mass Spectrometry*) method was selected. The objective of the dating of the selected seeds was:

1) To exclude the possibility of contamination of the finds by modern seeds from exotic fruits (peach, vine), which although present in Mikulčice are absent or very rarely found in other Early Medieval sites.
2) To help interpret the stratigraphy and the dating of the examined contexts. In the case of the samples from the sediments excavated from the riverbed, the aim was to clarify the process of filling – the manner and the speed of the deposition of the layers (BARTA et al. 2014).

5.3.1 Material

A total of eight samples of charred and waterlogged diaspores of cultivated plants were sent for radiocarbon dating [TAB. 2]. All the PMRs dated using radioactive carbon come from two contexts in Mikulčice[15] – from Area 93 – water-saturated layers of the riverbed – and the charcoal layer (context 86) at the subsoil from Area 103. The seeds and fruit stones, i.e. the peach stone (one piece) and the pips from cultivated grapes (two pieces) were waterlogged. The cereal grains dated: three grains of rye (two pieces from Area 93 and one from Area 103), barley (one piece) and wheat (one piece) from Area 103 were all charred. The absolute dating was conducted in the AMS laboratory in Poznań.

5.3.2 Results

Absolute dating of the selected finds of the seeds from arable crops (fruits and cereals) confirmed an early/medieval origin in all cases [TAB. 3].

15 Samples for the radiocarbon dating were also taken from Kopčany-Kačenáreň (one grain of rye from feature 1, which, unfortunately, has still not been dated).

Area	Lab. code	Ellevation	Context	Taxon
AR 93	Poz-61348	156.7	Bottom of riverbed	*Vitis vinifera**
AR 93	Poz-61350	156.7	Bottom of riverbed	*Secale cereale*
AR 93	Poz-61347	157.2	First layer of filling	*Vitis vinifera**
AR 93	Poz-61345	157.2	First layer of filling	*Secale cereale*
AR 93	Poz-61349	157.2	First layer of filling	*Persica vulgaris**
AR 103	Poz-61353	159.5	Context 86	*Triticum aestivum*
AR 103	Poz-61354	159.2	Context 86	*Hordeum vulgare-vulgare*
AR 103	Poz-61355	159.4	Context 86	*Secale cereale*

TAB. 2 | Mikulčice. Results of AMS dating of PMR. *non-charred, water-logged find (AR – area).

5.3.3 Area 93 (riverbed)

To narrow down the possible time interval and to overcome the plateau on the calibration curve, the data was calibrated using calibration modelling. For two possible scenarios, based on the stratigraphy, density and composition of PMR in the samples from different layers, two models were developed. In the first, the data was divided into two groups within which they were considered to be contemporaneous. The first group comprised all the samples from the bottom of the river and the layer immediately above it, which represented an earlier stage. The samples from the layers above represented a younger phase. Using this model, the older phase was dated to the period 775–805 cal AD and the younger phase to 860–880 cal AD. In the second model, all the PMRs were considered to be contemporaneous – coming from the same phase – and determined as spanning from 785 to 870 cal AD (Barta et al. 2014).

5.3.4 Area 103 (outer bailey)

In the case of the absolute dating of the PMR from the outer bailey (Area 103), only three finds of charred seeds from arable crops (barley, rye and wheat) were sent for AMS dating. All the seeds come exclusively from context 86, which is a thick, burned layer rich in organic material and situated just above the subsoil. The reason for dating this lowermost layer was to ascertain its "real" time date as there was the chance of finding the so-called "Avar bronzes" there. The bronzes would date the layer later than the Great Moravian period. This layer contained large numbers of charcoal fragments from different woody plants, the seeds of arable crops and wild species. Based on the homogeneous distribution of plant macroremains throughout the layer, it is assumed that the PMR it contained got there in the same (relatively short) period – and represents a single settlement phase. The aim was to select the least damaged seeds from the plant material available in this context in order to obtain as much carbon – necessary for radiocarbon dating – as possible. In this case, the data was not modelled during calibration in the OxCal environment; instead, each +date was calibrated separately.

5.3.5 Results – Area 103

The results of the radiocarbon dating of the PMR and the data calibration make it possible to date all the crops in context 86 to the period 686–881 cal AD, or to one of the following three intervals: 686–747 cal AD, 763–780 cal AD and 787–881 cal AD [FIG. 16]. Unfortunately, it was not possible to determine this more precisely because of the existence of the so-called "early-medieval plateau" on the calibration curve [FIG. 17].

Dating of this context to an earlier – i.e. pre-Great-Moravian – period cannot be ruled out. Absolute dating can be made more precise by dating PMR (and the bones of small ruminants – goats/sheep) from several layers above and below context 86. This is also how a more precise dating of individual layers could be achieved, in particular, the layers of the so-called floor modifications documented in the outer bailey.

TAB. 3 | Mikulčice. Results of AMS dating of PMR. *non-charred, waterlogged find (AR – area). Absolute data obtained by individual calibration of data in the OXCAL program (using the calibration curve by REIMER et al. 2013).

Area	Lab. code	14C years	Sigma ±	Taxon	calAD (95 %)
AR 93	Poz-61348	1190	30	*Vitis vinifera**	766–899
AR 93	Poz-61350	1120	30	*Secale cereale*	762–887
AR 93	Poz-61347	1145	30	*Vitis vinifera**	800–975
AR 93	Poz-61345	1290	80	*Secale cereale*	605–898
AR 93	Poz-61349	1210	30	*Persica vulgaris**	764–891
AR 103	Poz-61353	1235	35	*Triticum aestivum*	686–881
AR 103	Poz-61354	1245	30	*Hordeum vulgare-vulgare*	680–874
AR 103	Poz-61355	1210	30	*Secale cereale*	695–891

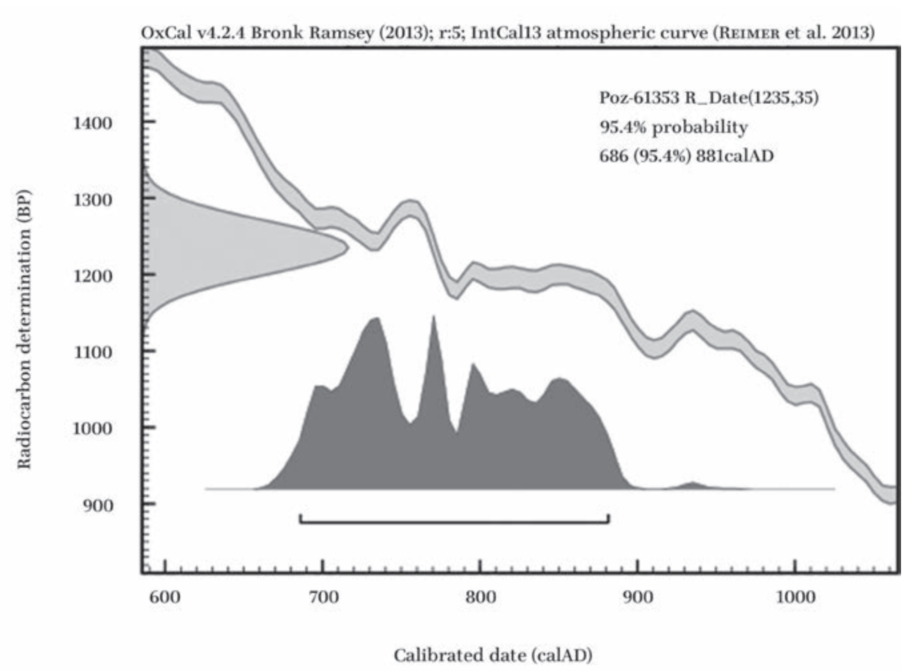


FIG. 16 | Mikulčice – Area 103, context 86. Results of calibration in so-called "singleplot".

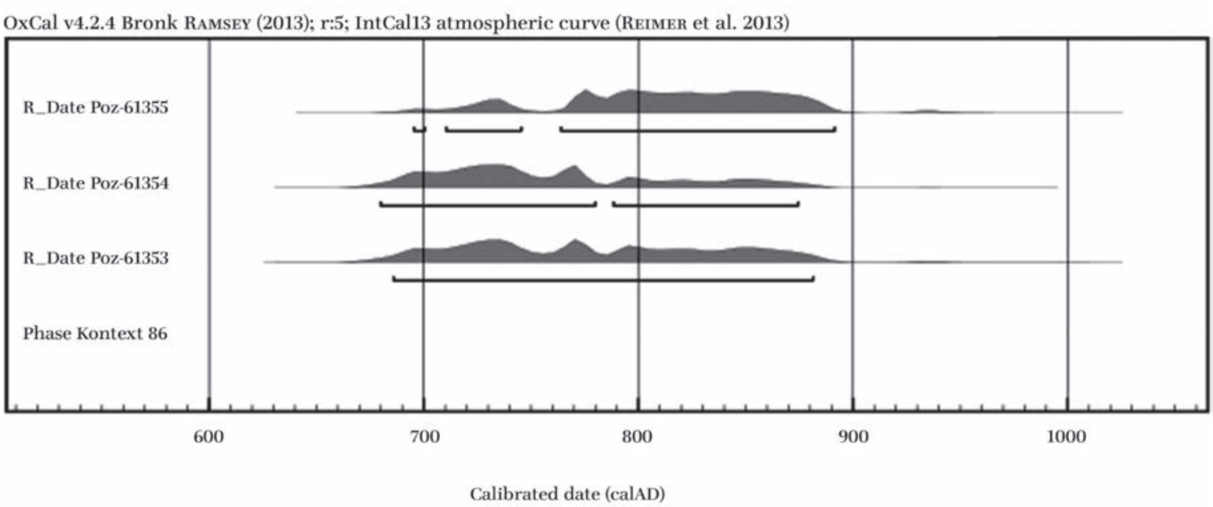


FIG. 17 | Mikulčice – Area 103, context 86. Results of calibration in so-called "multiplot".

6 General results

All the samples collected during excavations spanning from 2005 to 2013 [TAB. 4] were analysed and evaluated for the purposes of this study. Since 2014, field research and archaeobotanical sampling have continued in Mikulčice and Kopčany. These new samples are being processed and will be used in future for the verification of the results presented here.

The evaluated PMR come from a wide range of archaeological situations and contexts – ramparts, graves, settlement buildings sunken or built at ground level, sacral and profane buildings, the riverbed; situated in the settlement centre and in its outskirts – thus they reflect various types of settlement activities.

Most common and most numerous are the charred seeds and diaspores [FIG. 18] found in all the areas studied, all types of contexts and both dry and water-saturated layers. Non-charred waterlogged PMR are less numerous. These were mainly found in the deposits of a former riverbed investigated in Area 93 and in a smaller number of contexts in Area 103. Mineralised plant material is rare and comes mostly from areas situated under stone constructions examined during revision excavations of stone architectures (church buildings and a palace). It is presumed that their preservation was due to the presence of plaster rich in calcium (lime) where the minerals and salts entered the surrounding deposits.

Alongside botanical material, the samples also contained various types of other ecofacts and artefacts. These commonly consisted of animal bones (that belonged to both small and large mammals, birds, and fish). Fish scales, most probably from different fish species, were also relatively abundant. The combination of these types of ecofacts alongside pottery fragments indicates that samples represent common kitchen or household waste. Waste from craftsmen's workshops and/or other production processes was recorded in higher abundances in the excavations at Kopčany-Kačenáreň, where a relatively large number of small-size scales and fragments of blacksmiths' slag was found in the flot and in heavy residue fractions (LÁTKOVÁ 2014a). In other areas, similar findings appear only sporadically and in a small number or are totally absent.

The evaluated assemblage consists of **270** plant taxa determined from **26,994** seeds and plant diaspores out of which 16,966 are charred, 1,044 mineralised and 8,980 waterlogged; [TAB. 5].

The number of recorded plant taxa is lower than previously recorded from the site by E. OPRAVIL (2000), who identified 387 species. This difference was probably caused by the fact that Opravil's PMR mainly come from the fill of an extinct riverbed excavated on a large scale at multiple locations. Nevertheless, taxa identified in this study do come from various vegetation communities and biotopes [TAB. 6].

6.1 CULTIVATED PLANTS

The assortment of cultivated crops in the agglomeration of Mikulčice-Kopčany provides evidence of the consumption and use of various types of cultivated crops – cereals, legumes, fruits, vegetables and oil/fibre crops. Finds of cultivated plants at other Early Medieval sites are predominantly composed of the charred seeds of cereals. In Mikulčice, other types of crops, such as fruits, vegetables and oil/fibre crops were conserved due to a high level of groundwater. Due to taphonomic reasons these are only rarely preserved in dry archaeological deposits (JONES 1984, 1990).

6.1.1 Cereals

The largest number of finds in the assemblage of cultivated plants is clearly cereals. Unfortunately, some seeds had been exposed to high temperatures, which meant that only the inner nourishing tissue, the endosperm, remained

Area	Collected samples	Positive samples	Σ PMR	Volume per litre	Avg. density (PMR/l)
KSM	34	34	236	345	0.68
KAČ	517	157	2357	3441.05	0.75
AR 85	1	1	192	44	4.4
AR 86	19	19	2480	1083	2.28
AR 88	6	6	821	203	4.04
AR 89	2	2	471	139	3.38
AR 90	3	3	1336	76	17.57
AR 91	8	5	72	58.5	1.23
AR 93	62	58	8506	677.9	12.54
AR 95	4	4	1287	104.5	12.31
AR 96	85	70	2295	927.5	2.47
AR 97	9	9	535	160.5	3.33
AR 98	19	18	754	164.5	4.58
AR 100	10	8	145	95	1.52
AR 103	162	162	5023	1749.5	2.87
AR M17	30	24	488	901.05	1.84

TAB. 4 | Mikulčice-Kopčany. Basic characteristics of input data that were used for further analyses. Captions: KSM – Church of St Margaret of Antioch, KAČ – Kačenáreň, AR – area.

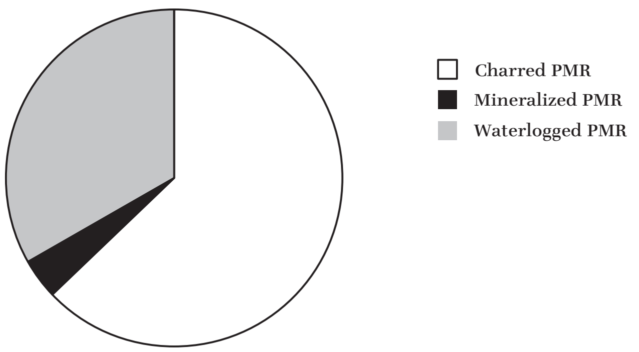


FIG. 18 | Mikulčice-Kopčany. Proportion of PMR included in the analysis based on the state of preservation.

Taxon	Cultivated crops	Wild species
Charred	18	175
Mineralized	9	115
Waterlogged	10	115

TAB. 5 | Mikulčice-Kopčany. Summary of taxa identified based on the type of preservation of plant material.

	n Taxon	% Taxon	n PMR	% PMR
To species	198	67%	17840	66%
To genus	88	30%	2127	8%
To family	11	4%	168	0.62%
Undetermined	.	.	4732	18%

TAB. 6 | Mikulčice-Kopčany. Summary of taxa identified based on the degree of plant material fragmentation.

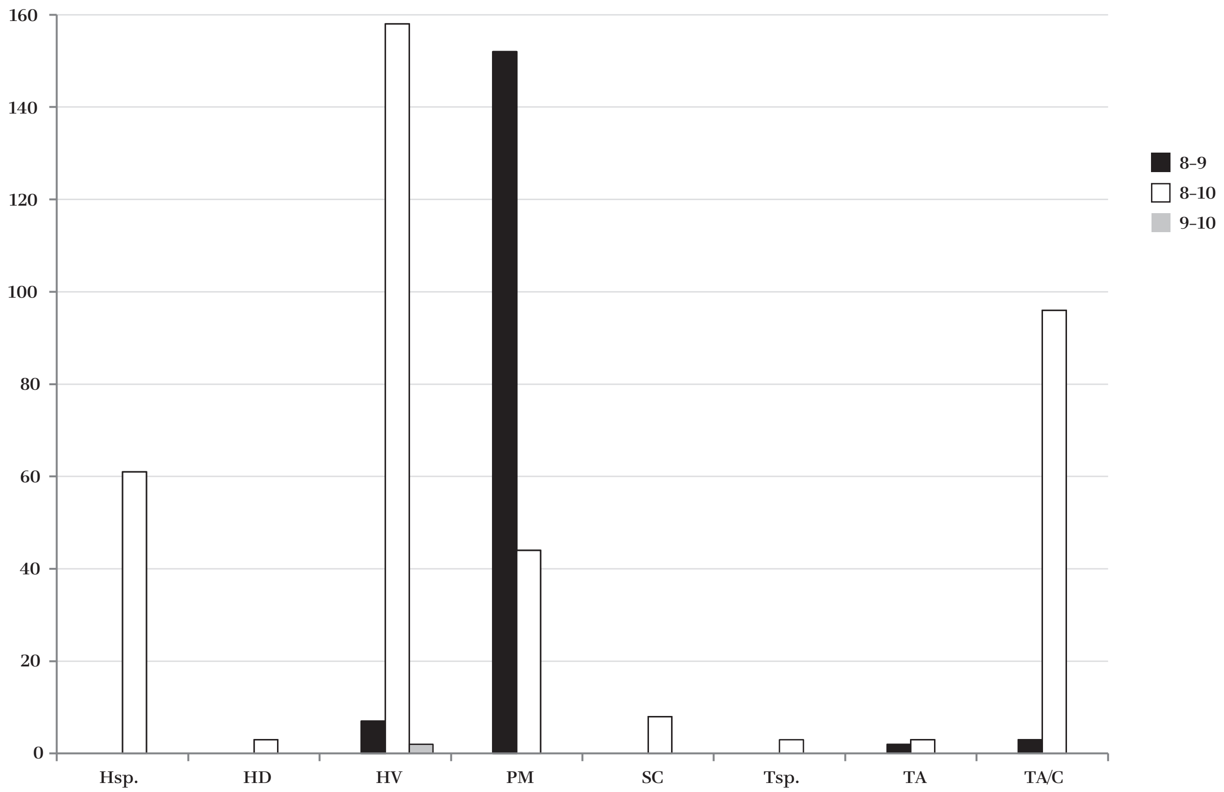


FIG. 19 | Mikulčice-Valy. Proportion of cereals in the Early Medieval period analysed by E. Opravil. Captions: Hsp. – *Hordeum sp.*, HD – *Hordeum distichon*, HV – *Hordeum vulgare*, PM – *Panicum miliaceum*, SC – *Secale cereale*, Tsp. – *Triticum sp.*, TA – *Triticum aestivum*, TA/C – *Triticum aestivum/compactum*.

(cf. Boardman/Jones 1990). More than 2,900 finds that were damaged this way could not be identified more closely. Nevertheless, they do carry some information and were used in some analyses.

The previous finds of cereals from Mikulčice were also identified by two other archaeobotanists – Z. Tempír (1973) and F. Kühn (1981) who together evaluated an assemblage of 7,999 charred cereal seeds [FIG. 19 and 20]. Unfortunately, it is not clear from the published works what contexts or areas of the site they come from. Most probably, they come from the central part of the settlement area – the acropolis – that was most intensively excavated in that period. However, a part of their material also comes from excavations of the layers of the riverbed and settlement layers in the outer bailey.

Unfortunately, in the past, the collection of archaeobotanical samples was not systematic. Usually only large seeds or kernels that were visible to the naked eye were individually hand-retrieved; rarely were the entire concentrations collected. Also, the method used for the extraction of PMR from (sporadically) collected samples of deposits was not ideal. The use of sieves with mesh greater than 1 mm caused the loss of part of the material (Čulíková pers. comm.). Despite these shortcomings, which can be ascribed to the period of time when this research was conducted, the above-mentioned authors managed to obtain and process a large assemblage of archaeobotanical data. Significant differences in both the assortment of cereals and their number can be observed among the results of the individual researchers (E. Opravil, Z. Tempír and F. Kühn). Since these are findings of common species of cereals that can be distinguished, the differences probably spring from the character of the archaeological situation, the context the findings come from, and the method of extraction used.

Based on the overall assessment of his assemblage, E. Opravil (2000) assumes that the main cereal consumed (and therefore cultivated) in Mikulčice was bread wheat. The second most frequently cultivated cereal was rye, followed by barley. The role of millet in the diet of the Early Medieval population of Mikulčice remained problematic. This crop, whose seeds are approximately 2 mm in size at the very most, were not recorded by Z. Tempír or F. Kühn at all [FIG. 20]. This probably stemmed from the method of collection (manual selection of individual seeds directly from the deposits) and the small number of samples analysed. Despite this, E. Opravil, who did record a small amount of millet, did not doubt its economic significance.

The intensive archaeobotanical sampling between 2005 and 2013 secured an assemblage of 11,129 charred cereal grains plus six mineralised and two waterlogged seeds [PLATE 1–2]. Findings of chaff are unique in the Mikulčice assemblage. Only three fragments of rachis internodes were documented; one in the excavation areas of Kopčany-Kačenáreň and two in Mikulčice in Area 95 and Area 96. All were determined as bread wheat.

Closer identification was possible for 7,587 specimens (68.12 %). Due to the high degree of damage to the grains, 650 finds were left in the category of *Triticum/Hordeum* (5.84 %) and up to 2,900 (26.05 %) finds (mostly fragments) were left in the category of *Cerealia* (cereals). Since a more detailed chronological assignment of the samples and finds has not been possible,[16] questions have not been able to be addressed regarding possible changes or trends in the exploitation of individual species over time. Unlike in E. Opravil's work (2000), no trend toward change was registered when comparing assemblages marked as "older" and "younger" [FIG. 21].

With respect that the majority of features under scrutiny and contexts from which samples were collected were only generally dated to the 9th century without any further chronological determination, attention tended to be more focused on the differences in the spatial distribution of species: the acropolis, extra-mural settlement, outer bailey, and the outskirts of the agglomeration.

The percentages of individual species of cereal crops and their frequency (ubiquity) were assessed for the whole assemblage [FIG. 62 to 64] and for each individual site [FIG. 65 to 80].

OAT (*Avena sp.*) was found in Mikulčice solely in a charred state (85 findings). Oat seeds usually appear in excavation areas where a more intensive sampling strategy was applied (Kopčany-Kačenáreň, Area 96 and Area 103); however, they also sporadically appear in other areas. Oat is the least frequently represented cultivated crop from the perspective of the absolute number of PMR.

Today, it is mainly used mainly as fodder crop for stable animals, especially horses. However, in the past, it was also an important human food. Direct evidence of its consumption by people is known from the Late Iron Age in Denmark in Northern Europe. The remains of plant food in the stomachs of mummified bog-bodies in Danish marshlands were identified as oat (Helbaek 1951, 1959). Unfortunately, it is not known if they were the remains of cultivated or wild oat. The increased frequency, as well as the overall number, of findings allow us to assume that in the early Middle Ages oat was already an intentionally cultivated species (cf. Kočár 2010, Hajnalová 1993, 85). With respect to the absence of oat lemma bases in the PMR assemblage from Mikulčice, it is impossible to ascertain if the crops were of wild or domesticated species.

BARLEY (*Hordeum vulgare*) is represented in the assemblage by 949 seeds and appears in samples from all the studied excavation areas. Alongside hulled seeds, five specimens of naked barley seeds were also documented. Barley seems to be a stable element from the perspective of the frequency of occurrence (ubiquity) in individual excavation areas. A higher concentration of barley was recorded in Area 96 (incision in a rampart behind Church II) and 103 (Mikulčice – a settlement in the outer bailey).

Barley is known predominantly as a non-bread cereal. In the human diet, it is mostly consumed in the form of porridge, soup and pancakes. Apart from this consumption, there has been a long tradition of its use in the production of beer (Šálková et al. 2012; Hajnalová 1993). It also serves as important fodder crop for domestic animals. It is a versatile species capable of growing in wetter or drier climates or on soil that is rich as well as poor in nutrients. Ethnographic studies from Greece established that common wheat and barley can be sown together as a so-called cereal mixture – maslin (Jones/Halstead 1995). Since in certain conditions they respond to precipitation almost contradictorily (cf. Kočár/Dreslerová 2010, Graf. 1), barley can compensate for a low wheat harvest in unfavourable weather (too dry, too humid, Šálková et al. 2012; Hajnalová 1993).

MILLET (*Panicum miliaceum*) is the most common crop in the studied assemblage (4,103 specimens). In most cases, it appears in a charred

16 Based on the archaeological information available, the PMR assemblage can only be divided into two time horizons/phases – "older" and "younger". The "older" horizon/phase include contexts from the period before the construction of churches, i.e. samples from pits that are in superposition with stone constructions. All other finds are considered "younger". It cannot be ruled out that "older" might also be a part of these finds. However, insufficient chronological sensitivity of especially ceramic artefacts does not allow to address this issue.

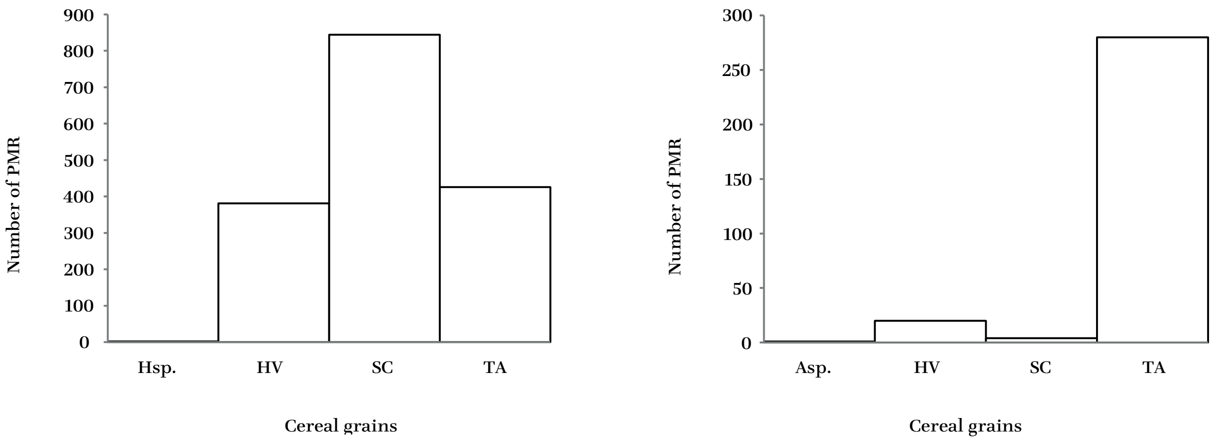


FIG. 20 | Mikulčice-Valy. The proportion and the occurrence of cereals analysed by Z. Tempír (left) and F. Kühn (right). The same captions as in FIG. 19.

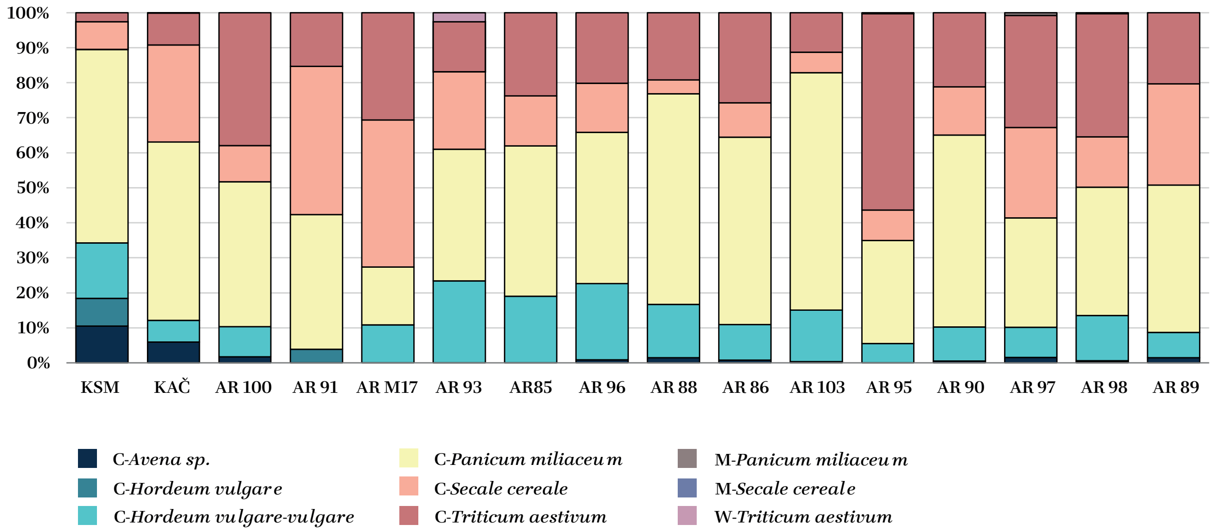


FIG. 21 | Mikulčice-Kopčany. The proportion of cereal species; absolute numbers from all the sites excavated after the exclusion of all closely unidentified fragments, n = 7587. Captions: C – charred, M – mineralised, W – waterlogged.

state. However, five mineralised seeds of this cereal were recorded as well. Apart from individual seeds from this crop, a lump of millet grains weighing 0.17 g was found in Area 96. Using the conversion of the average (charred) grain weight, this indicates the presence of 30 other millet seeds. Millet is the most numerous cereal in all the excavation areas. It has an equally dominant position in both "rich" and "poor" samples.

Currently, millet is an underestimated or even unknown crop that can be used for the preparation of various baked or boiled starchy dishes. It is a relatively environmentally undemanding spring-sown crop that endures very well in extreme hot conditions, soils poor in nutrients and long-term droughts (HAJNALOVÁ 1993, 91–92). This cereal could generally be classified as the most resistant towards unfavourable climatic circumstances and conditions (HAJNALOVÁ 1993). Due to its qualities, it is still cultivated in Russia, Eastern Asia and the Middle East (HAJNALOVÁ 2012, 80). Its vegetation cycle is short – the crop ripens as early as after 60–90 days (HAJNALOVÁ 2012, 80). This quality was also mentioned in medieval written sources, which state that the Slavs harvested millet up to twice a year (MARSINA et al. 1999). Although millet can be classified as an undemanding crop with respect to its ability to grow in soils with certain conditions, it has a very poor ability to compete with field weeds at the beginning of its vegetation cycle (BERANOVÁ/KUBAČÁK 2010, 74). However, due to its habitus, it is later able to suppress almost all surrounding weeds. At the beginning of the vegetation cycle it still needs soils void of weeds. This requires intensive hoeing and weeding of the millet plots, which make it a demanding crop.

RYE (*Secale cereale*) has a similar number of finds as barley – 927 charred seeds and one mineralised seed. This crop appears in smaller numbers in all the investigated excavation areas. It is more frequently found in Mikulčice-Trapíkov, Kopčany-Kačenáreň and the Church of St Margaret of Antioch, all of which are considered to be on the outskirts or periphery of the early medieval Mikulčice agglomeration.

Rye is a typical bread cereal. Rye flour has a different protein composition and contains less gluten (Hajnalová 1993, 66), which is why rye bread is sourer than wheat bread. Rye is also used as calorically valuable fodder or for the preparation of distilled spirits (Hajnalová 2012, 80). It yields a more stable harvest in harsher environments and therefore could have been preferred over wheat or barley in the past (Hajnalová 1993, 66).

WHEAT (*Triticum aestivum*) accounts for 1,515 findings of charred and two waterlogged seeds. The most numerous finds are documented in assemblages from the central part of the site, i.e. the acropolis (Area 86) and the outer bailey (Area 100 and Area 103). In Area 85 of the extra-mural settlement, it appears more frequently than in assemblages from Kopčany, where the lowest number of wheat grains was recorded in the excavation area of the Church of St Margaret of Antioch.

The seeds of common wheat have a high nutritional value. The composition of proteins in the grains provides this crop with excellent qualities for milling and baking. However, it is the most environmentally demanding crop in the assemblage. Likewise, it is demanding from the perspective of the care needed during the whole vegetation cycle (Hajnalová 1993, 53–54).

6.1.1.1 *Alternative methods for the evaluation of cereals*

When evaluating archaeobotanical assemblages of cereals, most authors take into account only the absolute number of findings of individual species. They also state their economic importance based on this number. Several authors pointed out, already at the end of the previous century that such a straightforward interpretation is not appropriate (cf. Jones 1984). When stating the economic role or the importance of individual crops, they advise to also consider such variables as the frequency or stability of the presence of the taxon in samples ("ubiquity"), the overall weight of the seeds and their caloric value (Kuna et al. 2013, 87–95). It is also necessary to take into account the contextual information and results of taphonomic analysis.

Evaluation of each of the four variables – absolute number, ubiquity, weight (of non-charred seeds), and caloric value – presents different results [fig. 22]. Based on the absolute number of finds and ubiquity, millet seems to be the most "important" crop in the assemblage. However, when evaluating the weight and caloric value millet ranks fourth. This discrepancy is caused by the size and the shape of a millet seed (ca 1 mm and round). In addition, it is not possible to compare millet to other cereals directly, as its preparation is different from that of other types of cereals. Millet is boiled and, when soaked and cooked, it increases its original volume approximately three times. The "importance" of the other three crops – wheat, barley and rye – is comparatively the same and balanced when evaluating the absolute number and ubiquity. When the weight of the seeds is taken into consideration, common wheat seems to be the most important crop, followed by barley. Millet and rye reach only half of the wheat or barley value. A similar result is also obtained when evaluating the caloric value of the four crops – at the most, millet and rye reach a quarter of the caloric value of wheat and barley.

The assortment of cereals from evaluated assemblages corresponds well with previous data from the site (Opravil 2000) and also with the opinion of Beranová/Lutovský (2009, 109–110) who believe that bread wheat and millet were the dominant crops in Bohemia and Moravia from the 8th to the 12th century (Almost all excavated sites within the central part of the agglomeration fit this scenario[17]). The situation in the periphery of Mikulčice agglomeration at Kopčany and Mikulčice-Trapíkov is different, where rye occupies the dominant position. The importance of rye seems to increase in Bohemia and Moravia from the 13th century (Kočár et al. 2010; Beranová 1975, 16–19; Beranová/Lutovský 2009, 327) in rare cases, and locally already since 11th century (Čech et al. 2013).

The difference between the other sites and Mikulčice lies in the differing numbers

17 A similar image with respect to the spectrum of cultivated crops with significant dominance of millet is also known from the Early Medieval settlement of Cracow (Mueller-Bieniek et al. 2015, 101) and Wolin (Latałowa 1999, 196, Tab. 6, Fig. 10).

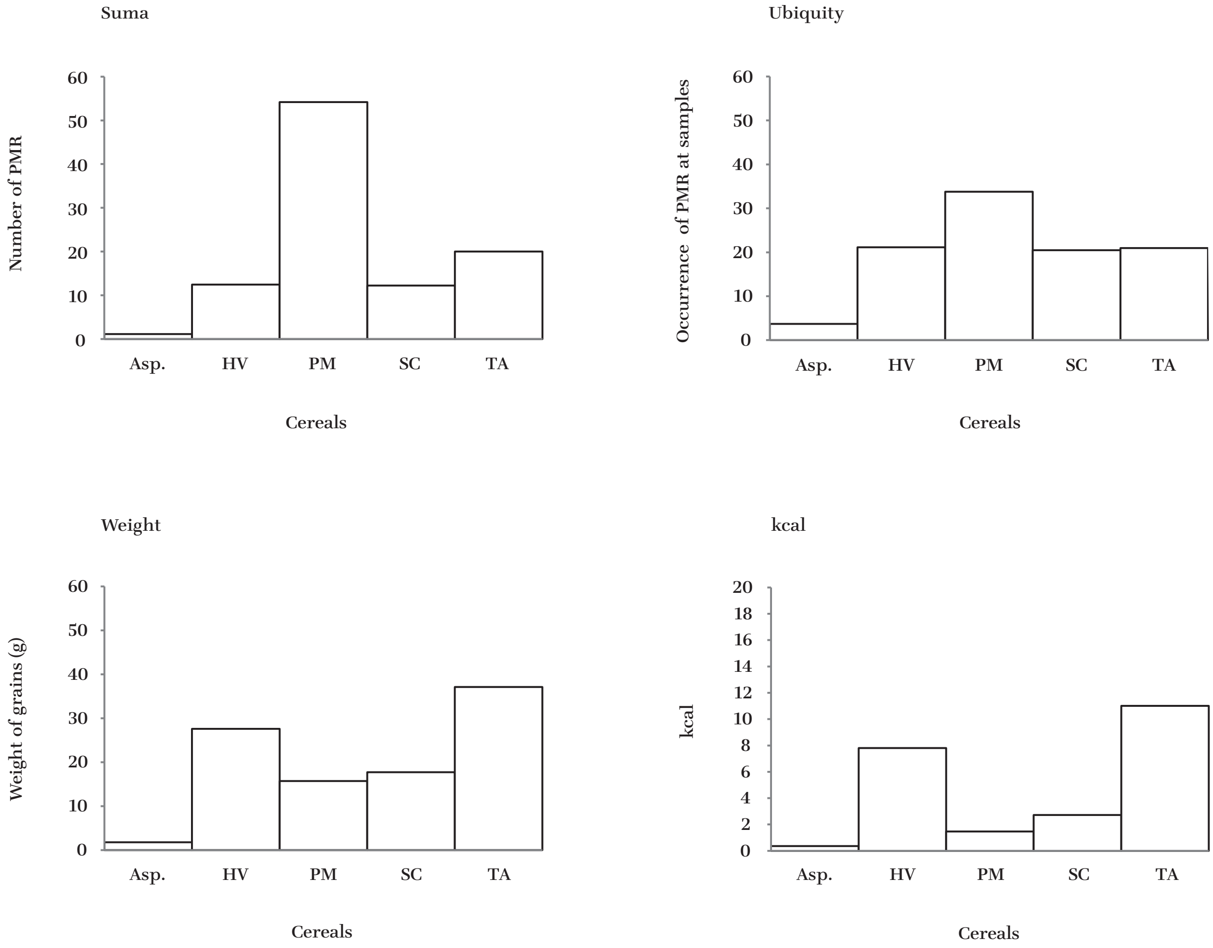


FIG. 22 | Mikulčice-Kopčany. The occurrence (significance) of cereal species. Captions: Asp. – *Avena sp.* (oat), HV – *Hordeum vulgare* (barley), PM – *Panicum miliaceum* (millet), SC – *Secale cereale* (rye), TA – *Triticum aestivum* (bread wheat).

and ubiquity of various crop finds. In the Early Medieval agglomerations of Žatec (Čech et al. 2013) and Nitra (Hajnalová/Hajnalová 2008) as well in the majority of other sites (Kočár et al. 2010, 54, Fig. 3) the most common cereal is bread wheat, followed by rye, barley, millet and oat and rarely by various species of glume wheat. In Mikulčice however, this was millet followed by wheat, rye, barley and oat. A similar situation with dominant millet is documented in Prague, from the excavation areas of Hartigovský Palace (Čulíková 1998) and Mostecká Street (Čulíková 2005). Millet as a dominant crop is also found at other Early Medieval central sites such as Bojná in Slovakia (Mihalyiová, pers. comm.), and Cracow (Mueller-Bieniek et al. 2015, 99, Fig. 2), Cracow-Wawel (Wasylikowa 1978, 181–182) and Wolin (Latałowa 1999, 202–203) in Poland.

The higher numbers of millet finds, and their absence or lower numbers on others, cannot be any more ascribed to the unsuitable methods of sampling, or extraction of plant remains. Some new, systematically sampled sites where plant remains were extracted by modern flotation techniques (e.g. Žatec) also witness the absence or scarcity of millet. It is therefore clear that millet was more favoured at some sites than at others. The reasons for this might have been both cultural and/or economic. The certain role could be attributed to the high demands on human labour (hoeing, weeding) needed at the beginning of its vegetation cycle.

6.1.2 Wilcoxon two-sample test[18]

6.1.2.1 Application of the method

The Wilcoxon two-sample test method was applied to an assemblage of charred cereal grains obtained from all the areas within the agglomeration.

18 For the description of the method, see the chapter 4.5.3 Wilcoxon two-sample test method.

This analysis tested the hypothesis that different types of cereal grains are linked with their provenance. In this case, the test characteristics were cereal species (AV, HVC, HVV, TA, PM, SC, T/H and CER) and two groups of sites were tested against each other. The samples were attributed to the groups based on the place of their origin within the Mikulčice stronghold. The samples from the acropolis, outer bailey and the closest suburbium were denoted as **O** "central"; samples from Kopčany's (KAČ, KSM) and Mikulčice-Trapíkov (M17) were denoted as **M** "marginal" in this analysis. [19] The test was conducted using the STATISTICA programme.

6.1.2.2 Wilcoxon two-sample test results

The results of the Wilcoxon two-sample test are presented in a table data matrix [TAB. 7] generated by a statistical programme.

For the oat (or, the evaluation characteristic/cereal species AV) the value of the test statistics is Z = −0.5988 and the value of probability is p = 0.5493. As the computed value of probability is $p > 0.05$, the hypothesis H_0 cannot be rejected on the level of significance $\alpha = 0.05$, i.e. the observed differences **are not statistically significant**. Thus the test did not confirm that the areas (O and M) influenced the values of the occurrence of AV. Translated into archaeology, there is no (statistically significant) difference between the occurrence of oats in the "central" and "marginal" areas; oats are found at both groups of sites in the same extent.

For the naked barley (evaluation characteristic/cereal species HVC) Z = 0.33585 and the p = 0.736983; as the computed value of probability is again larger than 0.05, the differences between the two groups of sites **are not statistically significant**. The frequency of occurrence of the HVC species is not dependent on the provenance.

For the hulled barley (denoted as HVV), the value of the test statistics is Z = −5.73811 and the probability $p = 0.000001$. As the computed value of probability is $p < 0.01$, the hypothesis H_0 can be rejected on the level of significance $\alpha = 0.01$; i.e. the observed differences **are statistically significant**. This means that the place of discovery influences the values of occurrence of HVV. The amount of hulled barley in the central areas statistically significantly differs from barley found at the periphery of the agglomeration. Thus, there is a (statistically significant) difference between the occurrence of hulled barley in the fortified areas and in the non-fortified peripheral parts of the Mikulčice agglomeration.

For millet (PM), the value of the testing statistics is Z = −5.70687; the probability is p = 0.00000001. The value of probability, in this case, is also $p < 0.01$ and the hypothesis H_0 may be rejected at the level of significance $\alpha = 0.01$. The assessed differences **are statistically significant**, which means that the quantity of millet is strongly influenced by the place where it is found; i.e. millet is found more often in the "central" parts of the agglomeration (the acropolis outer bailey, and the closest areas of the suburbium).

The statistical testing of the characteristic SC (rye) turned out the value of the test statistics Z = 2.76492 and the probability p = 0.005694. The value of probability is $p < 0.01$, therefore the hypothesis H_0 can be rejected on the level of significance $\alpha = 0.01$. The measured values **are statistically significant** and it is clear that the rye is found in larger quantities at the peripheral parts of the agglomeration.

For bread wheat (the statistical character TA), a value of the test statistic Z = −4.79304 and probability is p = 0.000002. Similarly, as before, the H_0 hypothesis can be rejected on the level of significance $\alpha = 0.01$. The values of the TA test unit **are statistically significant**. This shows that bread wheat is found in larger quantities in the central parts.

For the grains categorised as wheat/barley (testing of the T/H characteristic), the value of the test statistics is Z = −2.28066 and the probability is p = 0.022569. As the value of probability, in this case, is $p < 0.01$, the H_0 may be rejected at the level of significance $\alpha = 0.01$. The assessed differences **are statistically significant**; the location or amount of T/H is fundamentally influenced by the place of the occurrence. The T/H grains are found more often in the central parts of the agglomeration.

For unspecified cereal grains, but not millet (CER), the value of the test statistics is Z = −4.70452 and the probability of p = 0.000003. The value of probability is $p < 0.01$, therefore the hypothesis H_0 can be rejected on the level of significance $\alpha = 0.01$. This implies that the values measured **are statistically significant**. The value of the tested characteristic CER is to a large extent influenced by the place of occurrence, i.e. the amount of CER found at the central part is different from the amount at the margins of the agglomeration.

19 The areas were divided to the central part, which contained the fortified acropolis, outer bailey and no fortified suburbium (O). The sites situated in the agglomeration periphery (M) belong in the second group.

TAB. 7 | Mikulčice-Kopčany. Matrix of data based on Wilcoxon two-sample test focusing on the testing of the dependence of the occurrence of cereals per area: in the fortified area of the Mikulčice stronghold (O) and the peripheries (M).

	Rank Σ (M)	Rank Σ (O)	U	Z	p-level	Valid N (M)	Valid N (O)	2*1 sided exact p
Asp.	2488.500	5512.500	1627.500	-0.59880	0.549304	41	85	0.550801
HVC	2668.000	5333.000	1678.000	0.33585	0.736983	41	85	0.739978
HVV	1501.500	6499.500	640.500	-5.73811	0.000000	41	85	0.000000
PM	1507.500	6493.500	646.500	-5.70687	0.000000	41	85	0.000000
SC	2072.500	5928.500	1211.500	-2.76492	0.005694	41	85	0.005372
TA	1683.000	6318.000	822.000	-4.79304	0.000002	41	85	0.000001
T/H	2165.500	5835.500	1304.500	-2.28066	0.022569	41	85	0.022139
Cer	1700.000	6301.000	839.000	-4.70452	0.000003	41	85	0.000001
Suma	1555.000	6446.000	694.000	-5.45954	0.000000	41	85	0.000000

6.1.2.3 Summary

The aim of the statistical testing of the cereal species that was based on the Wilcoxon non-parametrical two-sample test was to clarify the interdependence between the presence of certain cereal species in particular excavation areas within the Mikulčice stronghold. This non-parametric method confirmed that there was a relationship between the amount of some cereals and their provenance.

Each of the cereal crops present has specific ecological requirements (e.g. soil moisture, temperature, pH) as well as requirements for cultivation methods (soil preparation, sowing time, weeding). Considering these requirements, it was originally assumed that the higher-quality and more demanding cereal species tend to be found more in the central parts (O) than in the periphery (M) of the agglomeration. However, the results of statistical testing indicate that a relationship between the number of finds and the place of origin (centre or periphery) as such can only be drawn for hulled barley (HVV), millet (PM), rye (SC), bread wheat (TA), barley/wheat grains (T/H) and undetermined cereal grains (CER) and not for oat (AV) and naked barley (HVC).

The comparison of the densities of the cereal crops found [FIG. 23] and the results of the Wilcoxon test show that the finds of wheat (TA) and millet (PM) are more typical and their average densities are higher in the central part (O) than in the periphery (M) of the agglomeration. Hulled barley (HVV) is similar, even though the average density and the statistical values are lower than those for wheat and millet. The average densities of rye (SC) and barley (HVV) in both parts show approximately the same range.

6.1.3 Legumes

Unlike cereals, legumes are usually found in smaller amounts in archaeobotanical samples, which is probably due to the way they are prepared for consumption. As they are boiled in water, there is less chance of them coming into contact with fire and becoming charred. Legumes are a rich source of various proteins. They can be a substitute for meat, and in combination with cereals, can provide a nutritionally balanced diet. During their growth, legumes fix atmospheric nitrogen and enrich the soil with nutrients. Written records from the time of the Roman Empire attest to the practice of so-called green manuring, which consisted of sowing leguminous crops, then furrowing the field and leaving the crops to wither (MAREŠ 1961).

The remains of cultivated legumes are preserved in both charred and mineralised form [PLATE 3]. In total, 415 charred and 8 mineralised seeds or seed fragments were found. These remains were present in 181 samples (19.13 %). In total, five species were identified – common lentil, common pea, Celtic bean, bitter vetch and grass pea [FIG. 24].

LENTIL (*Lens culinaris*) – the common lentil is much more numerous than other legumes in Mikulčice and represents almost 75 % of identified legume finds: 279 lentil seeds or fragments were identified in 136 samples. Aside from charred finds, there were also 4 mineralised seeds. The common lentil is one of the most ancient and popular legumes in central Europe and was identified at sites dated to the earliest Neolithic period (HAJNALOVÁ 1989). Compared to other legumes, it has a lower yield

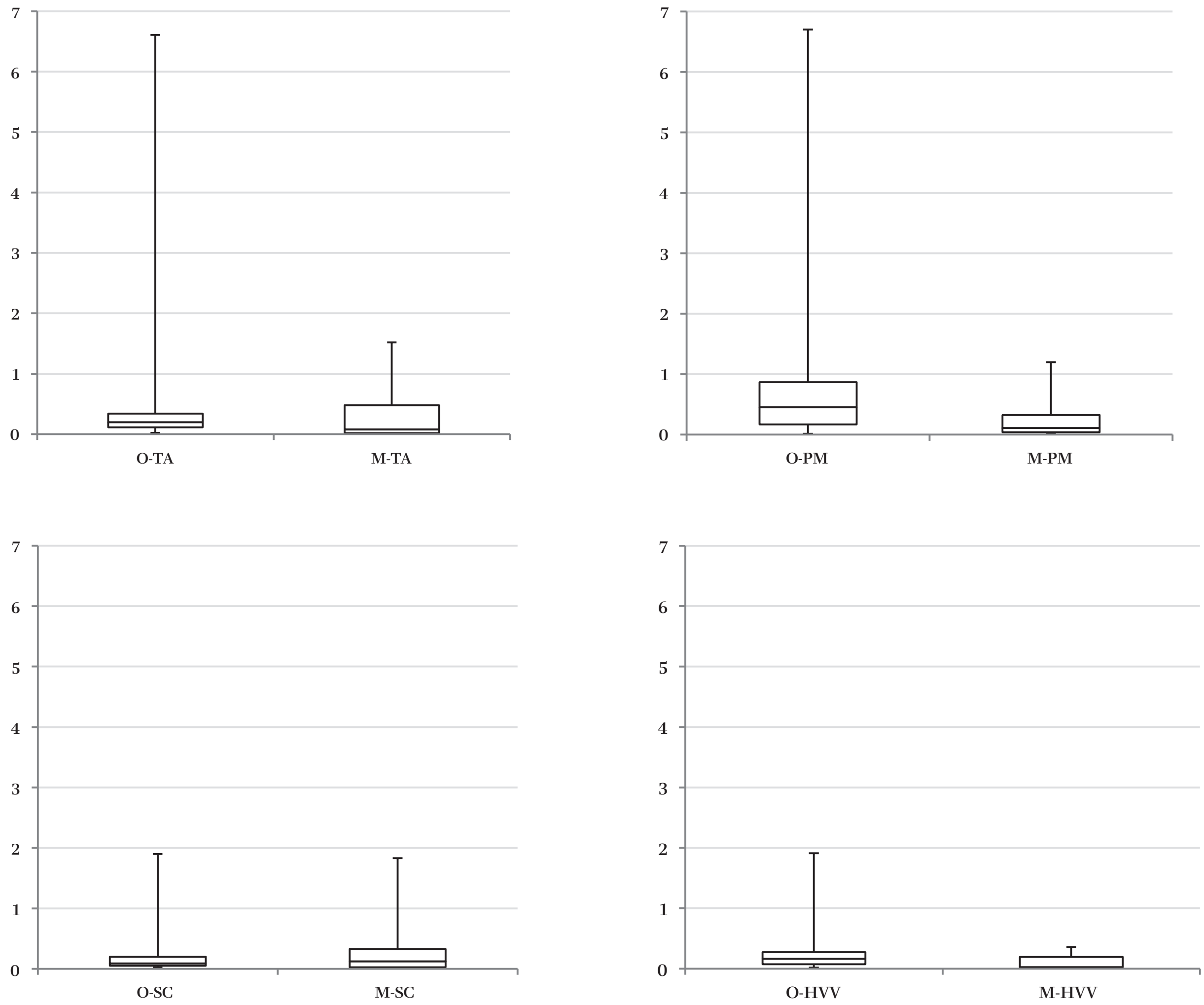


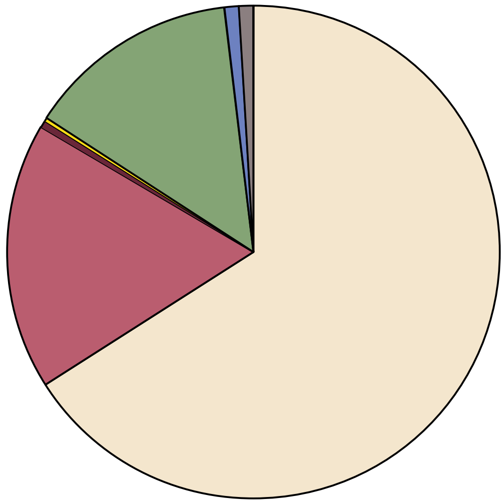
FIG. 23 | Mikulčice-Kopčany. Histograms of average values of selected types of cereals from selected areas. The species were selected based on Wilcoxon two-sample test to represent statistically significant crops, whose occurrence is linked with one of the researched areas. Captions: The Y axis shows the variance in densities of the cereals in both the areas. O – fortified area, M – unfortified peripheral parts of agglomerations, TA – bread wheat, PM – millet, SC – rye, HVV – hulled barley.

(500–1500 kg/ha, Hajnalová 2012, 82) although the protein content is as high as 25 % (Zohary/Hopf 2000, 98). The common lentil prospers in warmer climates. Depending on the specific climate, it can be grown as a spring crop (colder climates), or as a winter crop (warmer climates). The lentil is also able to handle lighter, warmer and sandier soils. If the soil is rich in nutrients, it produces more biomass than yield. Two cultivars of this species are currently identified – *microsperma and macrosperma* (Zohary/Hopf 2000, 98). These two cultivars are differentiated by the size of the seeds. However, legumes change size during carbonisation, shrinking by up to 20 % (Fuller 2007, 906). The seeds found in Mikulčice also included charred lentil seeds that were significantly smaller than the mineralised seeds.

PEA (*Pisum sativum*) – the common pea is the second most common legume found at Mikulčice. Its seeds (74 finds) were present in 49 samples, all of which were charred. Dried ripe seeds can be used in soup and porridge. The pea prospers best in warm Mediterranean-type climates; however, it easily adapts to the colder conditions of the temperate zone (Zohary/Hopf 2000). The pea gives the highest yield when grown on calcareous soil with moderate amounts of nutrients (Zohary/Hopf 2000, 102–105).

CELTIC BEAN (*Vicia faba*) – was found in Mikulčice only in one case and in charred form. The Celtic bean prospers on moist and clay soils, in which it provides the best yields. On lighter soils, however, its yield decreases and the beans are scarce. The bean's protein content is similar to lentil, approximately

FIG. 24 | Mikulčice-Kopčany. Proportion of cultivated legumes in researched excavation areas. Based on the number of seeds n = 423. Captions: C – charred, M – mineralised.



20–25 % (Zohary/Hopf 2000, 112). Despite this trait, the Celtic bean is considered to be a lower quality legume, due to its bitter taste. Three varieties can be identified according to size (Zohary/Hopf 2000, 112). All of the central European finds from the prehistoric and early medieval period can be categorised as the *minor* variety (Zohary/Hopf 2000, 112). It is assumed that this crop was also cultivated earlier as a fodder plant (Zohary/Hopf 2000, 112). Finds of Celtic bean dating from the early medieval period are known from Staré Město near Uherské Hradiště (Opravil 1980), and from older samples from Mikulčice analysed by E. Opravil (2000, 352). In Slovakia, this species is relatively rare in published archaeobotanical reports (Hajnalová 1989). It is more common in the Bronze Age samples from Zemianske Podhradie and from Hallstatt samples from Horný Vadičov – Ladonhora (Hajnalová 2012, 83–84).

BITTER VETCH (*Vicia ervilia*) – is relatively rare in the early medieval finds in the Czech Republic and Slovakia (Kočár/Dreslerová 2010, 211, Tempír 1966). In our assemblage, there was only a single seed present in the sample from the acropolis. Bitter vetch is a thermophilic legume probably originating in the Mediterranean region (Zohary/Hopf 2000). In raw form, this crop is extremely toxic, even to animals. When boiled, however, it is suitable for consumption, also by humans. In the regions where it is still grown today, it is sometimes considered to be a famine or a poor man's food (Zohary/Hopf 2000). In Greece, this crop was used for the preparation of ritually consumed meals (Valamoti et al. 2011). Bitter vetch is not commonly found in archaeobotanical assemblages of early medieval or prehistoric periods in the Czech Republic. The only known findings are the unpublished finds from Hulín (Kočár/Dreslerová 2010, 211).

GRASS PEA (*Lathyrus sativus*) – the grass pea was only found in Mikulčice in mineralised form (4 seeds). The grass pea is very rarely found in archaeobotanical finds in the Czech Republic. Until now, it was only identified at La Tène oppidum Závist, at the medieval Žabčice site (12th century) and from mass finds at the Dobšice site from the Bronze Age (Kočár/Dreslerová 2010, 211). It is a thermophilous legume, presumably cultivated in a garden setting.

A separate group of finds consists of unidentifiable fragments of cultivated legumes – *Leguminosae sativae*, which account for approximately 1/5 of the assemblage.

6.1.4 Fruit and Nuts

Fruits and nuts are an indispensable part of the human diet. Fruits are a rich source of sugars, vitamins and minerals. Fruits in a fresh form, however, can only be stored for a limited time and quickly lose their qualities. For this reason, prolonging the period of consumption suitability by drying or by use of various preservatives was of significant importance. This does not apply to nuts, which can be stored for long periods of time without losing their qualities. Fruit can be also used for the preparation of ciders, wines and spirits (Hajnalová 2001, 7).

Stones and seeds from grown fruits are finds that are highly characteristic for early medieval Mikulčice.[20] Due to systematic sampling and flotation, we were currently able to expand and widen the assemblage [PLATE 4–6].

20 Opravil 1962, 1972, 1978, 1983, 1998, 2000, 2003.

GRAPEVINE (*Vitis vinifera subsp. vinifera*) – grapevines produce fruit rich in sugars (15–25 %, Hajnalová 2012, 86). Aside from fresh fruit, it also provides dried raisins that can be stored for a long time, as well as the grape juice used in wine preparation. Grapevines prosper well in a Mediterranean type of climate, but can also withstand less favourable conditions (colder climate and increased humidity). The cultivated grapevine is related to the wild grape (*Vitis vinifera subsp. sylvestris*), from which it evolved through cultivation. Cultivation of the grapevine has led to many clones that are differentiated by morphological traits other than the shape of their seeds. For this reason, it is very difficult, if impossible, to identify numerous variants of grape vines in archaeobotanical material (Terral et al. 2010).

In older archaeobotanical analyses of the Mikulčice site, grapevine finds[21] were also identified, a significant portion of which (48 % – 741 seeds) were categorised as wild grape (*Vitis vinifera subsp. sylvestris*; Opravil 2000, 353). Wild grape is currently an extinct species in the Czech Republic. The native biotope of this species in central Europe consists of the periodically flooded floodplain forests in the warmer regions (Maděra/Martinková 2002). Therefore, its presence at the archaeobotanical assemblages from Mikulčice cannot be ruled out. A more detailed study of the Mikulčice grapevine suggests that the seed finds at Mikulčice could originate from some archaic (possibly extinct) or local cultivar of the **cultivated** grapevine, which may share certain specific traits with the wild grape (Látková/Hajnalová in prep.).

The grapevine seed finds are the most common and also the most numerous fruit found at the Mikulčice-Kopčany agglomeration site. The seeds were identified as charred (17 pieces) and mineralised (31 pieces), but most frequently in waterlogged form (119 seeds [plate 5–6]).

PEACH (*Persica vulgaris*) – is a relatively demanding tree. Most importantly, it needs warm climates and prospers best in regions with a mean annual temperature of 7–10 °C. It needs open stands and does not prosper well in shade. In insufficient illumination, the peach tree produces only a small amount of fruit buds and the fruit is discoloured and tastes bland. Peaches also have high soil quality demands and prosper best in soils with mixtures of clay and sand with a neutral or acidic pH with a lime content below 5 %. The peach tree does not prosper in cold, heavy and wet soils. The soil also needs to contain enough humus and required nutrients. The peach also has high demands concerning moisture when in bloom, in fruit growth and especially 3 to 4 weeks before the fruit is ripe. With insufficient nutrition and moisture, the tree does not have the required growth and its fruit is tiny and scarce (Lokoč et al. 2013, 12).

Peach finds were recorded in Mikulčice as early as the 1960s (Opravil 1972). We have confirmed the presence of and the early medieval date for this species. Two waterlogged stones originated in the layers filling a former riverbed (Látková/Hajnalová 2014) although charred stones and fragments were also recovered from the Great Moravian layer/context 29 at Area 96 (fortification behind Church II) and from Area 103 (the outer bailey).

Aside from Mikulčice, the early medieval peach finds were identified in Prague at Malá Strana, Hartigovský Palace (Čulíková 1998), Lichtenštejnský Palace (Čulíková 2001a) and the Hradčany sites (Čulíková 2001b). In Slovakia, the finds of peach stones, which would be a subject of consumption, currently only come from earlier periods (Hajnalová 2001, 68).[22] In Poland, peach stone finds from early medieval period are known from Cracow (Klichowska 1964).

PLUM (*Prunus domestica*) – require a protected place in a warm biotope with sufficient aerial humidity. They prosper best in an altitude of up to 350 m above sea level, with a mean yearly temperature of 7.5–8 °C and precipitation of 500–700 mm per vegetation season. Plums prosper best in sandy soils, soils with a mixture of clay and sand, or in permeable loams with abundant nutrients. These soils should be sufficiently moist with a higher level of ground water (50–60 cm, Lokoč et al. 2013, 11, 37).

During the archaeobotanical research, two stones were recovered that can be assigned to the domesticated plum varieties. The first charred fragment comes from Area 103 of the outer bailey and the second waterlogged fragment from the samples of the riverbed (Area 93). The latter find was identified down to a subspecies level as *Prunus domestica subsp. insititia*. There is another find of non-charred plum stone from Mikulčice identified by E. Opravil (2000) as *Prunus domestica subsp. domestica*.

21 Opravil 1962, 1972, 1978, 1983, 1998, 2000, 2003.

22 In Slovakia, peach stone finds are identified as from the end of the La Tène period at Palárikovo, Liptovská Sielnica and Liptovská Mara – these finds, however, are interpreted as decoration (Hajnalová 2001, 68).

Similarly dated *Prunus domestica subsp. insititia* finds are also known from Prague at Malá Strana, Hartigovský Palace (Čulíková 1998) and the Hradčany and Slévárenský dvůr (Foundry Court) sites (Čulíková 2001b). This variety of plum was only documented in Slovakia in the 14th century (Hajnalová 2001, 62). Contemporary finds of *Prunus domestica subsp. domestica* are unknown at other sites in the Czech and Slovak Republic. Therefore, it cannot be ruled out that they originate from later phases of occupation of the Mikulčice site and represent earlier intrusions (cf. Mazuch 2012).[23]

APPLE (*Malus domestica*) – apple trees require open areas with a warmer climate and sufficient humidity. The trees can be cultivated in altitudes up to 600 m above sea level (rarely even up to 700 m above sea level) although the most suitable conditions for cultivation of apple in central Europe are in areas around 200 m above sea level with a mean yearly temperature of around 8 °C. Apple fruit from the warmer climates has a richer coloration and is well formed, but with a shorter consumption period. Despite relatively shallow roots, apple trees need deeper soil with more nutrients and an adequate calcium content (Lokoč et al. 2013, 9, 17).

Domesticated apple seeds are documented at Kopčany-Kačenáreň (grave 4) and at Area 103 of the outer bailey at Mikulčice. They are documented in the PMR assemblage in both charred and waterlogged form. Apple seeds were determined to species using the criteria based on measurements of the seed (Villaret / von Rochow 1969; Schweingruber 1979). Apple seeds have been known in the Czech Republic since the La Tène period – Lovosice (Čulíková 2008) but were more numerous in the early medieval period. From the RS3 phase, only non-charred seeds were documented: all were exclusively from sites in Prague – Hartigovský Palace (Čulíková 1998), Slévárenský dvůr (Foundry Court) (Čulíková 2001b), and Mostecká Street (Čulíková 2005). In Slovakia, charred and non-charred apple finds were only identified sporadically in this period and only appeared in larger numbers in later periods (Hajnalová 2001, 59).

PEAR (*Pyrus communis*) – pear trees are more sensitive to temperature than apple and prosper best in well-protected but unshaded stands. If there is insufficient sunlight, the fruit does not ripen fully and has a beet-like taste. Roots are over 150 cm long and need deep and nutritious soil well supplied with humus and nutrients. They prosper best in soils with high clay content. In cold or wet soils, the leaves turn yellow and the annual shoots dry out. On dry soil, the fruit is very hard and small (Lokoč et al. 2013, 10, 32).

The only charred cultivated pear seed was found in a sample from the fortification behind Church II. The determination of the domestic species of pear is based on seed shape and measurements (Anderberg 1994, 33). Pear finds are documented in the Czech Republic only in the RS3 phase (Čulíková 2005, 1998) and originate exclusively from sites in Prague, Hartigovský Palace (Čulíková 1998) and Mostecká Street (Čulíková 2005). Similar to apple, this fruit gains only gains importance in later historical periods. In Slovakia, domesticated pear finds are only known from the 13th century onwards (Hajnalová 2001, 60).[24] Finds of early medieval domesticated pears are also documented in Poland at Cracow (Mueller-Bieniek et al. 2015, 102) and Wolin (Latałowa 1999, 202).

WALNUT (*Juglans regia*) – usually grow in open canopy forests (woodlands) and orchards. The stands face sufficient sunlight and moisture, but not permanent humidity (Lokoč et al. 2013, 45). Today, these trees are commonly found in lowlands and riparian forests where they often penetrate the natural growth situated on drier stands.

In Area 93 of the riverbed, one waterlogged fragment of a walnut shell was present. However, this very rare species is also known from earlier excavations of early medieval Mikulčice (Opravil 1983). Our finds alongside the finds from Prague – Mostecká Street (Čulíková 2005) are, to date, the earliest finds of this species in the Czech Republic. Early medieval walnuts are known from Cracow (Mueller-Bieniek et al. 2015, 102), and Cracow-Wawel (Wasylikowa 1978, 182–183). In Slovakia, they are mostly from the later period of 13th and 14th century sites of Partizánske, Bratislava and Nitra (Hajnalová 2001, 71). From an earlier date are the 8th century walnut finds (Hajnalová 2001, 71). In pollen records from nearby Hodonín oak

23 Four waterlogged plum finds, likely to be cultivated plums, were identified in the early medieval layers in Cracow (*Prunus domestica*) – however, it is unknown whether these are an unspecified subspecies (Mueller-Bieniek et al. 2015, 102).

24 However, the oldest find of a cultivated pear is known from the Iža-Leányvár a Roman fort and comes from a fill of the Roman period well where other "exotic or luxurious" plants were also present. Due to its context, it is assumed that this unique find represents an imported fruit (Hajnalová 2001, 60; Hajnalová/Rajtár 2009).

wood at Doubrava, the presence of walnut trees has been documented, possibly as early as the La Tène period (Jamrichová et al. 2014, 48) and in Mikulčice, walnut pollen was found in the samples from Area 93 (Dohnalová 2014, Taf. 8.2).

6.1.5 Vegetables

Vegetable seeds are sporadic and in all cases, waterlogged (plate 7). Garden parsley (*Petroselinum crispum*), carrot (*Daucus carota*) and cucumber (*Cucumis sativus*) were identified. The first two species, although cultivated vegetables, also occur in the wild.

6.1.6 Oil and fibre crops

Usually, the seeds of oil and fibre crops are less common than the other cultivated crops in archaeobotanical samples. As the seeds contain a relatively high amount of oil (Opravil 1991) then they often burn completely when in contact with fire. The seeds of oil and fibre plants are more common in waterlogged sediments. This is also the case of our assemblage. The most numerous finds are hemp seeds although flax and opium poppy are also present (plate 7).

HEMP (*Cannabis sativa*) – is one of the traditionally cultivated plants and is most suitable for cultivation in warmer zones in deep, clay-rich, neutral to mildly acidic soils (Kovář 2012). The fibres can be made into yarn, canvas, rope etc. The seeds are mostly exploited for hemp oil and used in various technologies or for light and when mashed can be prepared as a dish suitable for human consumption. Finally, the hallucinogenic and medicinal properties were known long ago, as documented by various traditional sources.

In our assemblage, there is a total of 353 hemp seeds (10 charred, 12 mineralised and 331 waterlogged). Hemp finds were the most numerous in the layers of the former riverbed (Area 93) and it has been hypothesized elsewhere that the place was used for hemp retting (Látková/Hajnalová 2014, 103). Numerous finds of fragments and whole millstones found at various locales within the riverbeds at Mikulčice, especially near the shores and the bridges, are seen as supporting evidence for using the water channels as a retting place (Marek/Skopal 2003). It is thought that these millstones were (among other functions) used to weigh down the hemp plants during the retting to prevent them from being carried away by the current. In the Czech Republic, hemp finds only start to appear in quantities in the early medieval period (Čulíková 2005, 2001b, 1998), even though it has been documented as early as the Neolithic period (Mohelnice, Kühn 1981). E. Hajnalová (1999, 69) assumes its cultivation in the region of the Slovak Republic since the La Tène period onward.

FLAX (*Linum usitatissimum*) – can be used for textiles or as a source of oil. Flax does not place high demands on soil or climate. In the studied assemblage, only two flax seeds were present and both were preserved in mineralised form. These were acquired in the Area 96 site (fortification behind Church II). Apart from cultivated forms, there are also two finds of wild flax seeds. Unfortunately, due to bad preservation, it was not possible to determine the species. Wild flax species grow in various sunny stands; however, they also occur as weeds in the fields. Archaeobotanical data shows that in the Czech Republic and Slovakia, flax has been cultivated since the late Neolithic period (Hajnalová 1989, 136; Opravil 1977; 1979). Other early medieval (RS3 phase) finds are only documented in Prague, in Hartigovský Palace (Čulíková 1998) and Mostecká Street (Čulíková 2005).

OPIUM POPPY (*Papaver somniferum*) – has been cultivated in (the western part of) Europe since the Neolithic period (Zohary/Hopf 2000, 109). Aside from its dietary uses, it could also have been used as a drug in medicinal or ritual practices (Sherrat 1991). Currently, it is cultivated globally, with the exception of very cold regions.

One charred seed of this species comes from Area 91 (fortification behind Church II). We believe that the opium poppy has been used as a crop at the site but it is rare in the samples due to taphonomic reasons (e.g. increased flammability due to high oil content in the seeds). Opium poppy has been known in the Czech Republic since the Eneolithic (Kočár/Dreslerová 2010, 212) period and in Slovakia since the La Tène period (Hajnalová 1989, 117). Similar to the finds of flax, opium poppy is rare in the early medieval (RS3) period. It is known from the Prague settlement excavation areas of Hartigovský Palace (Čulíková 1998), Mostecká Street (Čulíková 2005) and Žatec (Čech et al. 2013, 68).

6.1.7 Summary – cultivated plants

The assemblage composition of cultivated crops indicates the exploitation of a fairly wide range of taxa. Their remains were preserved by all three forms – charring, waterlogging and mineralisation. Most numerous are finds of staple crops such as cereals and legumes. When comparing the number, occurrence, weight and calorific value, there are three main cultivated cereals – bread wheat, common millet and hulled barley. Each of these crops has different requirements for the conditions of growth plus preparation and use is different. Legumes are documented only in charred and mineralised form. The most numerous is the common lentil. The charred lentil seeds are significantly smaller than mineralised seeds. Although the taxa of cereals and legumes in our assemblage are the same as found earlier by E. Opravil,[25] their proportions are significantly different. E. Opravil has named the common wheat as "the most popular" cereal followed by hulled barley, common oat and rye (Opravil 1972, 19; 2000; 2003). In legumes, E. Opravil finds the field pea to be more numerous than the common lentil (Opravil 1972, 19; 2000; 2003).

The seeds of cultivated fruits and vegetables are predominantly waterlogged and mostly originate from the sediments of the riverbed (Area 93). Delicacies of this type almost certainly supplemented the diet and did not serve as staples. Peach, grapevine, walnut, apple, plum and cucumber finds are documented. Derived from the current climate and soil conditions of South Moravia, E. Opravil (1972, 17) it is assumed that this region was suitable for the cultivation of relatively more demanding species, even during the early middle ages. Based on the measurements of the peach stones from Mikulčice, E. Opravil identified the peach as a small-fruit variety. He assumed that these variants reached the Pannonia and Noricum regions and then across Moravia, all the way to the Odra River region, along the routes already used by the Romans (and possibly the Celts). Emanuel Opravil assumed a similar trajectory of arrival for the plums and blackthorns (*Prunus spinosa*), which according to him, were being introduced into cultivation (Opravil 1972, 17). As for the grapevine finds, E. Opravil (1972, 18; 2003, 34–35) attempted to identify the wild and domesticated varieties using available metric indexes. He was the first to postulate a hypothesis that the Mikulčice finds could represent a local (now unknown) or archaic grapevine variety. For the finds of cucumber seeds, E. Opravil assumed that the "distributors" of this species in central Europe were Slavs. According to him, it is probable that the Slavs had become familiar with this plant in the Pontic region, in the Balkans or in Pannonia – however, he did not exclude the possibility of distribution of the cucumber to the central Danubian provinces via Greek or Roman colonies on the shores of the Black Sea (Opravil 1972, 19).

The main reason for the cultivation of oil or fibre plants near any kind of site, including the stronghold, is their broad use. The most numerous of these species is hemp; flax and opium poppy are rare. Their seeds are preserved in all three forms of preservation although the most numerous are waterlogged hemp seeds. In earlier archaeobotanical research, the same taxa were documented in approximately the same proportion (Opravil 1972, 19; 2000, 329).

6.2 WILD PLANTS

Due to three different processes, which contributed to the preservation of the plant remains at Mikulčice and Kopčany sites, the wide range of wild plant taxa originating from various biotopes has been recorded in the assemblage. They are evaluated below according to their economic or ecological traits.

6.2.1 Field weeds[26]

We have attributed to this category a large group of taxa considered today or in the recent past, to be field or garden weeds [tab. 8].[27] The presence or absence of certain taxa of weeds in archaeological contexts is closely related to past farming practices, the handling of the (by)-products and wastes from crop processing and the depositional taphonomic processes. According to the time of germination, there are field weeds that accompany the crops sown in autumn (*Secalietea*) and the crops sown in spring (*Chenopodietea*).

There are significant differences in ecology, growth habit and other characteristics among the cereal winter crop varieties and also among the weeds that accompany them. All of the weed

25 Opravil 1962, 1972, 1978, 1983, 1998, 2000, 2003.

26 A more detailed ecological analysis of the field weeds is included in the ecology of wild plants.

27 In the early medieval period, the number of taxa of wild plants grown in arable or garden plots could have been higher, and for example, similar to the flora of the fields and gardens still traditionally farmed today (cf. Hajnalová/Dreslerová 2010). Unfortunately, it is not always possible to determine which species of wild plants present (or their finds) in the archaeological assemblage were originally grown in fields or gardens and those which originate from other stands at the sites or their vicinity.

TAB. 8 | Mikulčice-Kopčany. Number and frequency of the finds of field-weed seeds.

Taxon	Charred		Miner-alized		Water-logged	
	Σ	f	Σ	f	Σ	f
Aethusa cynapium	.	.	.	.	4	4
Agrostemma ghitago	98	38	11	6	8	5
Arnoseris minima	3	1	.	.	.	.
Arenaria serpyllifolia	4	2	.	.	4	2
Artemisia vulgaris	3	3	.	.	.	.
Atriplex sp.	6	4	.	.	3	2
Asperula arvensis	7	4	.	.	.	.
Bromus arvensis	6	6	.	.	.	.
Bromus secalinus	25	21	.	.	.	.
Brassica rapa	2	2	.	.	1	1
Bupleurum rotundifolium	78	49	36	27	17	8
Capsella bursa-pastoris	.	.	1	1	.	.
Cardaria draba	2	2	1	1	.	.
Carduus crispus	.	.	1	1	1	1
Caucalis platycarpos	.	.	.	.	2	2
Centaurea cyanus	.	.	.	.	3	3
Echinochloa crus-galli	80	38	.	.	.	.
Fallopia convolvulus	244	109	110	42	139	23
Fallopia dumetorum	2	2	2	2	1	1
Fumaria officinalis	.	.	.	.	3	3
Galeopsis angustifolia	3	3	3	2	.	.
Galeopsis ladanum	1	1	.	.	6	2
Galeopsis tetrahit	.	.	.	.	1	1
Galium aparine	150	61	10	6	.	.
Galium mollugo	6	6	.	.	.	.
Galium palustre	27	16	.	.	.	.
Galium spurium	452	157	.	.	.	.
Geranium pratense	1	1	.	.	.	.
Glaucium flavum	.	.	1	1	10	7
Glechoma hederacea	1	1	.	.	.	.
Gypsophila muralis	10	7	.	.	.	.
Chenopodium album agg.	577	201	37	10	646	42
Chenopodium hybridum	175	98	.	.	174	21
Lepidium campestre	2	2	.	.	.	.
Lepidium ruderale	4	3	6	3	.	.
Linaria vulgaris	.	.	.	.	27	1
Lithospermum arvense	.	.	4	4	.	.
Lycopus europaeus	.	.	1	1	6	3
Marrubium vulgare	.	.	.	.	9	5
Medicago falcata	6	5	.	.	.	.
Medicago lupulina	22	11	.	.	.	.
Medicago sativa	1	1	.	.	.	.
Mentha arvensis	1	1	.	.	2	2
Neslia paniculata	6	5	.	.	35	9
Papaver argemone	1	1	.	.	.	.
Papaver rhoeas	6	6	.	.	.	.
Plantago lanceolata	1	1	.	.	.	.
Polycnemum arvense	7	7	.	.	.	.
Polygonum aviculare	42	35	3	3	78	15
Polygonum hydropiper	10	7	.	.	.	.
Polygonum lapathifolium	10	7	5	4	15	5
Polygonum rurivagum	1	1	.	.	3	2
Portulaca oleracea	2	2	.	.	.	.
Ranunculus acris	1	1	.	.	.	.
Ranunculus repens	1	1	.	.	97	9
Rumex acetosella	54	37	3	3	10	7
Setaria viridis/verticillata	57	37	98	46	360	17
Silene noctiflora	1	1	.	.	.	.
Sinapis arvensis	1	1	.	.	.	.
Solanum nigrum	23	15	2	1	19	7
Sonchus arvensis	.	.	.	.	3	1
Stachys arvensis	8	8	2	2	18	6
Stellaria media	17	14	.	.	9	5
Thlaspi arvense	5	5	5	6	12	3
Verbena officinalis	.	.	.	.	12	4
Veronica hederifolia	54	42	.	.	.	.
Vicia tetrasperma	93	48	1	1	.	.
Viola arvensis	4	4	1	1	7	4
Xanthium strumarium	4	3	.	.	30	5

taxa, however, share some traits (e.g. germination in autumn) that predetermine their common occurrence. Some of the weeds, which are traditionally associated with winter crops, were also present in Mikulčice and Kopčany, for example, *Agrostemma githago, Bromus secalinus, Caucalis platycarpos, Galium aparine and Vicia tetrasperma* [PLATE 8–9].

The weeds of spring crops are predominantly summer annuals, have a shorter life cycle and are better adapted to soil disturbance (cf. DEYL/UŠÁK 1964, 81). Typical crops that can only be sown in spring are common millet and oats although varieties of spring rye, bread wheat and barley exist. In our assemblage, among the most common taxa from this category, were finds that belonged to *Echinochloa crus-galli*, *Chenopodium album agg.* and *Setaria viridis/verticillata*.

Today, there is another very common group of weeds occurring in the garden plots and fields with root and tuber crops. Even though such crops are not attested for the early medieval period in east-central Europe to date, the weeds that are associated with them, such as *Solanum nigrum* and *Hyoscyamus niger*, were present in our assemblage. These weeds are highly adapted to frequent soil disturbance (tillage by hoeing, for example), which eliminates winter weeds propagated by seeds but favours species with vegetative propagation or those which germinate during the entire vegetative season. It is, therefore, possible that the presence of these species indicates the use of intensive farming practices in the cultivation of cereals and pulses. However, both species also naturally occur in various ruderal habitats on nitrogen enriched soils, such as footpaths or waste sites at the human settlements and thus could originate from such stands.

Specific group weeds consist of so-called ecologically "indifferent" taxa. These are characterised by adaptation to a wide range of ecological conditions so occur in a wide range of highly contrasting habitats. A substantial disadvantage of these weeds is the fact that they are resistant to common weed eradication methods. In the presence of these weeds, specific agricultural processes need to be used (ploughing, harrowing, weeding) in order to stop their reproduction. Indifferent weed species are also documented in the PMR assemblage, for example, *Cardaria draba, Sonchus arvensis* and *Viola arvensis*.

Field weeds, as well as cultivated crops, need water, nutrients, light and space in order to grow and prosper. In the presence of weeds, the cultivated crops have to share these resources with the weeds. Due to their position, the weeds, in contrast to the cultivated crops, are able to swiftly, and in large amounts, utilise the presence of favourable conditions (abundance of moisture or nutrients). Through their inherent resilience and stamina, which is often higher than in cultivated crops, they can present a significant threat to these crops. The disadvantages and damages caused by weeds can be summarised in several points:

› the weeds complicate working in the field
› they devalue agricultural crops
› some viral and fungal infections can also be transferred by weeds
› the weeds can also poison farm animals and people

Aside from these disadvantages, there are certain views in which the field weeds could be considered to be useful. Some weeds can be used as animal fodder due to their relatively high nutrient value. The weeds can also be used as green manure if ploughed in into the soil. The leaves and stalks of weed plants can be added into daub to increase the cohesion of this type of building material. However, at Mikulčice and Kopčany, the animal dung that would support the feeding of domestic animals on the stubble or with crop processing waste was not preserved while all studied (and generally vary rare finds of) daub fragments did not contain any seeds or vegetative parts of weed plants.

6.2.2 Gathered plants

Cultivated or gathered wild fruits and nuts [TAB. 9] are found in contexts from all over the site and are numerous in the assemblage, so it is plausible to suggest that they had to some extent enriched the diet of the Mikulčice stronghold population and in the case of wild species do not only represent stray finds from the surrounding vegetation.

We have documented, for example, cherry (*Cerasus avium*), various raspberries (*Rubus sp.*), black raspberry (*Rubus idaeus*), blackthorns (*Prunus sp.*) and chokeberries (*Prunus padus*). Cornelian cherry (*Cornus mas*) has frequently

TAB. 9 | Mikulčice-Kopčany. Number and frequency of the finds of seeds of gathered species.

Taxon	Charred		Mineralized		Waterlogged	
	Σ	f	Σ	f	Σ	f
Carpinus betulus	75	28	.	.	2230	32
Cerasus avium	8	3	.	.	6	4
Cornus mas	5	3	.	.	13	6
Cornus sanguinea	1	1	12	9	.	.
Corylus avellana	1	1	.	.	5	2
Crataegus sp.	1	1	.	.	105	17
Fragaria vesca	16	9	.	.	17	6
Fragaria moschata	7	6	.	.	3	2
Humulus lupulus	12	8	4	3	18	5
Malus sylvestris	.	.	1	1	.	.
Prunus spinosa	3	3	.	.	19	5
Rubus caesius	.	.	.	.	14	8
Rubus fruticosus	.	.	.	.	7	7
Rubus idaeus	4	4	1	1	1	1
Sambucus ebulus	90	23	447	91	189	32
Sambucus nigra	17	5	23	17	8	7
Sorbus aucuparia	5	1	.	.	.	.
Quercus sp.	8	6	.	.	177	24

occurred in various archaeological contexts as well as in the riverbed. This fruit, rich in vitamin C, therefore seems to be a valued addition to the people's diet or used for medicinal purposes. From an ecological standpoint, the Cornelian cherry is one of the significant diagnostic species of the xerothermic communities and nowadays is counted among the less common and endangered species in the area. Regular and numerous finds of the stones of this species in early medieval contexts of Mikulčice allow us to presume that it was more common in the past. This plant could have occurred naturally in the light forests of South Moravia and could also be grown in gardens.

For medicinal or magical purposes (Mrázek 2009), abundant gathered fruits such as hawthorn (*Crataegus sp.*), black elder (*Sambucus nigra*), danewort (*S. ebulus*) and rowan tree (*Sorbus sp.*) could also be used from the assemblage.

As walnut (*Juglans regia*) is not native to our region, its finds found waterlogged in the riverbed and charred in the settlement archaeological contexts point either to its import or local cultivation. Based on the local pollen analyses, we can assume its local presence in the near environs of the Mikulčice fortified settlement (Dohnalová 2014, Taf. 8.2; Jamrichová et al. 2014, 48).

The fragments of acorns (*Quercus sp.*) found in archaeological contexts, depending on the context, are considered to be evidence of their harvesting for animal fodder or human consumption. The finds from Mikulčice come from waste contexts, so we cannot interpret their origin. In our case, it cannot be ruled out that they entered the archaeological layers by chance from local vegetation. To date, the origin or original function of numerous finds of hornbeam seeds are unidentified. These finds, mostly charred, were found in the settlement contexts and in the cultural layers alongside the finds of charred cereals. Our finds are often fragmented, so we presume that they might have been crushed on purpose. It is known from ethnography, that they are traditionally used in the production of special oil (Bui et al. 2014).

All the mentioned species attest that the people of the Mikulčice stronghold were employed gathering fruit (and/or cultivation?) and exploited the natural resources around their "town" [plate 10–11]. However, the recovered taxa are only a fraction of the resources available in the surrounding countryside. The range of wild species gathered could have been even larger. However, some species, for example, those gathered for their tubes, roots, flowers and leaves, do not usually leave archaeologically visible traces. To research the foraging or "gathering economy" a wider range of analytical methods (e.g. palynology, phytoliths, FTIR…) would have to be applied.

6.2.3 Woody plants and shrubs[28]

It was very surprising, for an early medieval almost "town-like" environment, to recover finds of the seeds, buds and strobili of a wide variety of woody plants – trees and shrubs [tab. 10].[29] These were documented in the PMR assemblage in charred, mineralised and waterlogged form. If they are found in charred form, they can be attributed to the remains of fuel wood. We also cannot exclude the possibility of the use of twigs and shoots as forage for animals. Animal manure could have subsequently been mixed with the common settlement waste and burnt.

The identified taxa of shrubs and trees indicate the existence or exploitation of riparian forests. Oak (*Quercus sp.*) and alder (*Alnus sp.*) could grow very close to the waterways and on stands with submerged roots, while trees and shrubs like *Cerasus avium*, *Tilia cordata*, *Acer campestre, Cornus sanguinea, Carpinus betulus* and *Coryllus avellana* species in drier areas were most probably situated outside of the periodically flooded stands. The evidence of the presence of xerothermic (dry, warm and sunlit) stands in the landscape is provided by the *Cornus mas* species.

Aside from the representatives of forest communities, we have also documented taxa such as *Sambucus nigra*, *Rubus fruticosus* and *Betula pendula* from shrub communities that (from the order *Prunetalia*), occupy fallow or abandoned land and various ruderal stands.

There are also finds identified to the *Cupressaceae* and *Taxaceae* families, – which represent the charred seeds of the common juniper (*Juniperus communis*) and yew (*Taxus baccata*). For both taxa, we can assume a local occurrence. Yew is supported by (Opravil 1983) the wooden finds of buckets, found both in graves and in the riverbed, which were identified as being made from yew wood (Poláček pers. comm.). For the common juniper, the evidence is supported by the new palynological analyses (Kuneš et al. 2015; Dohnalová 2014).

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28 This group includes some species already mentioned above.

29 In general, charred seeds of forest trees and shrubs only occur sporadically in early medieval sites. In Mikulčice, their occurrence is greater in waterlogged material.

Highly unique and significant is the find of charred woody gall,[30] which based on its morphological traits (Landělová 2008) was identified as a gall of beech. The morphology of the gall indicates that it was made by a beech gall midge (*Mikiola fagi*), which lays its larvae exclusively on beech (*Fagus sylvatica*) leaves. The gall comes from Area 88 – Basilica from context 133 representing the fill of a structure (Poláček/Škojec 2012). We believe that the recovery of the charred beech gall in this situation might serve as indirect evidence of the growth of beech trees in the area of the Mikulčice stronghold. Today, the common beech usually occurs in places with an altitude of around 500 or more meters above sea level although it can also penetrate oak forests in lower areas. Based on the sporadic, but available finds of beech charcoal and mineralised or beech wood used for sword sheaths (Opravil 2000), we assume that in the wider Mikulčice area, beech was present as a member of mixed oak-hornbeam forests. This also supported by pollen records from the nearby Hodonín oak woods at Vracov Lake (Kuneš et al. 2015) and also from samples taken directly from the riverbed at Mikulčice (Dohnalová 2014).

6.2.4 Species from other biotopes

The assortment of obtained wild species in the PMR is relatively wide ranging due to the varied preservation conditions while it also mirrors the wide spectrum of exploited natural resources. An important countryside component is the permanent grass stands. Meadows and pastures are perennial or annual cultures with periodic agricultural care. The main product of meadows is hay, which is used as forage for farm animals, especially in winter, when other kinds of forage are scarce.

The finds of meadow species seeds can be divided into two groups [tab. 11]. The first group that can be assumed is based on the localization of the analysed Great Moravian stronghold, consists of mesophilic meadows. Mesophilic meadows are naturally supplied by groundwater or precipitation. Species in these meadows can, with adequate nutrients, moisture and care, provide suitable conditions for high-quality meadow growths and pastures. Also typical for these meadows is a groundwater level depth of 50 to 80 cm (Hron 1979, 11). Mesophilic meadows, however, need to be cut at least once per year, in order to keep their characteristic traits and species variability. The species characteristic for this biotope are documented in the PMR assemblage by the following species, for example: *Galium palustre, Geranium pratense* and *Poa palustris* [plate 12].

The finds of seeds indicating the presence of markedly xerothermic meadows were surprising in this context. Xerothermic species usually

tab. 10 | Mikulčice-Kopčany. Number and frequency of finds of seeds of woody plants and shrubs that were not included in the gathered species.

Taxon	Charred		Waterlogged	
	Σ	f	Σ	f
Acer campestre	.	.	2	2
Alnus sp.	2	2	151	18
Betula pendula	.	.	66	24
Juniperus communis	1	1	.	.
Taxus baccata	1	1	.	.
Tilia cordata	1	1	.	.

tab. 11 | Mikulčice-Kopčany. Number and frequency of finds of meadow-species seeds.

Taxon	Charred		Mineralized		Waterlogged	
	Σ	f	Σ	f	Σ	f
Agrimonia eupatoria	.	.	.	.	6	6
Alchemilla vulgaris/arvensis	3	3	.	.	.	.
Althaea officinalis	1	1	.	.	.	.
Althaea pallida	1	1	.	.	.	.
Anchusa officinalis	.	.	1	1	.	.
Artemisia campestris	1	1	.	.	.	.
Inula oculus-christi	3	2	.	.	.	.
Inula salicana	1	1	.	.	.	.
Phleum pratense	1	1	.	.	.	.
Phyteuma orbiculare	1	1	.	.	.	.
Poa palustris	50	27	.	.	.	.
Potentilla argentea	14	11	.	.	.	.
Potentilla erecta	4	2	.	.	.	.
Potentilla recta	7	5	.	.	.	.
Potentilla reptans	7	4	.	.	.	.
Ranunculus bulbosus	1	1	.	.	.	.
Salsola kali	2	2	.	.	.	.
Sideritis montana	1	1	.	.	.	.
Trifolium hybridum	1	1	.	.	.	.
Trifolium repens	8	2	.	.	.	.

30 In Mikulčice, there are eight documented waterlogged galls that have been identified as oak galls (Opravil 2000). These galls originate predominantly in moist and waterlogged sediments.

occur in meadows in warmer areas (possibly southern slopes), or on sand fills. Usually, there is a concentration of more xerophilous species, such as hard and dry grasses, both unsuitable for cultural-economic purposes and as pastures. Such finds among the meadow species include seed finds, for example, *Medicago falcata* and *Sideritis montana*.

The pastures share a number of phytocenological and phytoecological traits with meadows. In contrast with meadows, however, the pastures produce more biomass suitable for grazing. The species composition is significantly influenced by grazing. Pastures predominantly include species with a high forage value that are also resistant to stomping and chewing. Some of the PMR finds in Mikulčice and Kopčany can be categorised among these species, for example, *Trifolium hybridum* and *Trifolium repens*.

At the stronghold site, we have also documented a relatively high occurrence of plant species that need biotopes with a high level of ground water. The hygrophilous plants can be further divided into species growing on river banks, in a low level of water, in bank mud or on exposed riverbeds [TAB. 12]. These species can also naturally occur in moats or on flooded meadows. In general, it can be observed that they withstand permanently waterlogged soil well. These boggy biotopes are usually colonised by hygrophytes. The following species from Mikulčice (especially from Area 93) can be included in the hygrophytes: *Berula erecta, Iris pseudacorus, Lycopus europaeus*. The presence of these species in archaeobotanical samples is also evidenced in countryside biotopes that were permanently waterlogged – alternatively, in certain parts of the year (spring), these biotopes could have been impacted by groundwater level fluctuation, which could have resulted in significant waterlogging of the sediments [PLATE 13].

Based on the geographical position of the site in the countryside and the strong flow of the Morava River, which encircled the central settlement and created a number of cut-offs in the countryside, and also based on the PMR, we were able to reconstruct the nature of the watercourse. The nature of the watercourse can be reconstructed based on the finds of water plant seeds. These water plant seeds originate in the riverbed area (Area 93). Typical plants growing in bodies of water are hygrophytes, which have adapted their internal and external structure to a water environment. The assortment of water plants in a given biotope is influenced by the presence of oxygen and the movement of the water.

TAB. 12 | Mikulčice-Kopčany. Number and frequency of finds of water and hygrophilic species seeds.

Taxon	Charred		Mineralized		Waterlogged	
	Σ	f	Σ	f	Σ	f
Alisma plantago-aquatica	.	.	.	.	20	11
Berula erecta	.	.	.	.	4	1
Carex dioica	48	18	18	10	2	2
Carex divulsa	3	3	1	1	82	10
Carex gracilis	1	1	.	.	3	3
Carex spicata	.	.	.	.	1	1
Ceratophyllum demersum	.	.	.	.	8	4
Iris pseudacorus	.	.	.	.	19	9
Oenanthe aquatica	.	.	.	.	1	1
Potamogeton natans	.	.	.	.	156	19
Potamogeton crispus	.	.	.	.	41	7
Potentilla supina	9	6	.	.	.	.
Rumex aquaticus	2	2	.	.	10	4
Rumex conglomeratus	31	23	8	7	27	6
Rumex maritimus	10	2	.	.	19	3
Rumex palustris	1	1	.	.	2	1
Saponaria officinalis	1	1	.	.	1	1
Scirpus sylvaticus	2	2	.	.	.	.
Thalictrum flavum	.	.	.	.	48	10
Typha sp.	63	19	.	.	17	3

The identified finds of water plants, which are documented through seed finds, are best characterised by the following species: *Alisma plantago-aquatica, Ceratophyllum demersum and Potamogeton natans*. These species grow exclusively in stagnant or slow-moving bodies of water (Látková/Hajnalová 2014). These water plants create continuous growths on the water surface, which has likely also contributed to the sedimentation and sludging of the riverbed, caused by the dying vegetative parts of water plants.

Another biotope that can be reconstructed based on the PMR, is the forest. Every Central European forest resembles the original Carpathian forest with the variety of species and organisms living in the forest. The Carpathian forest is characteristic for its layered plant layout. In this type of forest, there are predominantly woody plants[31] although this section of the assessment will focus on the plants in the herb layer. The species range of forest herbs has relatively strict demands, which allow us to determine the type of forest in the analysed area, even after

31 See chapter 6.2.3 Woody plants and shrubs.

the change of forest cultures. The seeds of forest herbs, obtained by flotation, document two types of forest [PLATE 14].

The first group consists of seed finds that are common in shadier and moister riparian forests [TAB. 13].[32] Riparian forests consist of a hygrophilous forest community, which is usually situated near rivers and creek valleys. These forests are usually often flooded or waterlogged. In this group, we can include the hemicryptophyte species, for example, *Viola reichenbachiana* and *Glechoma hederacea*.[33]

The other group can be characterised as the group of oak-hornbeam forests. This biotope is characterised by moderately hygrophilous mixed leafy forests with the predominance of oak or hornbeam. These forests are the natural biotope of the herb species, e.g. *Stellaria holostea*.

In this context, the finds of *Atropa belladona* seeds are remarkable, since the natural biotope of this plant is beech forests. Similar to the beech gall mentioned above, these finds[34] constitute another piece of secondary evidence of beech occurrence in the surroundings of the Mikulčice central settlement.

The last presented category consists of so-called ruderal species [TAB. 13]. Ruderal areas are synanthropic ecotopes characterised by the wild land created by the actions of man and his activity in the environment. Among these biotopes, we can count the settlements themselves, land roads, dump sites and various contaminated soils supporting ruderal vegetation. The flora near human settlements is richer in comparison with the surrounding countryside biotopes. Within the PMR, there were the following identified ecotypes of the order *Stellarietea mediae, Sisymbrietalia* – these are weed communities at dump sites and in ruderal areas. From this order, we can document the presence of the following species: *Sisymbrium altissima*. The second group is characterised by the finds of the *Artemisietea vulgaris* class – these are ruderal communities of biennial and perennial herbs. This class is documented by the finds of the seeds of A*rtemisia campestris* and *Artemisia vulgaris* species. Nitrophilous flanking ruderal communities of *Galiu-Urticeatea* class are documented based on the presence of *Galium mollugo* and *Urtica dioica* seeds. The dense road network in the surrounding area is documented by the abundantly present species of *Plantaginetea majoris* community, which usually occur on frequently trodden roads and paths. This biotope is documented through the abundance of *Polygonum aviculare* and *rurivagum* species, which prefer such biotopes [PLATE 14].

TAB. 13 | Mikulčice-Kopčany. Number and frequency of finds of seeds of forest herbs and ruderal species.

Taxon	Charred		Mineralized		Waterlogged	
	Σ	f	Σ	f	Σ	f
Atropa bella-donna	4	2	.	.	2	2
Barbarea vulgaris	2	2	.	.	.	.
Diplotaxis muralis	1	1	.	.	.	.
Galium mollugo	6	6	.	.	.	.
Genista pilosa	.	.	1	1	.	.
Hyoscyamus niger	2	2	.	.	41	14
Chelidonium majus	1	1	.	.	1	1
Lamium maculatum	.	.	.	.	3	1
Physalis alkekengi	3	3	.	.	18	7
Ranunculus lanuginosus	.	.	.	.	15	6
Reseda lutea	1	1	.	.	9	8
Scleranthus sp.	3	2	.	.	.	.
Silene nutans	7	5	.	.	.	.
Silene vulgaris	14	12	.	.	.	.
Sisymbrium altissima	3	1	.	.	.	.
Solanum dulcamara	2	2	1	1	.	.
Thalicrum minus	.	.	.	.	18	6
Teucrium scorodonia	1	1	.	.	.	.
Vicia sylvatica	3	2	.	.	.	.
Viola biflora	1	1	.	.	.	.
Viola reichenbachiana	.	.	.	.	4	2
Urtica dioica	.	.	.	.	28	11

6.2.5 Summary – wild species

The wide range of the seeds of wild species that have been described depicts many different habitats in the landscape surrounding Early Medieval Mikulčice. The fact that these habitats were exploited in the time of the early Middle Ages is evidenced by the presence of the PMR of wild species in charred or mineralised archaeobotanical samples. The waterlogged PMR come from the backfill of the riverbed where they were deposited over a longer period than in the “traditional” archaeological contexts (settlement objects,

32 Riparian forest biotope can also include numerous other species, as is shown in the table of forest herbs. These are, for the most part, also harvested crops, for example: *Humulus lupulus* etc.

33 *Glechoma hederacea* is categorized among the field weeds (moist fields) according to the [TAB. 8], but it is also often present in the riparian forests.

34 See 6.2.3 chapter Woody plants and shrubs.

cultural layers), from which the archaeobotanical samples were taken. The presence of species preserved through different plant-macroremain conservation processes shows that these species were really used and did not get into the archaeobotanical samples in a secondary manner.

It is noteworthy that this part of the analysis proves that the seeds of the wild species in the habitats of fields, meadows and forest plantations[35] come from plants with significantly different habitats. In the environment of field plantations, it is possible to observe both species linked to humid, nutrient-rich soils as well as field weeds from poor soils, which are represented in an equal measure. There is a similar situation in the meadow and forest-herb plantations. These two polarities provide evidence of both xerophilous and hydrophilous plant species whose biotopes differ from each other significantly. This, in turn, proves the diversity of the populated and exploited landscape, from where the seeds entered into the archaeological contexts. It is thus clear that in the vicinity of the central settlement there were sites that were not regularly flooded in the Middle Ages and where even underground water was rather low. It is also quite probable that there used to be settlements in even less favourable positions, where occasional flooding occurred.

In the earlier archaeobotanical studies, where the PMR were evaluated by E. Opravil, relatively large attention was paid to wild species.[36] The above-mentioned author was the first to address the topic and the nature of forest and water habitats. Based on the results of the PMR examination, Opravil assumed that a vast hardwood forest stood in the floodplain of the Morava River in the 8th and 9th century. He showed the occurrence of soft riparian forests was limited to the areas with river branches overgrowing with vegetation and other more frequently flooded low spots (Opravil 1972, 16). The finds from the herb and shrub layer of the forest indicated clearances in the vicinity of the stronghold, which the author linked to the expansion of settlement, field growths and forest pastures (Opravil 1972, 16). The finds of seeds from the extinct riverbed, which indicate the character of this habitat, were defined by E. Opravil (1972, 16) as coming from swamp communities that were not significantly influenced by man. More intensive intervention could perhaps take place in the area of fords, bridges and watering places.

6.3 COMPOSITION OF THE SAMPLES

When addressing the questions of taphonomy, economy and ecology, it is important to understand the origin of the analysed samples (cf. Jones 1990). A rough idea whether the samples are of the same character can be reached by comparing the main "sample constituents" (cf. van der Veen 1992). These are usually seeds of cultivated cereals and pulses, cereal chaff and the seeds of wild plants. What is typical for the composition of archaeobotanical samples from Mikulčice and Kopčany is the significant absence of cereal chaff. This is not surprising as it is almost a rule for any early medieval plant remains assemblage. This is mostly because this period is connected with the expansion of free-threshing cereals such as bread wheat and rye, of which cereal chaff is very light and easily burns (cf. Boardman/Jones 1990).

At Mikulčice, only three chaff remains were found; therefore we looked at the proportions of crops to wild plants. It is evident [fig. 25] that in most areas the cultivated crops dominate the assemblage.[37] In the areas where different settlement contexts were excavated, be they sunken or above-ground, and not necessarily residential (in particular in Mikulčice in Areas 85, 86, 88, 89, 98, 103 and M17), the proportion of wild species ranged from 10 % to 20 %. Higher numbers of wild plant seeds were detected where the plant macroremains were not in the primary, but secondary or tertiary contexts. This was observed at Kopčany (KSM, KAČ) and in Mikulčice (Areas 96, 91, 100 and 97).

The finds of charred and waterlogged seeds from the riverbed (Area 93) are a special category. The seeds deposited in the sediments of the riverbed are thought to originate from the near vicinity of the river channel, either from the settlement or from the vegetation stands up-stream. The charred seeds in the riverbed are most probably the residues of settlement waste, discarded into the stream. The mixing and the deposition of PMR of a different origin in the riverbed is a different mechanism to the formation of "dry" archaeological contexts; therefore, the material from the riverbed cannot be directly compared to material from other areas of the site.

For attributing samples into interpretative categories such as "waste" or "product" for the crop processing, we have, apart from other more sophisticated methods described further in the text, at first used a simple method. Inspired by

35 This cannot be observed in gathered crops and woody plants.

36 Opravil 1962, 1972, 1978, 1983, 1998, 2000, 2003.

37 Such an analysis was conducted on each sample [fig. 81–96]. The charts show only a summary of the major components in individual areas.

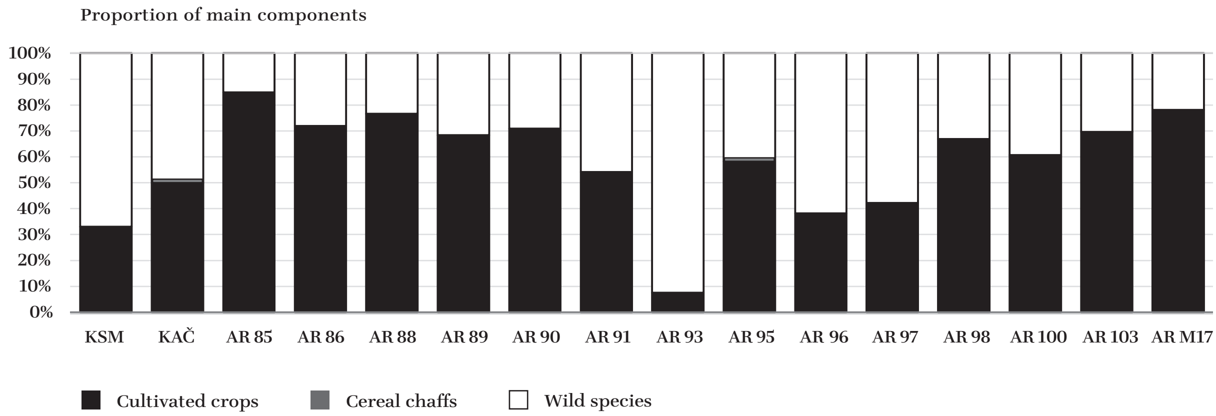


FIG. 25 | Mikulčice-Kopčany. Ratios of the main sample constituents at individual residential areas.

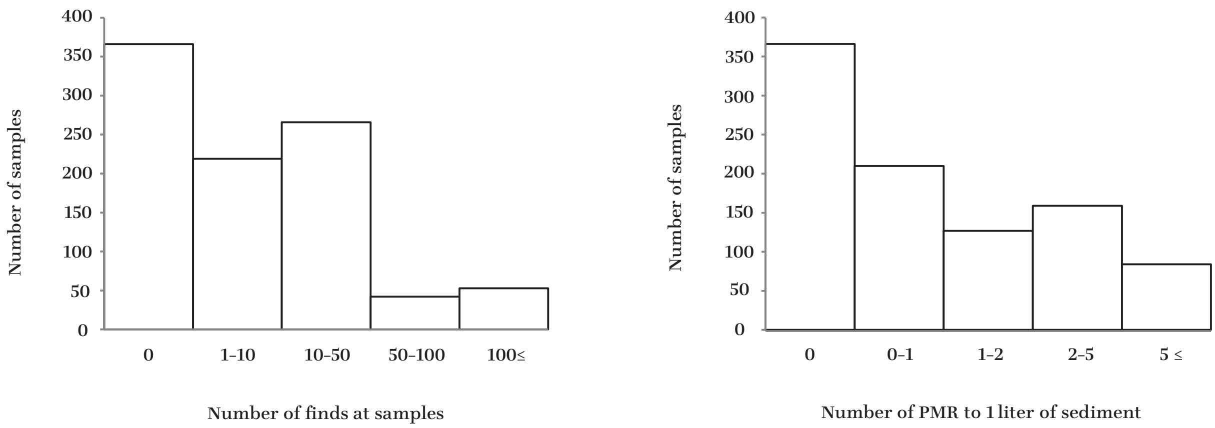


FIG. 26 | Mikulčice-Kopčany. Histogram of frequency of finds (left) and average density of seeds per litre of sediment (right).

various archaeobotanical and ethnographic papers, but mostly by JONES/HALSTEAD (1995), we have set up a percentage threshold. Samples with a low proportion of seeds of weeds (up to 10 %) were considered as the cleaned final product (stored grain); samples with up to 25 % of wild species were considered as a partly cleaned product; the samples and contexts with up to 50 % of weed species were considered as an uncleaned product or a possible mixture of waste and/or products.[38]

The assemblage is also characterized by the large variation in the number of finds per sample and in the density of seeds per litre of sediment.[39] At Mikulčice, both variables are strongly influenced not only by the sampled sediments and contexts but also by the variety of sampling strategies applied at different excavation areas. In Kopčany, particularly at the Kačenáreň site, where the complete fill of excavated features – graves and settlement pits – was sampled, almost 80 % of the samples were sterile, without PMR (LÁTKOVÁ 2014a). Due to mostly judgement sampling at Mikulčice, where contexts with visible or expected PMR were often selected for sampling, the samples are relatively rich and the number of sterile samples is negligible (14 %).

The graphic output [FIG. 26] shows that next to sterile samples, samples with the number of finds from 10 to 50 are more numerous. “Richer” samples, where the number of finds ranged from 50 to 100+, are less frequent. These samples mainly come from settlement pits in the acropolis (Areas 86, 88 and 98). The majority of the samples from the riverbed (Area 93) are from the “100+” category.

The density of seeds for each sample differs significantly between the sites within the

38 This method was only applied to cultivated plants (cereals and legumes) and from the group of wild types, the types were applied that were able to grow with cultivated plants in fields (weeds).

39 Such analysis was carried out for each sample and area [FIG. 97–104]. The charts show the summary of the evaluation of the number of finds and the average density in the whole settlement complex.

examined settlement agglomeration. The highest density was recorded in Area 93 (the riverbed) and the lowest in Kopčany. In the areas of the Mikulčice acropolis, the outer bailey, suburbium and adjacent unfortified areas, the density of PMR per litre of sediment is higher. In these areas, the average intervals of density (for individual samples) range from 1–2 to 2–5 seeds per litre of sediment. In exceptional cases, the density rises to five or more finds, even in the "normal" settlement layers. The density values of the analysed assemblage (excluding the riverbed) are relatively low; therefore, the samples are thought to represent residential waste or intermediate products from cereal processing.

7 Taphonomic analysis and origin of archaeobotanical samples

7.1 INTRODUCTION

Taphonomy studies the decay of various organisms in time and space. In archaeology it, above all, explains the origin of fossil assemblages with the aim to gain as much understanding as possible about how the sediments and contexts were formed and in what way they changed over time (Lyman 2010, and other examples). It is clear from the numerous archaeobotanical analyses which started in the 1970s that PMR samples cannot be compared directly with each other (Dennel 1974, 1976; Hillman 1984). However, it is possible to characterise their origin and the taphonomic processes that led to their formation. It is of no less importance to deal with issues connected to PMR preservation (charring, waterlogging, mineralisation) and to state which stages of the post-harvest crop processing the finds come from (van der Veen 1992, 81–82). Taphonomic processes are the basic source of identification of whether deposited macroremains reflect and represent human activities or other (e.g. natural) processes.

The characteristics of taphonomic processes that lead to the formation of an archaeobotanical sample depend on more factors than usually significantly influence the interpretation of the finds:

› Factor 1: Production of seeds by a plant species: the number, size, and nature/character of seed-coat, or the characteristics of its vegetative parts (e.g. lignifying or soft stems, etc.)
› Factor 2: Ability to preserve parts of plants with respect to the nature and conditions of the environment (pH, humidity, type of deposit) in which they were deposited
› Factor 3: Cultural processes (pre-depositional farming practices, gathering methods, preparation of food by baking or cooking in water, waste treatments)
› Factor 4: Preservation method
› Factor 5: Sampling strategy and archaeological excavation methods
› Factor 6: Methods of extraction of plant material from deposits

Samples from Mikulčice and Kopčany contain charred, mineralised and waterlogged PMR (see chapter 6 General results). The occurrence of finds preserved by three different preservation methods also reflects three types of various taphonomic processes that participated in the formation of these assemblages. That is why it is problematic to evaluate these three groups directly with each other. M. Hajnalová (2012, 95) summarised numerous ways and possibilities of settlement waste treatments that influence the formation and final nature of archaeological contexts. We believe the settlement waste treatment is one of the most important factors affecting PMR density in archaeological deposits. For example, features and contexts in a settlement that have been open for a longer period of time usually have a lower average density of seeds per litre of sediment than contexts formed as a result of a single event (e.g. fire in a house, cf. Hajnalová in Kuna et al. 2013, see chapter 6.3 Composition of the samples). According to this hypothesis, the assemblage of samples from Mikulčice and Kopčany with the low average density of finds per litre of sediment represents finds that cannot be considered the result of a single event[40] (*single event context*)[41]; they were formed over the course of a longer period of time (*multiple event context*). Various depressions in the terrain (ditches) that

40 Apart from water-preserved seeds on the bottom of the river bed. In this respect, charred PMR need to be taken into account.

41 An example – an accidental fire in a house, or more precisely, a granary (e.g. Hoste – charred cereals in the borrow pit).

have been open for a longer period of time and where gradual sedimentation occurred (erosion, charred seeds brought by water or wind) are an example of such contexts.

7.2 DENSITY OF PMR

The value of seed (find) density, expressed as the number of finds per litre of sediment, is one of the best (or most objective) indicators of the characteristics of samples. In assemblages where sediment samples do not have constant volumes, the value of density removes distortion caused by different volumes when samples are compared and evaluated with each other. Density values of finds also provide information about the nature of formative and depository processes (Kreuz 2004; Kuna et al. 2013, 95).

When evaluating more heterogeneous assemblages (i.e. assemblages with inconstant volumes of a sample and a great variety in the number of variables), which is based on the comparison of average values, it is very important to choose the correct method of averaging.

The value of the average density of finds in samples of an (sub)assemblage can be calculated and expressed in a number of ways [tab. 14]. Each of the acquired values has certain positives and negatives. The first (basic and easiest) method of stating the value of the average density is the arithmetic average. This is calculated by adding all finds and dividing them by the total volume of sediment. Using the arithmetic average in an assemblage where samples with different volumes are present has several risks. For example, when the volume of samples varies, a significant loss of information about the nature (richness) of the samples can occur. Thus when the volume of sediment in samples is different, it is more appropriate to use the so-called weighted average method.[42] The weighted average generalises the arithmetic average and at the same time provides the information on the nature of the assemblage. It is used when calculating the arithmetic average of an assemblage is composed of more sub-assemblages (samples). Other mathematically useful methods to characterise the "average" is the median or mean value, which divides the analysed value/assemblage into two parts so that 50 % of the values are higher and 50 % lower than the median value. The modal value is determined as the most frequently recurring value. Max and Min represent the maximum and minimum values of the average densities of a sample assemblage.

Significant differences between assemblages from individual locations are apparent when comparing the resulting values for the arithmetic and weighted averages. Since the objectivity of the arithmetic average is considerably limited (due to varying volumes of the sediment samples), it is more appropriate to rely only on the weighted average when determining the overall average density in the individual excavation areas of Mikulčice and Kopčany. The highest density of finds in an assemblage of water preserved deposits can be found in Area 93 – river bed (arithmetic average – 14.83, weighted average 70.17). Samples from Mikulčice Church IV[43] (Area 90) reach the highest average density from among the samples of charred material (weighted average – 14.59). Assemblages from Kopčany – St Margaret's of Antioch Church, and Mikulčice-Trapíkov – Area M17 (0.75 and 1.05, respectively), have the lowest weighted average, i.e. the lowest average density of seeds. The weighted average of densities ranges from 1 to 12.1 seeds per one litre of sediment in other researched excavation areas.

Like the arithmetic and weighted averages, the median and modal values vary greatly. Similar to the weighted average, the highest calculated median value (18.71) also comes from Area 90. The lowest median values are similar to the weighted average calculated in KSM and Area M17. In many cases, it was not possible to determine the modal average since data was polymodal (i.e. it had more modal values). The modal value of density, determined to be 0.5, is notable for the assemblage of samples from the river bed (Area 93). During the archaeological research, sediments from the fill were sampled from the top to the bottom layers. It was noted that macroremains were more numerous at the bottom layers of the river bed (Látková/Hajnalová 2014). Their number (and density) markedly decreased in the upper layers. Despite the highest number of PMR within the studied assemblage, the determined modal value for all samples from Area 93 is low due to intensive sampling, which produced a large number of sterile samples.

Maximum and minimum values of average density are important indicators of density variation in individual excavation areas of the site. The comparison of these two values suggests there is a large difference between the maximum and minimum densities within each excavation area. This difference is the smallest

42 The average of average densities.

43 The sediment comes from settlement features from the beginning or the course of the 9th century (Poláček/Škojec pers. com.) located under the church foundations.

TAB. 14 | Mikulčice-Kopčany. Average values (averages as well as variances) for all the positions. Captions: KSM – Church of St Margaret of Antioch, KAČ – Kačenáreň, AR – area, polyM – polymodal data, i.e. the excavation area researched has more possible modes, which is why mode value cannot be ascertained. *A single sample was examined.

Area	Σ PMR	Arithmetic avg.	Weighted avg.	Modus	Median	Max	Min
KSM	236	0.68	0.75	0.42	0.42	3.87	0.10
KAČ	2357	1.81	2.18	1.00	1.00	38.13	0.04
AR 85*	192	4.36	4.36	4.36	4.36	4.36	4.36
AR 86	2480	2.28	2.24	polyM	1.96	7.86	0.18
AR 88	821	4.04	6.55	polyM	4.45	20.2	1.12
AR 89	471	3.38	3.18	polyM	3.18	4.30	2.07
AR 90	1336	17.57	14.59	polyM	18.71	22.10	2.95
AR 91	72	1.75	1.74	polyM	1.87	2.85	0.14
AR 93	8506	14.83	70.17	0.50	2.20	1105	0.08
AR 95	1287	12.31	12.1	polyM	11.27	24.80	1.10
AR 96	2295	2.75	4.24	0.50	1.54	54.33	0.06
AR 97	535	3.33	3.31	polyM	3.33	4.80	0.42
AR 98	754	4.78	4.70	polyM	2.81	24.1	0.20
AR 100	145	1.98	1.90	polyM	1.00	7.10	0.11
AR 103	5053	2.86	3.16	2.00	2.22	36.15	0.09
AR M17	481	0.56	1.05	0.10	0.40	7.77	0.02

from all in Area 90; however, the difference between these two values is significant even in this case. By contrast, there are also excavation areas with much bigger recorded differences in the maximum and minimum values (such as Area 96 and KAČ). These differences are caused by systematic sampling of all contexts – even contexts where judged by visual assessment, PMR did not occur.

The density variation of archaeobotanical finds in sediments in individual excavation areas is also demonstrated by box-plot diagrams in [FIG. 27]. Three excavation areas were not included in the diagram – Areas 85, 89, and 93. The first two excavation areas were not included as they did not contain a sufficient number of samples – only a single sample comes from Area 85 and two samples come from Area 89. Although there is a sufficient number of samples from the river bed, the majority of PMR are waterlogged and the context is not a "standard" archaeological context either. This excavation area was therefore not included in the average densities.

The greatest variation of densities can be found in assemblages from Areas 90 (Mikulčice Church IV) and 95 (the ditch between the palace and the basilica). The third largest variation has been recorded in the excavation area of the surroundings of the basilica from Area 88. As in the case of Area 90, samples from the basilica represent settlement pits revealed under the foundations of a stone building. The density variation of other studied excavation areas is low and ranges in approximately the same value interval (0 to 5 finds per litre of sediment).

The average density of seeds is relatively low in almost all studied sites where "common" archaeological contexts (settlement features, graves) were sampled. This applies both to excavation areas where sampling was more intensive or systematic and also where samples were taken on a judgement (targeted) basis only. In most cases, samples do not represent more significant PMR concentrations. It can be assumed that the majority of contexts with PMR were formed during a longer period of time and are not a result of short, single activity events (cf. Kuna et al. 2013).

In an intensively populated settlement area, such as the stronghold of Mikulčice-Kopčany, it can be presumed that a large number of various settlement activities took place. The treatment and disposal of waste must have been common, e.g. from crop processing or cooking. Relatively low values of PMR density indicate that settlement waste, including the waste from processing crops and preparation of plant foods, can be found in a secondary or tertiary position within the settlement features or layers (for further discussion see Kuna et al. 2013). For example, settlement features and depressions could have been "open" for a longer period of time and artefacts and ecofacts including PMR were deposited gradually there either by anthropogenic activities or natural processes such as water and wind erosion.

PMR from graves in Kopčany is assumed to be foreign or indirectly related to the original context. Although the fill of a grave can be regarded a single event context (the covering of a body by earth), artefacts and ecofacts present in it might be of foreign origin, and unconnected to it.

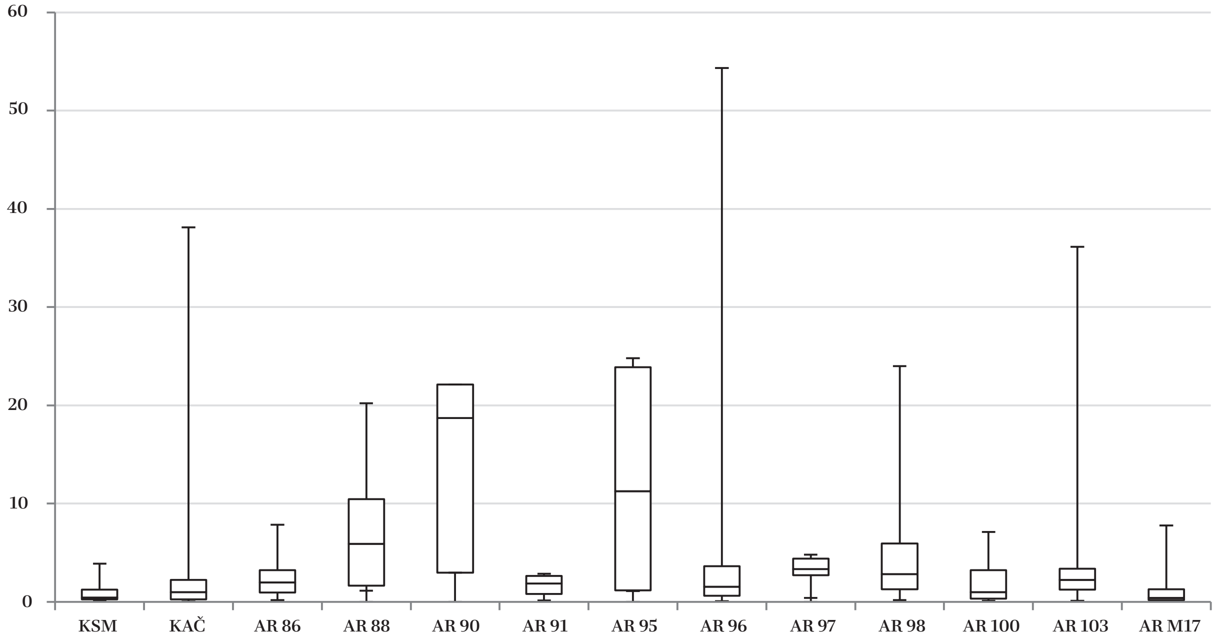


FIG. 27 | Mikulčice-Kopčany. Histogram of density of finds in the excavated areas of the agglomeration.

They can attest that i.) before the sediment was used for filling the grave it had its own diagenesis as a "culture layer" or ii.) the finds could have infiltrated the grave after it was filled (e.g. the result of bioturbation). We support this notion because the material resembles and corresponds to the finds from the fill of the settlement features or the cultural layer into which the graves were dug. The question of whether seeds got into the sediment before digging the grave and covering it with earth, and were part of an older cultural layer into which the grave was dug, or got there by bioturbation from the surroundings only after the establishment of the grave, can only be answered after radiocarbon dating of the finds (Látková 2014a; Hajnalová 1978).

In addition to PMR and charcoal, the fill of the graves also contained other finds [TAB. 15] recovered during flotation. Among the ecofacts were animal bones, fish scales, and egg shells, which can be regarded as common and originated in household waste. Artefacts such as hammer scales, slag or fragments of mortars are of the so-called production waste category. The occurrence of these finds together with PMR provides evidence that samples contain a mixture of household and "industrial" waste. This is true for graves in Kopčany and also for several areas within Mikulčice. Animal bones represented a standard part of almost all samples.[44] They were often fragments of bigger bones; still, finds of entire bones of small mammals, birds, and fish were also common. Charred bones were present in some samples in six excavation areas. Fish bones were frequent and documented in all studied excavation areas except Area 93 (river bed). Hammerscales are a by-product of metalworking. They are formed in the course of heat treatment and shaping of metal objects during melting and forging (P. Čáp senior pers. comm.). They are small (max 3 mm) and hardly ever visible in the field. Hammerscales from samples of deposits from Mikulčice are considered to be evidence of local metal production and processing activities. They were most numerous (in hundreds) in samples from Kopčany-Kačenáreň – feature 1. In Mikulčice, they were found only sporadically and, in most cases, only one or two pieces were found.

The size of the recovered mollusc shells ranges from 0.25 to 2 mm. These snails could not have been a subject of consumption, thus they had to enter the deposits by natural processes. Like animal bones and fish scales, they were very frequent in sediments. Snail shells can be determined to the species level, and they live their whole life within one small area. Some of them are strictly attached to specific environments and thus represent ecologically "sensitive" material on which it is possible to reconstruct the local conditions of the environment (humidity, temperature, type of biotope). Identified mollusc finds document a considerably varied range of biotopes within the inhabited area of the Mikulčice stronghold (Horsák 2014).

44 Note: these may in some cases be recent remains of animal bones (mice, voles…).

TAB. 15 | Mikulčice-Kopčany. Proportion of artefacts and ecofacts in archaeobotanical samples.

Excavated area	KSM %	KAČ %	AR 85 %	AR 86 %	AR 88 %	AR 89 %	AR 91 %	AR 90 %	AR 93 %	AR 95 %	AR 96 %	AR 97 %	AR 98 %	AR 100 %	AR 103 %	AR M17 %
Animal bones	44.12	22.44	100	100	83.33	50	37.50	66.67	6.45	50	76.47	88.89	63.16	20	87.04	43.33
Charred animal bones	2.94	4.06	.	.	.	.	12.50	.	.	.	20	.	.	.	0.62	3.33
Fish scales	5.88	18.76	100	105.26	83.33	50	12.50	66.67	.	75	58.82	88.89	73.68	10	77.16	13.33
Snail shell	41.18	10.83	.	84.21	66.67	50	25	100	4.84	100	48.24	100	94.74	10	85.19	16.67
Consch shell	.	3.09	.	.	.	.	.	.	.	.	25.88	.	.	.	1.85	10
Slag	.	2.13	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bronze	2.94	.	.	.	.	.	.	.	1.61	.	8.24	.	.	.	.	.
Fe frag.	5.88	0.58	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Morgar	55.88	5.03	.	.	.	.	.	.	.	.	25.88	.	.	.	.	.
Pottery	2.94	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hammer scale	.	15.86	.	5.26	.	.	.	.	.	.	.	.	21.05	.	0.62	.
Egg shells	.	1.16	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Others	.	.	.	.	.	.	.	.	.	.	.	.	5.26	.	.	.
Charred	100	29.98	100	100	100	100	62.50	100	43.55	100	80	100	94.74	70	100	80
Mineral-ised	8.82	2.51	100	63.16	50	100	.	66.67	.	50	44.71	55.56	47.37	.	54.32	.
Water-logged	.	.	.	.	.	.	.	.	93.55	.	7.06	.	.	10	1.23	.
Seeds Σ	34	517	1	19	6	2	8	3	62	4	85	9	19	10	162	30

Finds of other artefacts (fragments of glass and metal objects, fragments of puddle and pottery) and ecofacts (charred animal bones, egg shells, and conch shells) were only sporadic in the samples.

7.3 MULTIVARIATE STATISTICS I[45]

The multivariate statistical analyses were conducted with the aim to help with:

1) The identification of samples coming from the processing of cereals.
2) The determination of the mutual relationship among individual samples.
3) The observation of context similarity in time and space.

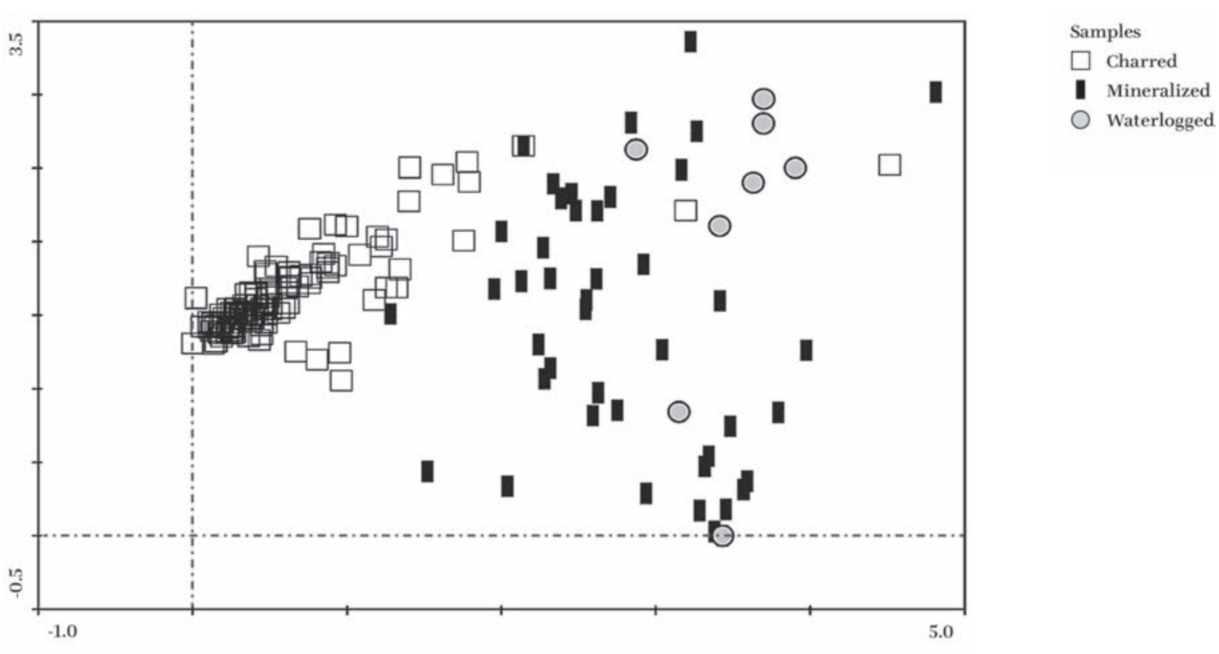
The first two detrendent correspondent analyses (DCA) were targeted at the identification of the relationship between charred, mineralised, and waterlogged remains [FIG. 28]. In DCA1, the values of the variables (species) were expressed by the density of each species (taxa) in a given sample. In DCA2, only the information about the presence/absence of a species in a sample was used as a variable.

The results of both analyses show that there are significant differences in species composition between assemblages of different preservation. There are different taxa preserved by charring, waterlogging and mineralisation. This is seen as evidence that each type of preservation reflects an assemblage of species resulting from different economic or cultural activities, and pre- and post-depositional processes.

In DCA1, the charred samples separate from the mineralised and waterlogged samples, which are placed close to one another. The most significant factor influencing the distribution of samples in the ordination graph is the density of PMR. Charred samples have a (considerably) lower density of finds than mineralised and waterlogged ones. However, the groups also differ in species composition as supported by DCA2.

In DCA2, the samples cluster in the graph only on the basis of the species spectrum, and they also create two larger groups. Samples with charred PMR are closer to each other, which can be explained by the higher similarities in their species composition.

45 For the description of the method, see Research methodology, Assessment methods, Methods of statistical analysis.



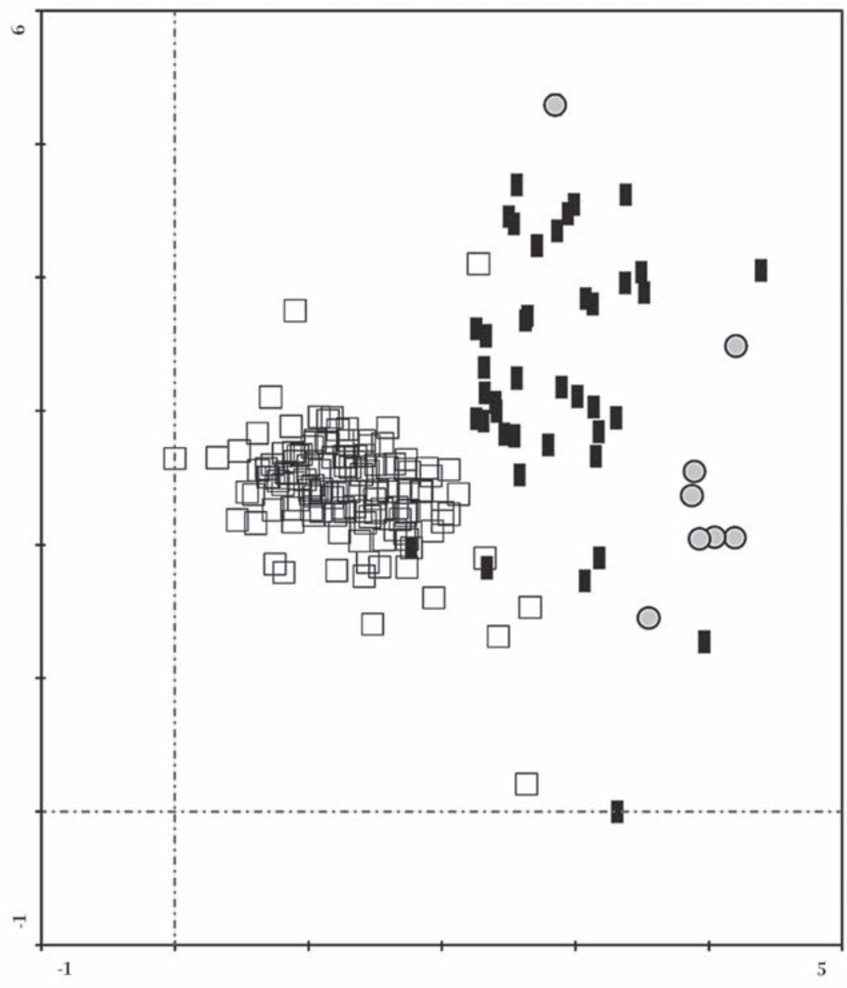
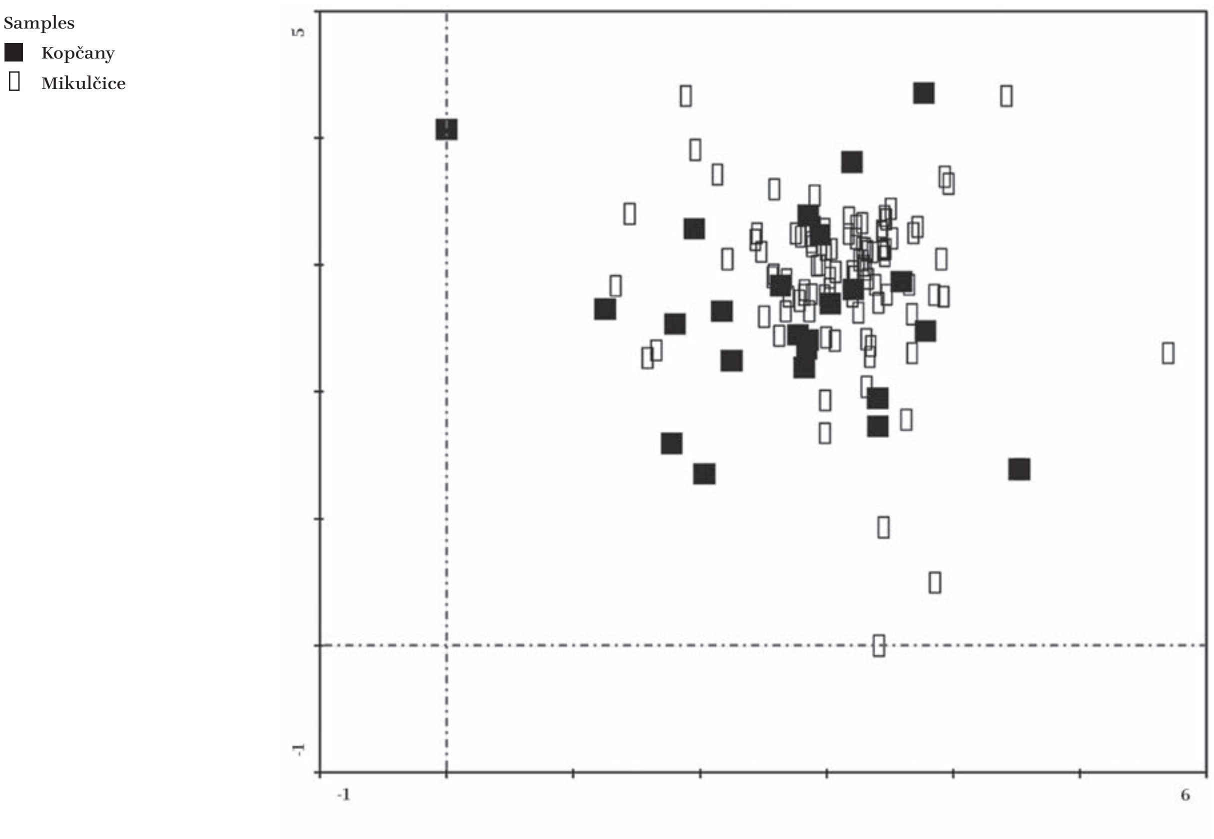


FIG. 28 | Mikulčice-Kopčany. Detrended correspondence analysis aimed at determining the similarities between charred, mineralised and waterlogged samples using the values of density of plant macroremains per liter of sediment (DCA1) and presence /absence of the species in the samples (DCA2).



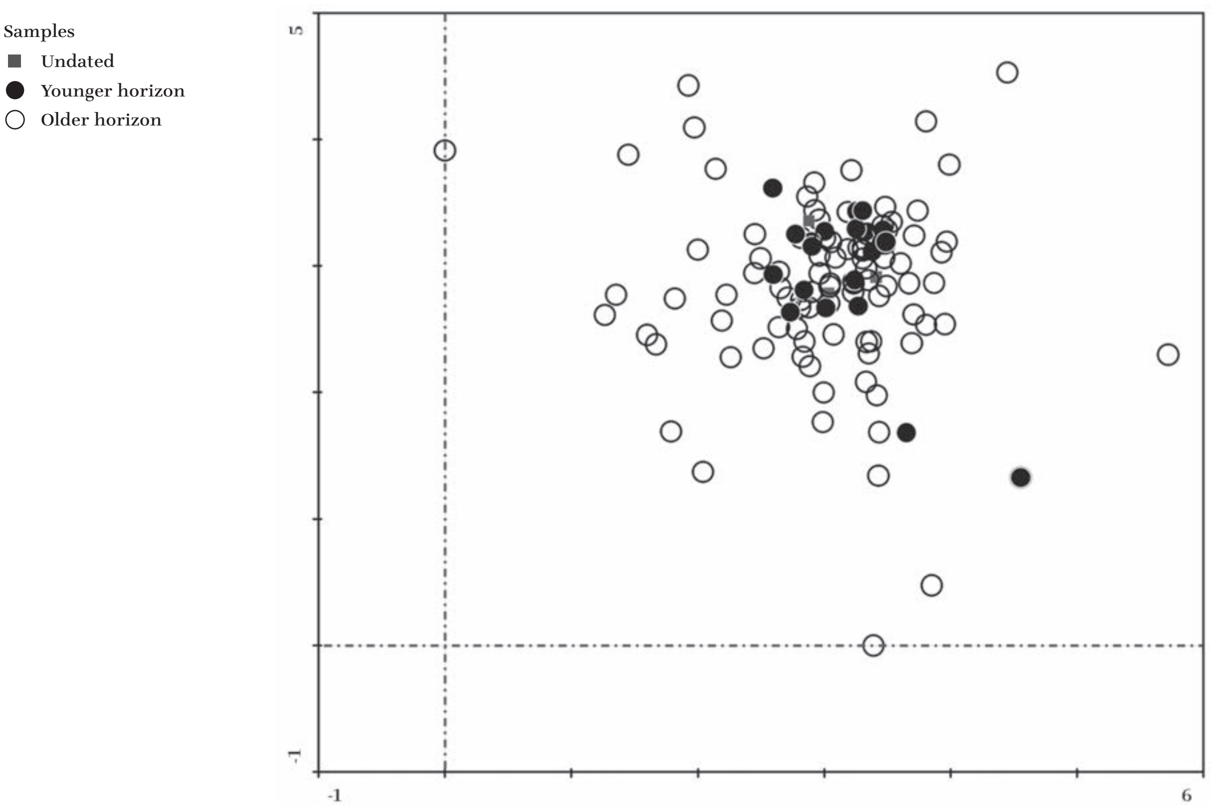
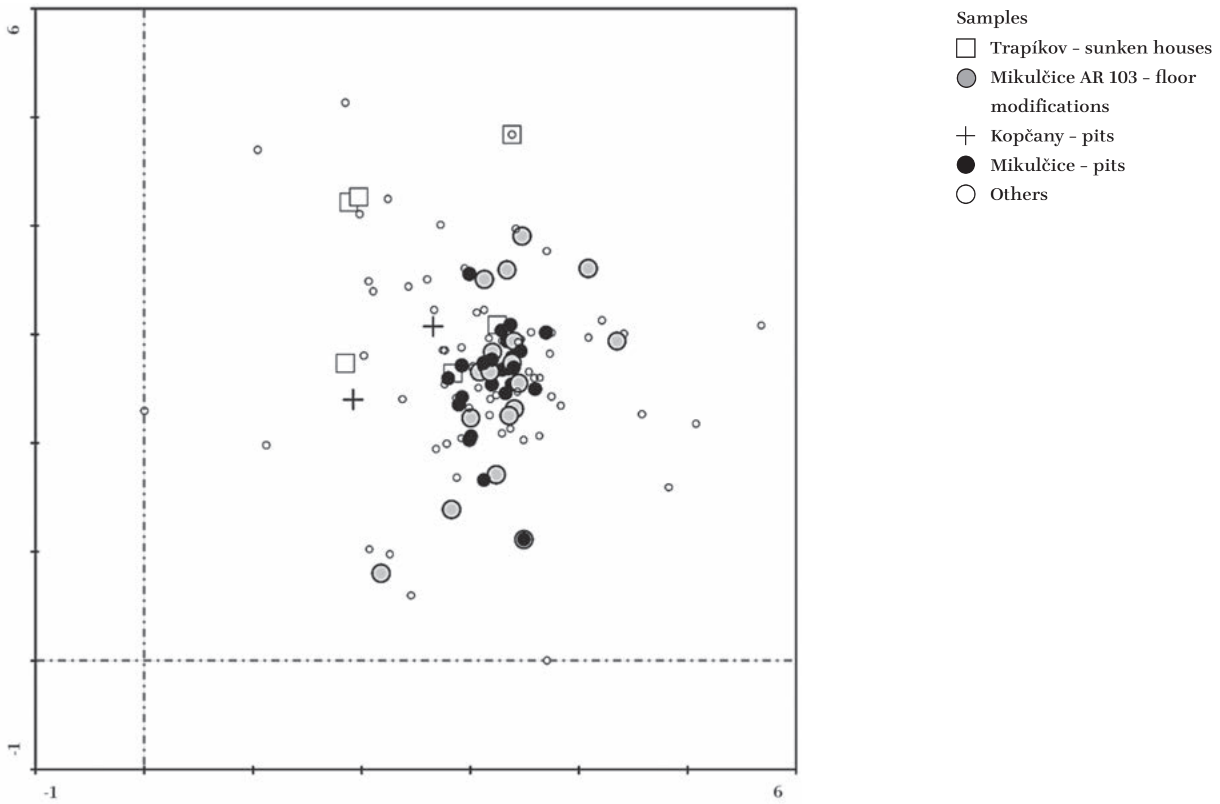


FIG. 29 | Mikulčice-Kopčany. Detrended correspondence analyses of charred plant assemblages using wild species and their density values. DCA3 shows affiliation of samples to areas of Mikulčice and Kopčany. DCA4 shows the information on dating of the samples.



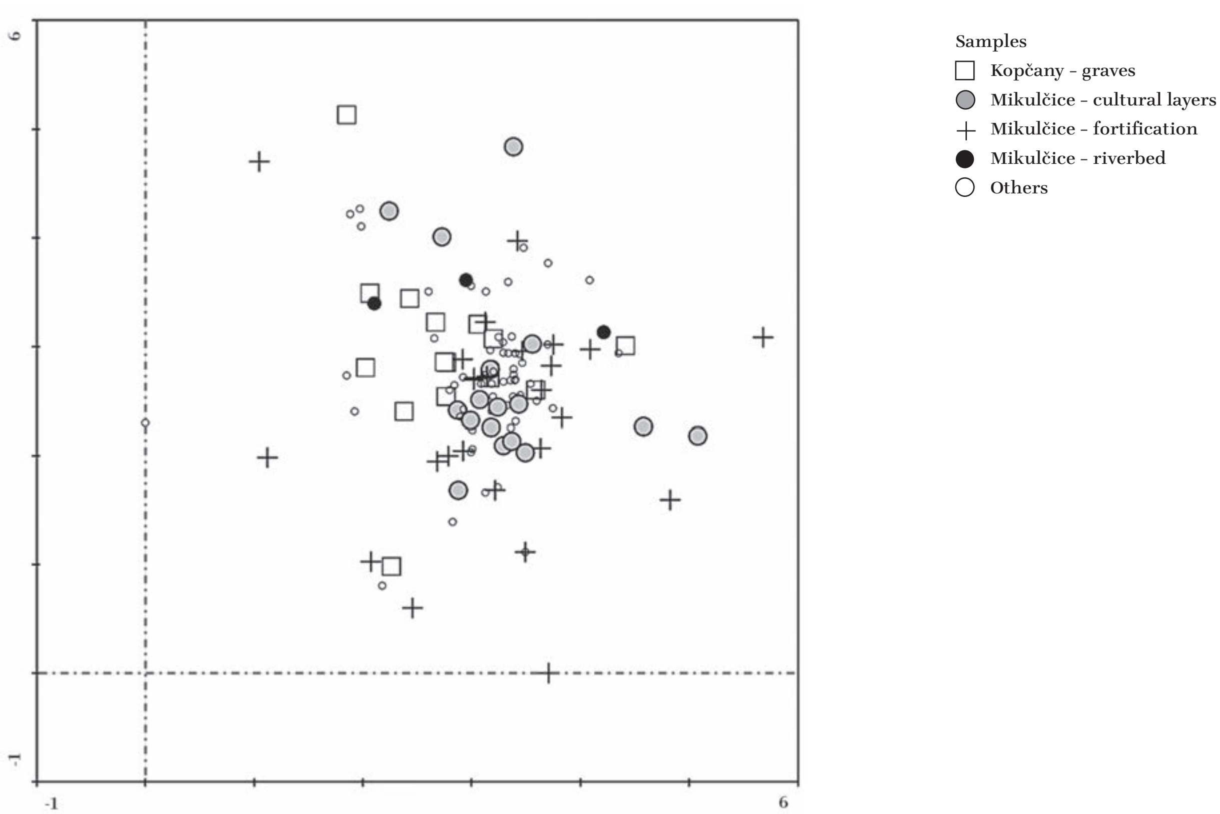
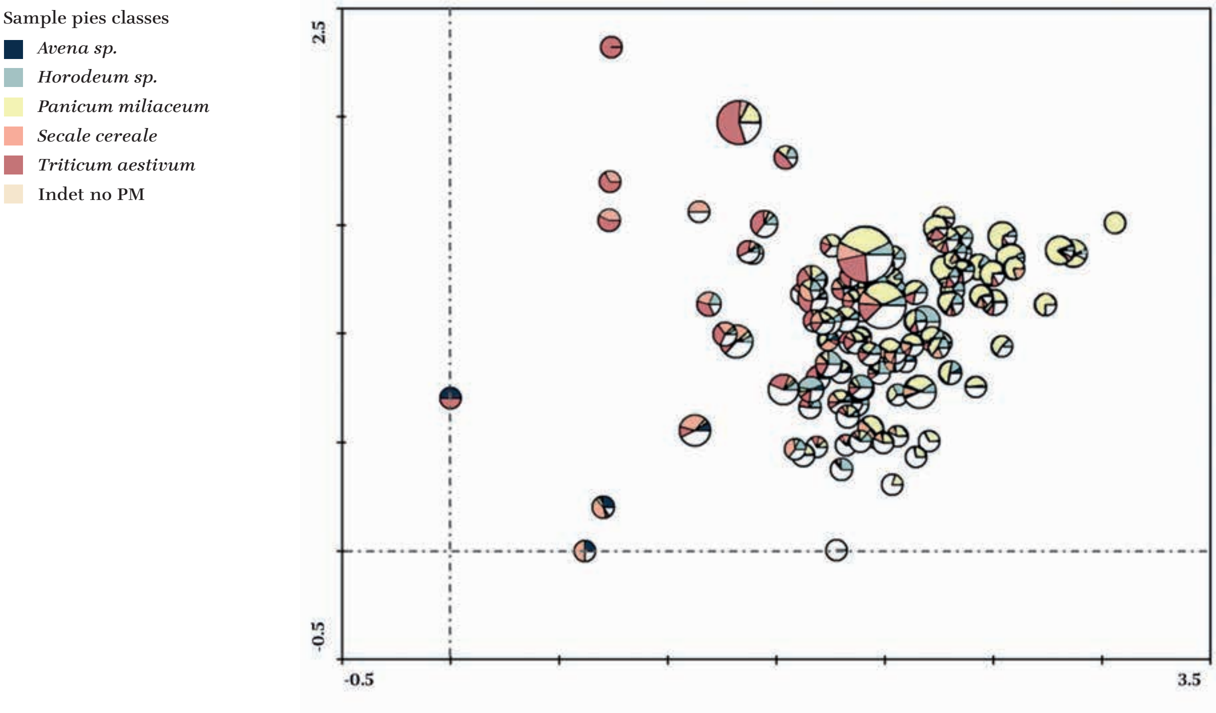


FIG. 30 | Mikulčice-Kopčany. Detrended correspondence analysis of charred assemblages using wild species and their density values. DCA5 focus on the identification of a relationship between the samples from the primary and in DCA6 secondary contexts.



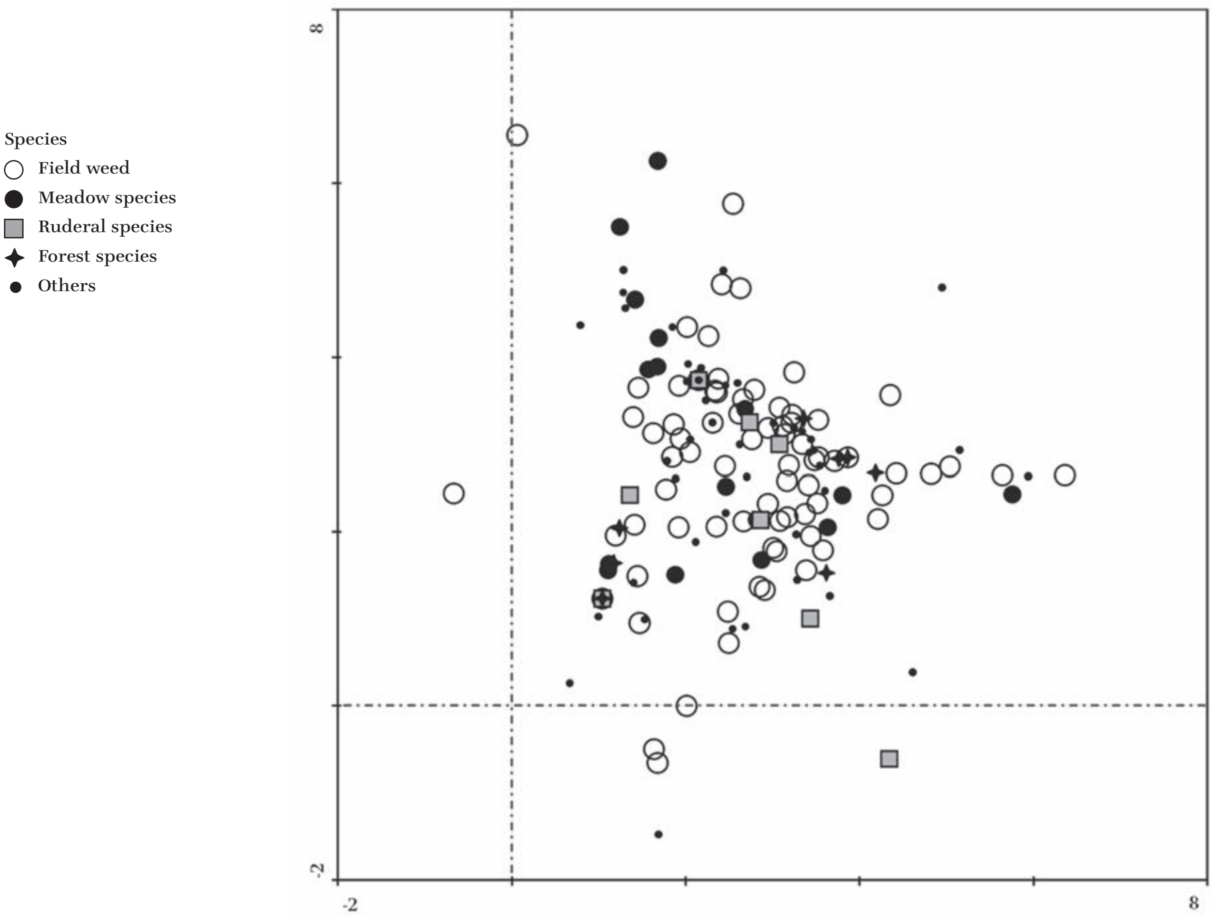


FIG. 31 | Mikulčice-Kopčany. Detrended correspondence analysis DCA7 of charred assemblages using information on density of cereal crops and shows the proportion of cereals in individual samples. DCA8 of charred assemblages using information on density of finds focused on the identification of the relationship between different wild species.

Charred assemblage is formed mostly by seeds, cereal crops and legumes, and field weeds. A different and much more varied distribution of wild species is present in mineralised and waterlogged samples. Waterlogged assemblage differs from others mostly by the presence of vegetable seeds and oil/textile plants, both wild and cultivated fruits, and wild taxa of non-arable origin. Among the mineralised finds are many species with a specific predisposition for preservation – a hard and compact seedcoat. Crops are rare in these two groups.

The results have shown, that for the purpose of further analyses that will address the question of crop processing activities taking place on the site (see chapter 7.6.1 Method 1 and 7.6.2 Method 2), it is appropriate to use only the assemblage of charred samples.

The DCA3 conducted on the charred samples from Mikulčice and Kopčany [FIG. 29] shows that the density of finds and the composition of species in samples from both excavation areas are similar, although samples from Kopčany have a greater variance than samples from Mikulčice. This is caused by the fact that a wider spectrum of species is recorded in the majority of samples from Kopčany. In both excavation areas, samples from contexts where PMR are likely to be in a secondary or tertiary position are situated further from the centre. Such samples come mainly from the upper layer of the fill of grave pits (mixed cultural layer) in Kopčany and samples from rampart sections (Area 96) and a ditch (Area 98) in Mikulčice.

To see if any changes in crop production have taken place over time, the samples were assigned to two phases. As "the older" are considered samples from settlement pits placed in superposition to the foundations of stone buildings[46] all the other contexts were designated as "the younger".

When relative dating of the samples is visualised, it is clear that the samples from the two "periods" do not differ ([FIG. 29], DCA4). If the assumption that pits located under the foundations of stone buildings are older than other contexts, the result can be seen as evidence that the settlement activities that took place on the site in these two "phases" were very similar – e.g. they produced the same spectrum of crops and weeds; there was no difference between the treatment of settlement waste; or, there was only a very short time between the period of the filling of the pits and the formation of "younger" contexts. Also, the possibility that the part of the samples now considered "younger" is contemporary with the "older" ones cannot be ruled out.

In the next step, only samples originating from contexts in which the primary occurrence of PMR was assumed ([FIG. 30], DCA5) were visualised, that is where only a short period of time between the circulation of remains in a living culture and their deposition in the place of the find was expected. These were samples from the houses, the pits and the "floors." They would represent remains from kitchen activities (e.g. sunken houses, floor modifications) or places that served for the accumulation of kitchen waste or waste from processing cereals (waste pits, depressions after sunken houses that lost their function, etc.).

The outcome of the DCA5 shows that the composition of PMR and the density of finds of species in the contexts in which PMR are in primary positions is similar. Even the settlement pits from Mikulčice and floor modifications from Area 103 (outer bailey) are similar. This is surprising because they are supposed to be from different periods (see also DCA4) with different settlement activities and different husbandry practices connected with the production of crops (?). Samples from pits in Kopčany (two features from the excavation area of Kačenáreň) and sunken houses in Mikulčice-Trapíkov (Area M17) differ more significantly from the pits and floor modifications of Area 103. The difference is chiefly caused by a different assortment of plants and not by the density of finds in samples, since samples rich in PMR are present in Mikulčice-Trapíkov (Z4) and Kopčany (feature 2) alike.

The contexts in which PMR occurs in a secondary or tertiary position (DCA6) were then visualised. This is where PMR could have entered after a longer period of time or multiple relocations – such as graves, fortification systems (ramparts, ditches), a river bed and cultural layers [FIG. 30]. Dislocated and mixed PMR lose their informative value for addressing various issues (e.g. reconstruction of arable farming practices). On the other hand, these deposits, in a way, "average out" the settlement activities.

The "dislocated" PMR (DCA6) show a much greater variance of data than the previous category (DCA5). The greatest variance can be observed in samples from graves (KSM and KAČ) and fortification systems (rampart: Area 91, 96, and 100; ditch: Area 98). This is mainly caused by a wider species spectrum in these "dislocated" and mixed deposits. The density of finds also varies greatly in this group. Despite the fact that these two types of contexts show the greatest variance, they are found in opposite parts of the ordination graph (DCA6). The position of the samples

46 See chapter 5 Characteristics of find contexts of archaeobotanical samples.

from the cultural layers and charred PMR from the river bed in the ordination graph show that they are similar in composition and density to the samples from settlement pits from Mikulčice and floor modifications from Area 103 (DCA5). The similarity of the composition of PMR in cultural layers and fills of "standard" settlement features is understandable since their formation processes are closely linked to similar settlement activities. The similarity of samples of charred PMR from the river bed and the samples from cultural layers indicates that their origin can be sought in similar settlement activities connected with the deposition of waste.

The results of detrended correspondence analysis were also used to detect groups of samples that could be assigned to a specific crop or a certain combination of crops ([FIG. 31], DCA7). The size of the pie chart expresses the size of a given sample (the number of PMR). It is clear from the plot that both "rich" and "poor" samples usually contain a combination of more than two crops. It is possible to form more than ten combinations where a different share of the "main" cereals is characteristic [TAB. 16].

TAB. 16 | Mikulčice-Kopčany. Ratio of the combinations of groups of cereal species from DCA7. Captions: PM – millet, TA – bread wheat, HV – barley, SC – rye.

No	Group	Context No
1	most TA	3
2	same portion SC and TA	3
3	most TA + SC, 1/3 PM	5
4	most SC, 1/3-PM, TA	7
5	most Indet (no PM), 1/3PM	4
6	most PM, 1/3 TA, SC, HV	26
7	only PM	6
8	most PM + TA, 1/3-SC, HV	38
9	most indet (no PM), 1/3 PM, HV, SC, TA	16
10	mix – different proportion of all species	12

The most numerous are combinations where millet (PM) is the dominant crop and other cereals – such as bread wheat (TA), rye (SC), and barley (HV) – have a 1/3 of the millet proportion (Group 6). This combination is most often found in Area 103 (outer bailey) where it is documented in up to 62 % of the contexts observed. It is also documented in Kopčany in feature 1 in the excavation area of Kačenáreň and two unspecified contexts, three settlement pits from Area 88 (basilica) and a pit from Area 86 (palace). This combination of crops is documented to the same extent in the younger as well as the older horizon and occurs in sunken settlement pits, floor modifications and cultural layers.

The next most common is the combination where millet (PM) and wheat (TA) are evenly represented and the other cereals have a 1/3 share. It is documented in 12.5 % of samples distributed throughout the site. It is common in sunken settlement pits and in layers of the fortifications (wall Area 100, rampart Area 96, ditch Area 98) and is rare in Area 103. The analysis clearly shows that most of the combinations are composed of millet accompanied with other crops. Other combinations are scarce and no trend could be seen in their contextual or space distribution.

7.3.1 Wild plants – weeds or not?

To address the questions of arable farming practices and crop husbandry, it is necessary to specify, which species could have grown in the fields of early medieval Mikulčice and which could not. This is because various archaeobotanical papers have recently demonstrated that apart from plants that are considered field weeds today, some of the plants currently considered as meadow, forest, or ruderal could also have grown in the fields in the past (cf. BOGAARD 2004, VAN DER VEEN 1992).

The assortment of wild species from Mikulčice and Kopčany is very wide, both from the perspective of the species spectrum and method of preservation. Wild plant seeds could have entered the assemblages not only with crops but also via other economic activities such as the handling (and consequent burning) of hay, forest grazing (waterlogged and burned animal dung?), the collection of medicinal herbs, etc. Therefore, it was necessary to specify which species will be considered as crop weeds. An unpublished botanical record from fields (and gardens) with einkorn (*Triticum monococcum*) and other crops such as rye, oat, bread wheat, barley from Romania and Slovakia cultivated by non-mechanized traditional agricultural systems was used for the purpose of this classification (HAJNALOVÁ/DRESLEROVÁ 2010; Hajnalová/Eliáš unpublished data).

It is apparent from the correspondence analysis ([FIG. 31], DCA8) where botanical species were classified into "phytosociological" groups on the basis of given criteria, that the composition of individual samples/contexts is significantly mixed. Field weeds are accompanied in each sample by species from other plant communities such as meadow/pasture, forest and ruderal. Therefore, for the purposes of the following taphonomic analyses (see chapter 7.6.1 Method 1 – Weed seed categories and 7.6.2 Method 2 – Crop and weed seeds),

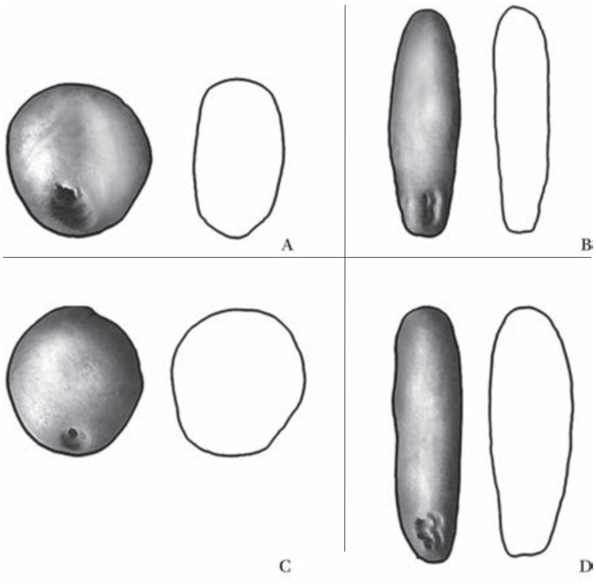


FIG. 32 | Schematic plot demonstrating the four basic seed types based on correlation of measured and calculated indexes of length and thickness. Captions: sector A – circular (round) and thin, sector B – elongated and thin, sector C – circular and thick, sector D – elongated and thick (on the left is the dorsal side, on the right the lateral cross section of the seed).

we have decided to use as weeds of all species classified in DCA8 as field weeds and also meadow and ruderal.

7.3.2 Summary of DCA

It has been demonstrated that the similarity or difference in species composition in individual samples and types of contexts in Mikulčice is caused mostly by the method of preservation (fire, water, and mineralisation), the settlement activities, and formative and post-deposition processes. The fact that samples from a particular feature/context are scattered and not concentrated in one part of the ordination diagram indicates that the remains of various settlement activities are present in each feature.

7.4 RATIO OF GRAIN LENGTH AND THICKNESS COEFFICIENTS[47]

7.4.1 Method

Only seeds that were undamaged, i.e. were not fragmented or destroyed in any other way (e.g. "puffed" up due to charring) were measured. Due to time limitations, we haven't measured the entire assemblage although suitable specimens were chosen [TAB. 32]. Species for measurements were selected on the results of the Wilcoxon two-sample test, which proved common millet, barley, rye and common wheat to be statistically significant crops. The measured assemblages include 10 % of seed finds of each species from each context, which were picked at random (blind selection).

7.4.2 Results

Cereal grains from 13 of the examined sites were measured, since two of the sites (KSM and Area 93) did not contain any undamaged seeds from the selected cereals. In total, **1,095** cereal grains were measured out of the total number of 7,497 (14.67 % of seeds were measured). The measured results were examined against the measurements taken by E. HAJNALOVÁ (1989), who also measured, inter alia, the Early Medieval finds from Slovakia. Her measurements were made in sites located mostly in south-eastern Slovakia. The results are assessed and presented via dependency graphs, where the variables are the measured length and width values (coefficients). These are then interpreted according to a chart [see FIG. 32].

The first assessed species was hulled barley. In total, 181 charred seeds of this species were measured out of the total number of 949 – 19.27 % [TAB. 17]. The measured grains come from all archaeological areas (acropolis, outer bailey, extramural area, and the periphery). The comparison of measured dimensions and counted coefficients proves that the barley grains from Mikulčice and Kopčany are generally smaller compared to barley seeds from the Early Medieval sites in Slovakia [TAB. 17, FIG. 33]. According to the length

47 See intention and utilized method description in the chapter 4.5.5 Method using the ratio of the indexes of grain length and thickness.

TAB. 17 | Mikulčice-Kopčany. The values and indices of dimensions of barley grains measured compared to finds from Slovakia. Captions: HVV – barley, M – Mikulčice, K – Kopčany.

Measured values HVV	M + K	Mužla-Čenkov	Pobedim
Max index of length	308	.	.
Min index of length	132	.	.
Average index of length	194	210	193
Max index of thickness	123	.	.
Min index of thickness	53	.	.
Average index of thickness	79	73	73
Max length (mm)	7.1	7.9	7.5
Min length (mm)	3.6	2.6	4.5
Average value of length (mm)	5.24	6.3	5.8
Max width (mm)	3.7	4	3.7
Min width (mm)	1.7	1.8	2.1
Average value of width (mm)	2.73	3	3
Max thickness (mm)	3.5	3.5	3
Min thickness (mm)	1.2	1.1	.
Average value of thickness (mm)	2.07	2.2	2.2

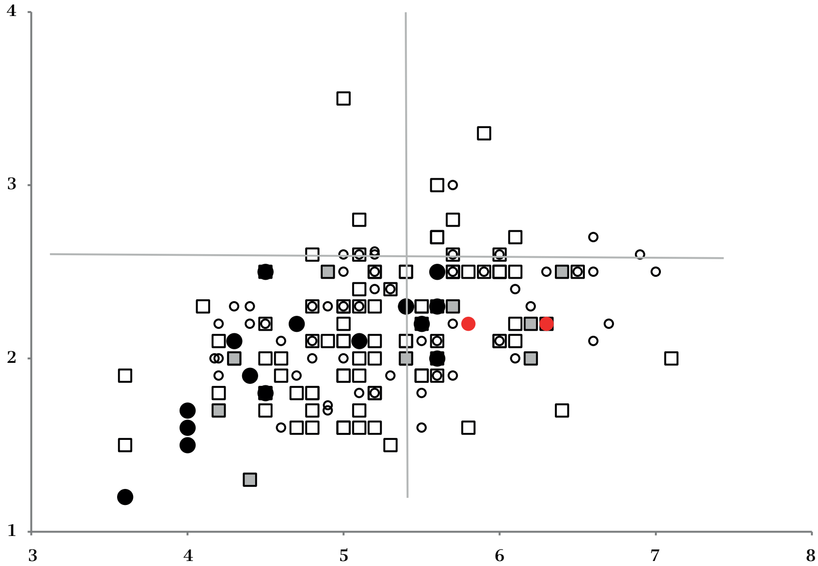


FIG. 33 | Mikulčice-Kopčany. The ratio of measured length (horizontal axis) and thickness of grains (vertical axis) of hulled barley (*Hordeum vulgare*) compared to the average values in Slovakia (SVK).

and thickness ratio of the seeds, the finds originating in Slovakia are concentrated in sector D, whereas the majority of finds from Mikulčice and Kopčany are concentrated in sector C. The sector C majority of measured barley seeds come from the periphery of the agglomeration.

For common millet, we measured 444 charred grains, which is 10.80 % out of a total of 4,108. The dimensions of millet grains from Mikulčice and Kopčany are similar, although not identical, to the finds from Slovakia. In general, it can be observed that the millet seeds from Mikulčice and Kopčany mostly consist of smaller (shorter) specimens [TAB. 18]. A graphical representation of millet seed measurements is not included – the sensitivity of the measurement tools used led to small deviations and the resulting graph was confusing.[48]

For rye, we measured 172 rye grains, which is 18.53 % out of 928 [TAB. 19]. Rye grains are also smaller than their counterparts from Slovakia [FIG. 34]. It is clear that the seeds of various shapes

48 For example, the common size of a millet seed is 2 mm, while the measurable deviations were maybe 1 mm. This difference would be impossible to determine in the graph, which would only serve to confuse the reader.

Measured values PM	M + K	Mužla-Čenkov	Prešov
Max index of length	166	.	.
Min index of length	0.003	.	.
Average index of length	111	113	146
Max index of thickness	121	.	.
Min index of thickness	0.003	.	.
Average index of thickness	84	69	94
Max length (mm)	2.5	2.0	2.1
Min length (mm)	1.1	1.2	1.6
Average value of length (mm)	1.8	1.8	1.9
Max width (mm)	2.2	1.9	1.9
Min width (mm)	0.9	1.5	1.3
Average value of width (mm)	1.6	1.6	1.7
Max thickness (mm)	1.9	1.5	1.8
Min thickness (mm)	0.8	1.0	1.2
Average value of thickness (mm)	1.3	1.1	1.6

TAB. 18 | Mikulčice-Kopčany. The values and indices of dimensions of millet grains measured compared to finds from Slovakia. Captions: PM – millet, M – Mikulčice, K – Kopčany.

Measured values SC	M + K	Mužla-Čenkov I	Mužla-Čenkov II	Čakajovce	Pobedim
Max index of length	366	.	.	.	.
Min index of length	135	.	.	.	.
Average index of length	240	243	267	208	248
Max index of thickness	143	.	.	.	.
Min index of thickness	57	.	.	.	.
Average index of thickness	92	90	86	100	74
Max length (mm)	7	6.7	7.3	6.1	8
Min length (mm)	3.2	4.2	3.6	4.1	3.6
Average index of thickness	4.91	5.1	5.6	5.0	5.7
Max width (mm)	2.8	2.6	2.8	2.5	3
Min width (mm)	1.2	1.5	1.3	1.5	1.6
Average value of width (mm)	2.06	2.1	2.1	2.4	2.3
Max thickness (mm)	2.7	2.3	2.6	2.8	2.7
Min thickness (mm)	1.3	1.5	1.2	1.9	1.2
Average value of thickness (mm)	1.86	1.9	1.8	2.4	1.7

TAB. 19 | Mikulčice-Kopčany. The values and indices of dimensions of rye grains measured compared to finds from Slovakia. Captions: SC – rye, M – Mikulčice, K – Kopčany.

and sizes are region-specific (Slovakia) or even area-specific (in the case of Mikulčice). The assessed length and thickness dimensions of rye seeds prove that the finds from Slovakia are mostly concentrated in sector D with the exception of one site (Čakajovce), which lies in sector B. The finds from the periphery (mainly from Kopčany) are in sector C. Cereal seeds from the acropolis, extramural area and outer bailey are scattered; however, most of them are concentrated in sectors A and B. The rye seeds are markedly absent in sector D.

The last assessed cereal species is bread wheat. In total, 297 charred wheat grains were measured, representing 19.57 % out of the total number of 1,517 [TAB. 20]. There are no significant observable differences between wheat finds from Slovakia, Mikulčice and Kopčany. They are parts of the same whole. There are also no significant differences between seeds from individual areas of the Mikulčice agglomeration. Wheat grain is mostly present in sector C. They are less frequently present in sector B. Other shapes are negligible [FIG. 35].

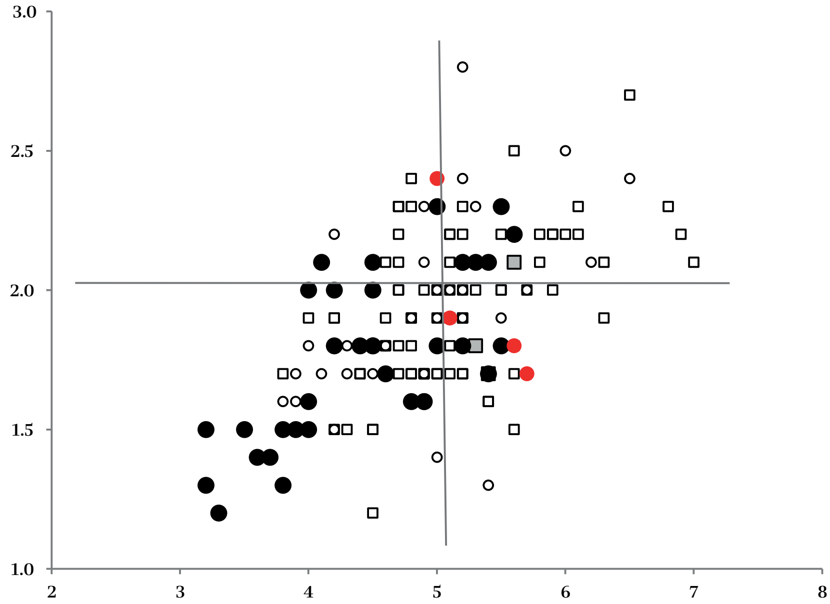


FIG. 34 | Mikulčice-Kopčany. The ratio of measured length and thickness of grains of rye (*Secale cereale*) compared to the average values in Slovakia (SVK).

Acropolis
Extra mural settlement
Outer bailey
Outskirts of the agglomeration
SVK

TAB. 20 | Mikulčice-Kopčany. The values and indices of dimensions of wheat grains measured compared to finds from Slovakia. Captions: TA – bread wheat, M – Mikulčice, K – Kopčany.

Measured values TA	M + K	Mužla-Čenkov	Čakajovce	Pobedim
Max index of length	220	.	.	.
Min index of length	100	.	.	.
Average index of length	146	162	148	176
Max index of thickness	117	.	.	.
Min index of thickness	48	.	.	.
Average index of thickness	78	77	77	72
Max length (mm)	6.1	5	5.7	5.9
Min length (mm)	2.6	3	3.4	4.8
Average value of length (mm)	4.29	4.2	4.6	5.1
Max width (mm)	3.9	3.9	4	3.1
Min width (mm)	1.9	1.6	2.3	2.5
Average value of width (mm)	2.96	2.6	3.1	2.9
Max thickness (mm)	3.2	2.5	3	2.7
Min thickness (mm)	1.6	1.5	1.9	1.9
Average value of thickness (mm)	2.27	2	2.4	2.1

7.4.3 Summary of the ratio of grain length and thickness coefficients

In assessing the results of the three basic dimensions measured (length, width and thickness) in cereal seeds, we can assign each individual species assemblage into a notional quadrant according to the length coefficient compared to width, which serves to differentiate between the seeds of various sizes and shapes.

The results show that the majority of barley and rye seeds are long and thin (sector B) and small and wide (sector C). While the latter grains are mostly from the periphery areas, long and slender (thin) seeds (B) are mostly from finds originating in the Mikulčice areas (the acropolis and extramural area). The finds from Slovakia measured by E. Hajnalová (1989) are usually long, wide and thick seeds (sector D). It is surprising that similar finds are only rare in the Mikulčice acropolis, where the presence of the largest seeds and probably those of the highest quality (?) as far as nutritious matter is concerned, would be expected.

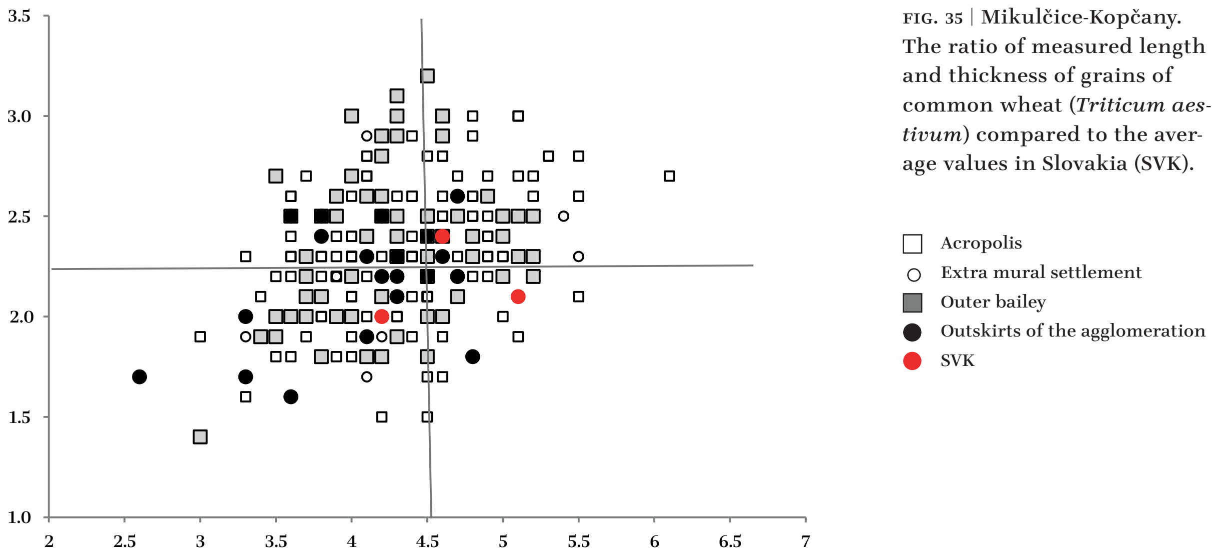


FIG. 35 | Mikulčice-Kopčany. The ratio of measured length and thickness of grains of common wheat (*Triticum aestivum*) compared to the average values in Slovakia (SVK).

The results for bread wheat are specific. These are scattered in all the sectors in equal measure (with the exception of sector D) and we are unable to determine a dominant type (long/short, wide/thin). This is true for individual areas of Mikulčice and the sites in Slovakia. It is also worth noting that all the finds from Slovakia, Mikulčice and Kopčany are very similar.

To summarise, when comparing the finds from Slovakia, Mikulčice and Kopčany, we observe that the cereal grains from Slovakia are generally larger. This could indicate that the cereals from the Slovak sites were cultivated in soil of a higher quality with a more ideal moisture regime, temperature and pH. This conclusion is also supported by the fact that most of the finds originate in the Danubian Lowland (such as Čakajovce) with soil that can be considered highly fertile under a certain climatic regime (however not always, Hajnalová 2012, 156). In crops cultivated in suitable conditions, the size of the seed grows, while crops cultivated in less than ideal conditions yield smaller seeds (Čvančara 1962, 728). The environmental conditions, however, can be influenced to a certain degree by the application of suitable arable farming practices (irrigation, fertilisation, hoeing etc., Bogaard 2004). Aside from these factors, clustering of the finds from sites or regions on the basis of measurements of grains might indicate use of local seeds or landraces (E. Hajnalová pers. comm.). If this is true, use of local or "own" seed for both consumption and sowing could be assumed in all the examined areas of Mikulčice.

In the archaeobotanical material from the early medieval stronghold of Nitra Castle and the surrounding open settlements examined by E. Hajnalová and M. Hajnalová (2008), the authors documented the relationship between the size of the seeds found and the site of origin (Hajnalová/Hajnalová 2008). Large cereal seeds were more often found in the Nitra Castle itself. For rye and barley grains, this trend was, to a certain degree, also documented in archaeobotanical assemblages from Mikulčice and Kopčany.

7.5 PRODUCTS AND BY-PRODUCTS AND TAPHONOMIC ROLE OF CROP PROCESSING

When reconstructing the economy of a site and the economic activities that taken place there, it is necessary to understand the origin of the sample – whether it was a final product (e.g. stored grain), or a by-product or waste from one of the crop processing stages.

The charred plant remains from archaeological contexts most commonly contain the remains of cereals and weeds that grew with them in a field. This is because these commodities are usually present in settlements in large quantities – as food or fodder supply or waste from processing and because they also have a higher chance of coming into contact with fire, such as during cooking or baking, or during accidental fires (Jones 1984, 1990, Bogaard 2004, Fuller/Stevens 2009). Other types of crops like legumes, which are cooked in water, are usually much rarer (Kočár et al. 2010). Seeds from other wild species that are the result of different settlement activities, such as handling and storing of hay or animal fodder, or the gathering and storing of fruit and vegetables can also be present.

These are usually rare in charred assemblages and much more common in waterlogged sites, nevertheless it needs to be assessed which species were or were not possible weeds (see above).

At present, there are several taphonomic methods or models to classify and identify the origin of samples, based mostly on ethnographic observations (cf. Hillman 1984; Jones 1984, 1990; Fuller/Harvey 2006).

To obtain the final product – cleaned grain – the harvested crop has to be processed. It has been ethnographically attested that the crop processing of free-threshing cereals such as free-threshing wheat, rye and barley[49] has eight basic stages. During the process [fig. 36] in each stage, waste is separated from the "intermediate" product which is then treated further. The chaff and the weed seeds are filtered out and cleaned grain (product) is obtained. Since there are only very minor deviations in the process worldwide (cf. Hillman 1984; Jones 1984; Fuller/Harvey 2006), these models can be applied to archaeology when the methods and technologies used in traditional agriculture and the studied period are supposed to be very similar or identical. This rule does apply to the Early Medieval period.

The processing of free-threshing cereals and legumes is different from the processing of millet. The main difference is that in millet, the same as in glume wheat, there is one extra step – dehusking. This is necessary in order to release the seed from the glumes. After dehusking, additional winnowing is necessary, in which the chaff is separated from the grain and the final product, the clean grain, is obtained [fig. 37].

It is important to stress that products and by-products (waste) from different stages of the process do not have the same chance of being archaeologised. The final product (stored grain) or the waste from cleaning (weeds with size and shape similar to grain) have the highest chance of being preserved by charring. This is mostly because the grain is stored in large quantities for a long period of time and thus can be burned in accidental fires. Also, cooking by baking or drying the grain in kilns increases its chances of carbonisation. Winnowing and sieving by-products have a chance of being preserved by charring if the harvest is processed (threshed, winnowed, sieved) at the settlement, or if they were imported and stored there. By-products rich in chaff and weeds could be used as animal fodder, or as a temper for daub or ceramic paste. Intermediate products that are subsequently processed further are short-lived and thus would be missing in archaeobotanical assemblages.

To compare and assess the samples and sample assemblages from various areas of the Mikulčice stronghold, we have to understand their nature and origin. We also need to reconstruct the economic activities that took place in each area and interpret the economy of the site as a whole; it is necessary to determine whether the samples represent the final products or the processing waste and whether the by-products come from the earlier or later stages of crop processing.

To determine the origin of the samples from Mikulčice and Kopčany, two methods a taphonomic analysis were conducted with each monitoring and assessing different entities and qualities.

7.6 TAPHONOMIC ANALYSES

To assign the samples to the product or by-products of individual stages of crop processing, two methods were used. Method 1 is based on the relative abundance of the seeds of wild species categorised according to the physical properties of the seeds. Method 2 combines part of the observations from method 1 with information about the weeds and crop finds ratio in individual samples.

7.6.1 Method 1 – Weed seed categories

This method is based on ethnographic observations of traditional non-mechanised crop processing studied at Amorgos Island in Greece (Jones 1984). Its advantage is that it does not use specific plant species, but instead, artificial weed seed categories relevant to the behaviour of the seeds during the crop processing. These categories can also include species that are found outside of Greece. The method is based on the presumption that the seeds of wild species with specific physical properties (which can be considered to be a statistical determinant) will be eliminated in different stages of the crop processing. Based on the occurrence and mutual ratio of the seeds of these categories, it is then possible to determine the processing stage that the sample probably originated from (Jones 1984).

The individual categories were created based on a combination of the relevant characteristics:

- *seed size* – differentiates the samples from fine sieving as the small seeds fall through a fine sieve (with the waste) and the large seeds stay in the sieve along with harvested crops (and enter further processing).

49 Millet processing consists of different post-harvest processing steps than in naked-grain crops.

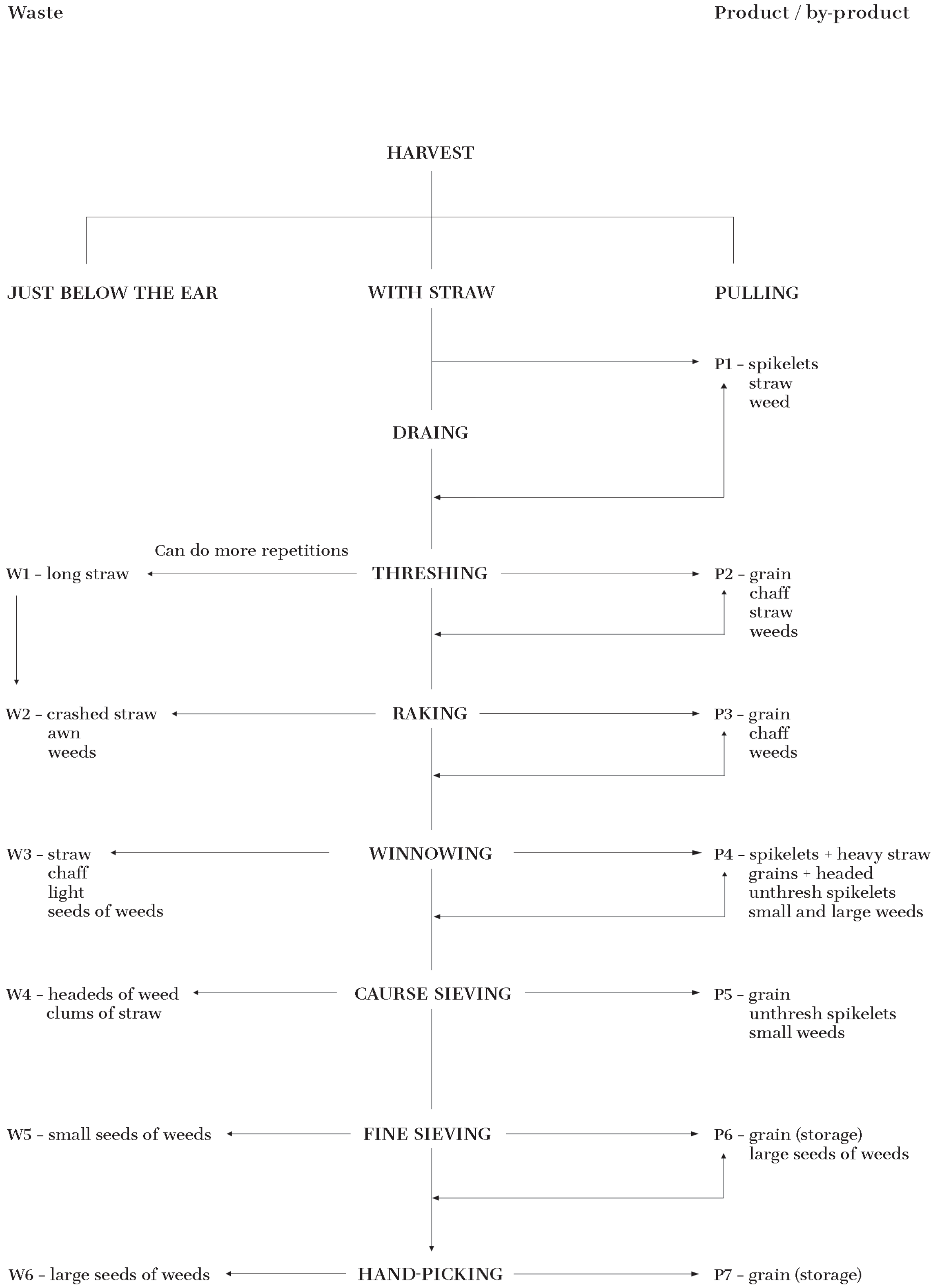


FIG. 36 | Crop processing of free-threshing cereals. Captions: 1–10 – Stages of the crop processing. P1 to P7 – Products, W – Waste (Modified; based on Hajnalová 2012 and Fuller/Harvey 2006).

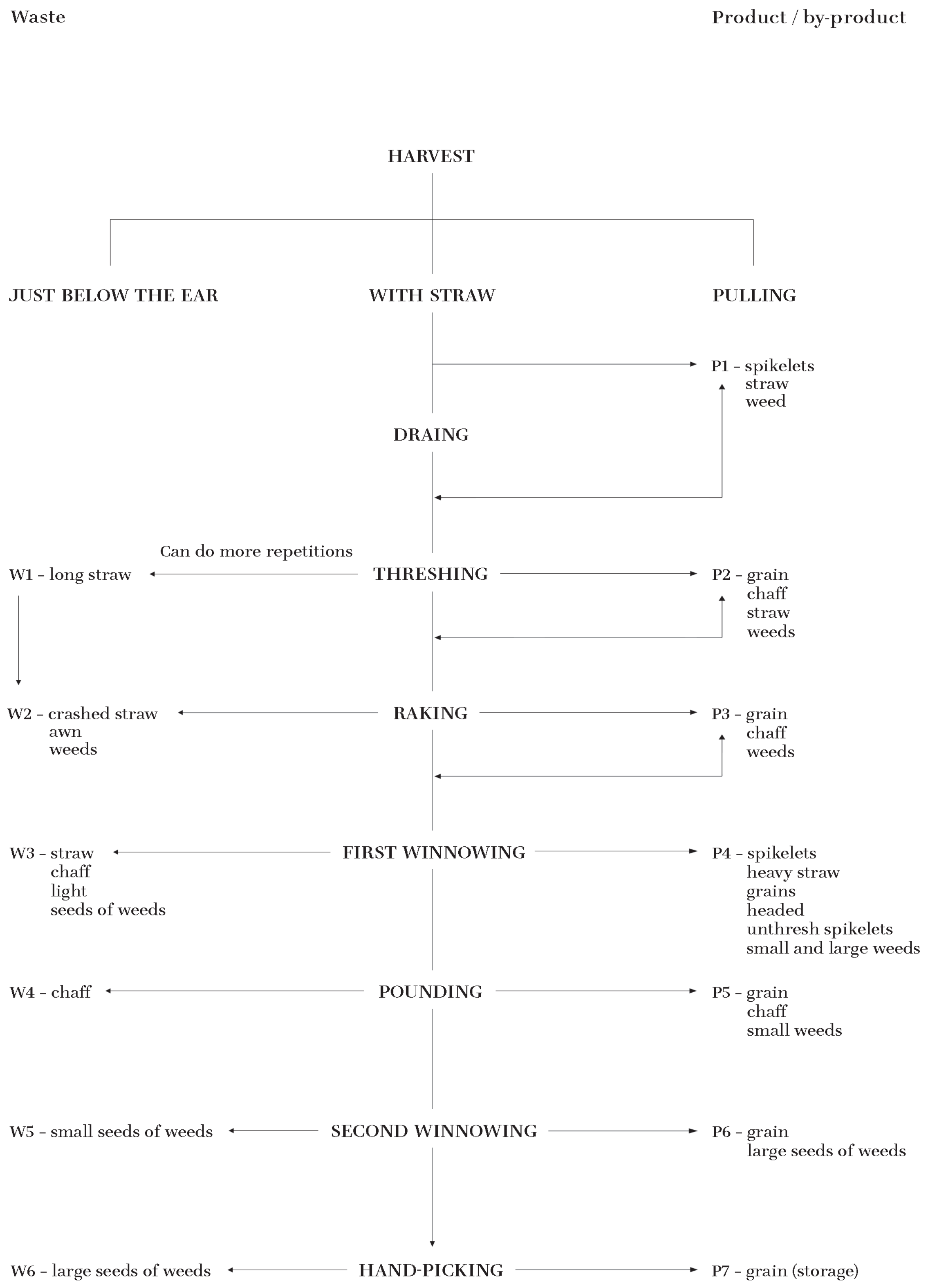


FIG. 37 | Crop processing of millet. Captions: 1–10 – Steps of the crop processing. P1 to P7 – Products, W – Waste (Modified; based on Hajnalová 2012 and Fuller / Harvey 2006).

Area	Waste from winnowing Σ	Waste from course sieving Σ	Waste from fine sieving Σ	Products Σ
KSM	.	.	2	.
KAČ	.	.	6	.
AR 86	.	.	5	3
AR 88	.	.	1	3
AR 89	.	.	1	.
AR 90	.	.	.	1
AR 95	.	.	.	2
AR 96	.	.	2	2
AR 97	.	.	2	.
AR 98	.	.	3	2
AR 103	.	.	12	4
AR M17	.	.	1	1

TAB. 21 | Mikulčice-Kopčany. Characteristics and information on the classification of samples in method 1.

- *tendency to remain in "heads" or clusters* – helps to differentiate waste from coarse sieving as the large compounds stay in the sieve (with the waste) while loose seeds fall through with the intermediate product.
- *aerodynamic qualities of the seed* – combines size, shape and presence (or lack) of features such as pappus, wings or hairs – helps determine winnowing waste, as the "light" seeds and the seeds with "wings" are carried away by the wind.

The categories combining these properties are labelled with three-letter acronyms where the first letter determines the size (B – *big*, S – *small*), the second the ability to stay in compound fruit (H – *headed*, F – *free*) and the third the aerodynamics of the seed (H – *heavy*, L – *light* [TAB. 33]).

Using these categories, the weed seeds are eliminated in the following order during the individual stages of the crop processing:

- Harvest – all types are present
- Threshing – all types are present
- Winnowing waste – SFL
- Coarse sieving waste – SHL, SHH, BHH
- Fine sieving waste – SFH
- Manual sorting of the final product – BFH

When using this method, a properly prepared archaeobotanical data matrix based on identified and classified wild species is confronted with the original ethnographic data matrix in a two-step Discriminant Analysis [FIG. 38].[50]

50 I would like to sincerely thank G. Jones (Sheffield) and A. Bogaard (Oxford) for the ethnographic data matrix and M. Hajnalová for the discrimination function.

According to the function based on an ethnographic model, archaeological samples are classified into four major groups: waste from winnowing, waste from fine sieving, waste from coarse sieving and storage.

Other advantages of this method are that it does not work with information about crops, and/or the information of the number of PMR. As the numerical data are transformed during the data preparation it can be applied equally well to samples with high or low numbers of PMR. It also identifies unusual or potentially contaminated samples (JONES 1987; for Kopčany see LÁTKOVÁ 2014a). This method, however, can only be used for samples that contain more than 11 seeds of wild species.

7.6.1.1 Application of method 1

The analysis included, like in analyses DCA3–8, only samples with charred PMR. In some cases, the "sample" represents a set of more samples, which were combined prior to this analysis, based on their composition and the context they come from. Therefore, even samples/contexts which would not be included in the analysis if evaluated individually were incorporated. The final analysis has been conducted on 50 samples/contexts (40.16 %).

Discriminant analysis was conducted on several matrixes of data: 1) using the basic data, i.e., the individual samples that were not combined; 2) using the samples combined according to contexts; 3) using only the species that are nowadays considered field weeds, and 4) using the species which are nowadays considered to grow in fields, meadows and ruderal communities. [51]

51 They always appear together with crops and behave in the same way as field weeds in the DCA analysis.

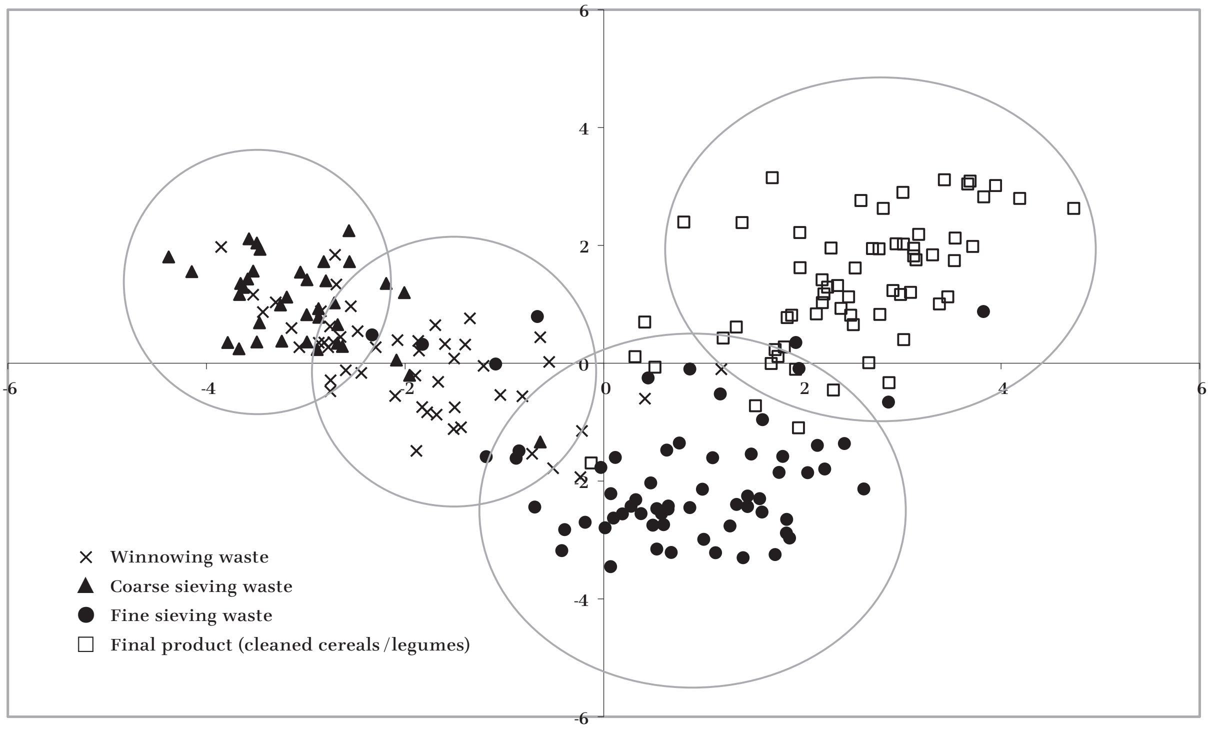


FIG. 38 | Discrimination analysis of samples of recent plant material from different processing phases using ethnographic data from the Greek island of Amorgos (JONES 1984). The circles mark the occurrence of individual sample groups.

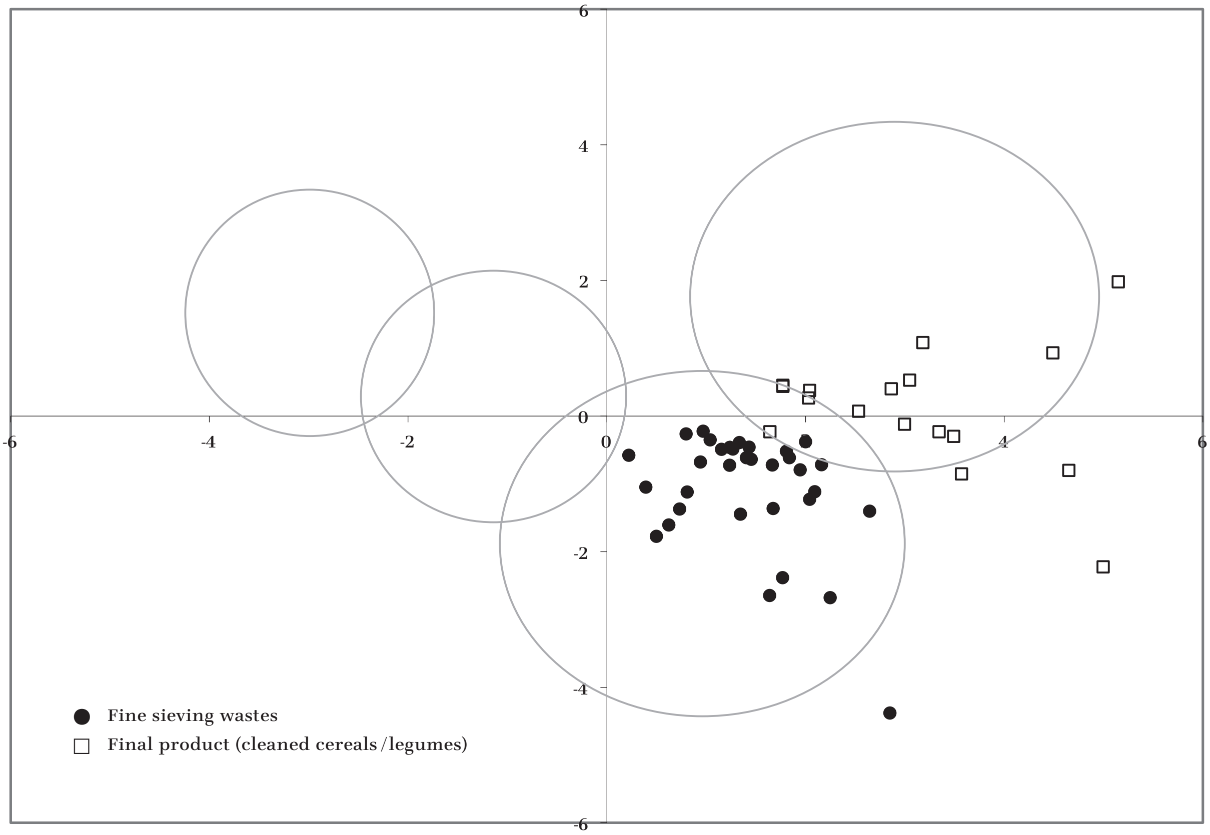


FIG. 39 | Mikulčice-Kopčany. Classification of Early Medieval samples in a discriminant analysis where ethnographic data serves as control variables.

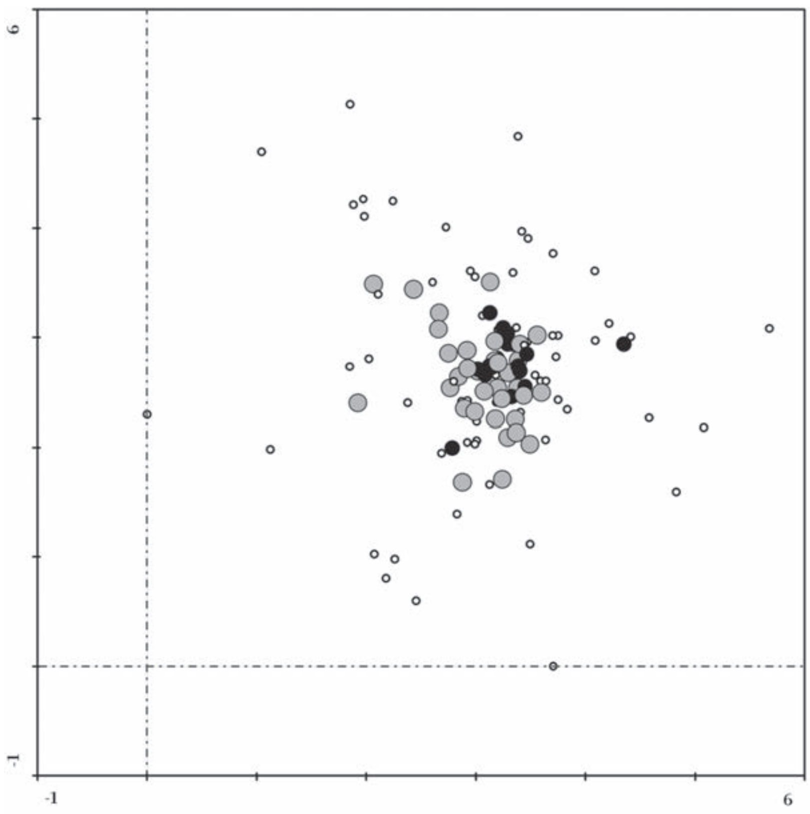


FIG. 40 | Mikulčice-Kopčany. Detrended correspondence analysis of charred assemblages using information on density of wild plants DCA9 plots the samples according their classification by the discriminant analysis, method 1.

7.6.1.2 Results of method 1

There were no significant differences between the results of the four analyses mentioned above. However, the application of samples combined according to context was found to be more optimal as a balanced representation of "rich" and "poor" samples was reached. The analysis [FIG. 39] is presented that uses combined contexts and seeds of plants from fields, meadows and ruderal communities. In all cases, the samples were always classified only into two categories – waste from fine sieving (here 22 samples), and the final product (here 28 samples [TAB. 21]). The low proportion of the samples was classified differently in various analyses.

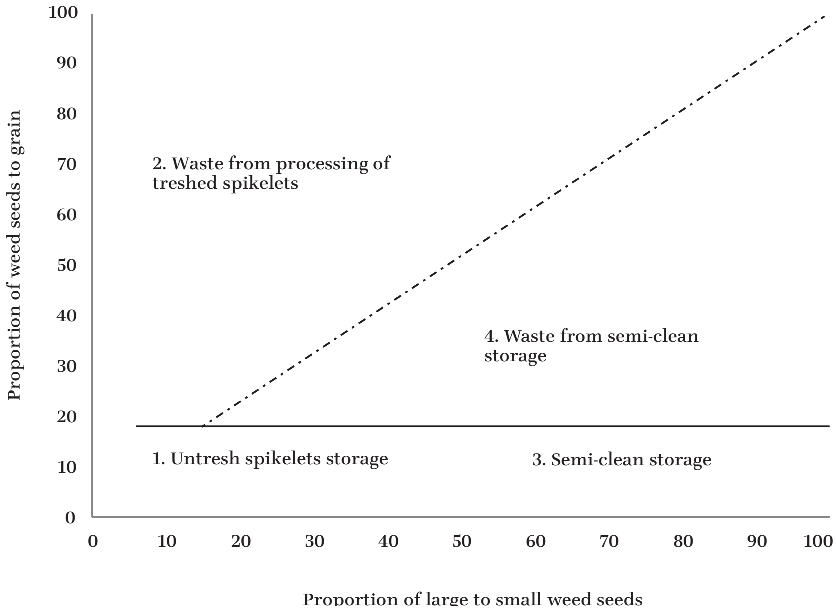
7.6.1.3 Summary of method 1

The results of this method show that the samples from the Mikulčice stronghold represent only the final stages of the crop processing. All samples were classified as either waste from fine sieving or final products (cleaned grain). The problem with this method is that in the case of the final product, the method does not distinguish between the "grain storage" itself in which the "big" seeds of weeds are still present, or if it is those "big" seeds thrown away. This can be, however, determined when combining the results with the ratio of weeds and crops in the given sample/context. The large proportion of crop seeds in those samples shows that these represent the final product and not the waste from its cleaning.

The contexts classified as the final product (cleaned grain) are most frequently located in areas inside the acropolis (Area 86, 90, 95, 97 a 98), and in most cases are from pits in the "early" phase preceding the construction of the churches [FIG. 40]. Among the samples from the outer bailey (Area 103), only 13 contexts from the floors and cultural layers out of 53 were classified as final products. Apart from the acropolis and the outer bailey, the final products were also found in the extra-mural settlement (Area 89), although in smaller numbers. Samples and contexts from unfortified peripheral parts of the agglomeration in Kopčany (KSM and KAČ) and Mikulčice-Trapíkov (Area M17) were usually classified as waste from fine sieving (compare DCA9 with DCA5).

No samples were classified as waste from the earlier phases of the crop processing (winnowing and coarse sieving) from any of the analysed areas in the agglomeration.

Fig. 41 | Wastes and products from early and late crop processing phases based on correlation of the proportion of the seeds of cultivated crops and the categories of field weeds (after FULLER / STEVENS 2009; HAJNALOVÁ 2012, 106).



7.6.2 Method 2 – Crops to weed seeds

Unlike the previous method, this also takes into account the information about the amount of crop seeds in the samples. It is also based on the observation that undesirable impurities (chaff and weed seeds) are removed gradually during the crop processing. D. Q. FULLER and C. J. STEVENS (2009) pointed out that the proportion of weed seeds gradually decreases from one to the next stage of processing. Samples from the initial phases would contain the largest proportion of weed seeds, while in the samples from the final phases of processing, crop seeds would prevail. Also during the process, small weed seeds are "filtered" away in earlier phases, while weed seeds of a size similar to crop seeds can still be found in the final product. The proportion of small and large weed seeds is, therefore, a sensitive indicator of a stage of crop processing. Archaeological samples from the initial phases of processing would contain a large proportion of small weed seeds and fewer crop seeds while in samples from the final phases, there would be more crop seeds and large weed seeds would prevail.

D. Q. FULLER and C. J. STEVENS (2009) tested this hypothesis on various assemblages of archaeological samples. They visualised the result with a simple scatter plot. According to them, it is possible to separate the samples with higher proportions of weeds in particularly small weed seeds (these samples would represent waste from the processing of unprocessed or partially processed crop) and the samples containing more crop seeds and large weed seeds (waste from cleaning the "cleaned" store). This was extended by M. HAJNALOVÁ (2012, 106, Obr. 32) who added two other groups consisting of products (or "stores") – an unprocessed or only partially processed "semi-cleaned store" and a relatively well "cleaned store". The semi-cleaned product would contain 100 % to 90 % of crop seeds and more than 50 % of small weed seeds. The second group contains an equally high proportion of crop seeds while there are more than 50 % of large weed seeds. This is why the samples of products are located in the bottom part of the graph. Point 0 represents fully cleaned storage that contains only crop seeds [FIG. 41].

7.6.2.1 Application of method 2

Only samples containing over 40 charred crop seeds or "field" weeds were analysed. Similarly to the previous method, weeds that were classified in DCA8 as field, meadow and ruderal types were used. This method was also applied to four different matrices as in method 1. The results presented here represent the application of samples combined according to context with the use of field, meadow and ruderal types of weeds [TAB. 33]; 67 contexts were analysed (53.51 %).

7.6.2.2 Results of method 2

The results of the analyses of all the different matrices were, similarly to the previous method, almost identical. Most of the samples are again

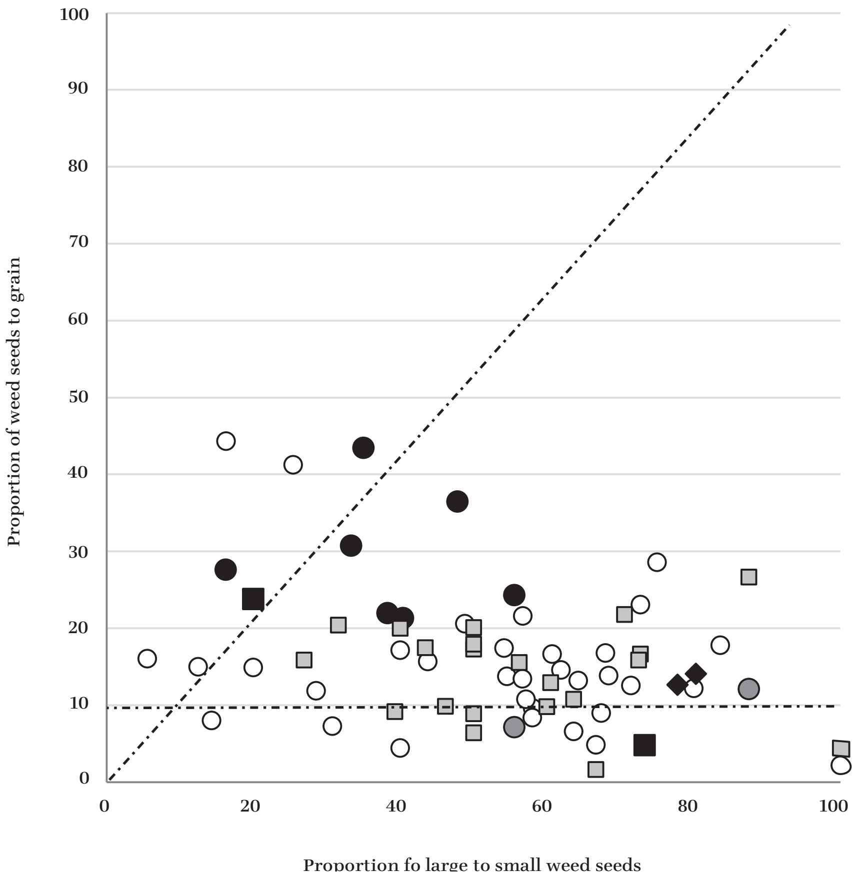


FIG. 42 | Mikulčice-Kopčany. Samples according their origin in terms of excavated areas.

classified as coming from the later phases of crop processing [FIG. 42]. The results are similar for both individual and combined samples. In the second analyses, it was possible to also include also areas that could not be evaluated individually.

Eleven contexts were classified as “clean” product, which contains less than 10 % of weeds from which over 50 % are large weed seeds (samples situated in the very bottom right corner of the graph). This category contained contexts from all researched areas with the exception of Kopčany. Six samples were classified as uncleaned (unthreshed and/or unwinnowed) product which has less than 10 % of weeds, and over 50 % of small weed seeds (the very bottom left corner of the graph). “Uncleaned” products come from 3 samples from the acropolis and 3 (4) samples from the extra-mural settlements. Most of the samples were classified as waste from cleaning the “clean” product. These are situated in the right part of the graph and contain less than 10 % of crops and over 50 % of large weed seeds. Contexts in this category come from all areas. The last category – waste from “semi-cleaned” product – contains 7 contexts. These come from Kopčany (two contexts), Mikulčice-Trapíkov (one context) and from the acropolis (four contexts). The proportion of weeds in the samples is, however, lower than 50 %. It is therefore possible to classify them as residues of “cleaned” and “uncleaned” product. It was not possible to include samples/contexts from Area 91 in the analysis as there were not enough finds of PMR [TAB. 22].

7.6.2.3 Summary of method 2

This method produced different results than the previous method. Samples were classified not only as originating from later crop processing stages but also as waste from the initial phases of processing or “uncleaned” products. Still, the majority of the samples were classified as waste from cleaning the final products or the final product itself. Only a few samples were classified as waste from the cleaning of the “uncleaned” or partially processed crop (e.g. unthreshed ears). It is interesting that residues from both early and later processing stages were located both in the peripheries (KAČ and Area M17) and the acropolis of the stronghold (Area 88 and 96). It is also important that contexts classified as waste from “cleaned” product are mostly located in the secondary contexts/areas.

TAB. 22 | Mikulčice-Kopčany. Characteristics and information on the classification of samples in method 2.

Area	Storage of untresh spikelets Σ	Semi-clean storage Σ	Waste from the processing of treshed spikelets Σ	Waste from semi-clean storage Σ
KSM	.	.	.	1
KAČ	.	.	2	4
AR 85	.	.	.	1
AR 86	.	.	.	9
AR 88	.	1	1	2
AR 89	.	.	.	1
AR 90	.	.	.	1
AR 93	.	1	.	1
AR 95	.	3	.	.
AR 96	3	3	1	3
AR 97	.	.	.	2
AR 98	.	.	2	2
AR 100	.	.	.	1
AR 103	2	5	.	13
AR M17	.	1	1	.

7.6.3 Chi-square goodness of fit test[52]

7.6.3.1 Method application

To determine if there is a relation between the size of weed seeds from Mikulčice and Kopčany and their place of occurrence, the goodness of fit test was used. The tested feature is the amount of large and small weed seeds, and the tested areas are those in close or distant proximity to the central part of the Mikulčice stronghold. Areas from the acropolis, the outer bailey and the extramural settlement are considered "central" and are marked as **O**, and those located further from the centre, are considered peripheral (Kopčany KSM and KAČ and M17 Mikulčice-Trapíkov) and marked as **M.** [53]

The tested null hypothesis H_0 is: Both types of samples come from the same basic assemblage, i.e. there is **no** statistically significant difference between the tested groups **O** and **M** in the observed features (numbers) of large weeds.

The null hypothesis was tested against the following alternative H1 hypothesis: Samples do not come from the same basic assemblage, i.e. there is a statistically significant difference between the tested groups **O** and **M** in the observed features (numbers) of large weeds.

The null hypothesis for the observation of small weeds can be formulated in the same way – only the observed feature will be replaced by a different unit observed.

7.6.3.2 Method results

Values tested are presented in a data matrix [TAB. 23]. This data was used in the statistical chi-square test and evaluated in a statistical program.

The value of the chi-square test for the statistical testing (proving/rejecting the null hypothesis) of the place of occurrence of small and large weeds is 19.733 and the probability value is p = 0.00000891 with the number of degrees of freedom equal to 1. As the calculated probability value is $p < 0.5$, the hypothesis H_0 is rejected with the significance level $\alpha = 0.01$. This means that observed differences are statistically significant, and the place of occurrence does influence the values (presence) of large and small weeds, or more precisely, the amount of large and small weed seeds (values or quantity of observed units) found in the central fortified area is statistically significantly different from their occurrence in the peripheral parts. Based on this fact, it is possible to claim that the difference between the observed frequency counts is too high to be just a consequence of random sampling, and is therefore statistically significant.

52 For the description of the method see chapter 4.5.4 Chi-squared goodness of fit test x^2.

53 The abbreviations of areas in this analysis are the same as in the Wilcoxon signed-rank test (see the chapter 4.5.3 Wilcoxon two-sample test method).

7.6.3.3 *Summary and interpretation of the chi-square goodness of fit test*

The post-harvest processing, as described in the chapter 7.6 Taphonomic analyses, causes the elimination of weed seeds and other "impurities" from the harvested crops. The proportion of large and small weed seeds during this process is perceived as an indicator of the farming activities. Samples which come from the earlier stages of processing (winnowing and coarse sieving) contain a high proportion of small weed seeds. Samples from the final phases of processing should then contain only large weed seeds, or at least their proportion should be higher (see the chapter 7.6.2 Method 2 – Crops to weed seeds).

It was statistically proven that the relationship between the proportion of large (and/or small) weed seeds in archaeobotanical samples is not random and that the presence of small weed seeds is typical of locations more distant from the centre while a higher proportion of large weed seeds can be found in the central part of the area. According to the test, this distribution is not a consequence of random distribution and selection of the PMR assemblage – but there is a definite regularity.

7.6.4 Summary of the taphonomic analysis

The aim of the taphonomic analyses was to identify the origin of archaeobotanical samples in the assemblages from various areas of Mikulčice and Kopčany. Two methods were used. The results complement each other because they work with different variables and are based on different principles. The first method, which works only with arable weeds (charred field seeds and also meadow and ruderal taxa) discovered only one category of waste, i.e. waste from fine sieving. All the other observed units were classified as the final products. The proportion of crops and weeds in these "products" suggest they represent residues from the crop (or its store) before the final cleaning by hand. Waste from fine sieving and waste from hand-sorting the final product were located mostly in the areas of Kopčany or in secondary contexts (e.g. fortifications, graves). Waste from hand-sorting – removing large weed seeds from the "clean" grain before consumption was found to a similar extent in both the "older" (pits in the superposition of churches) and "younger" phase of occupation in Mikulčice (Area 103). Completely cleaned products, **preserved in situ**, usually have a high average density of finds and this can often be noticed visually during the excavations. In the analysed sediments from Mikulčice and Kopčany, there were no concentrations of crop seeds recognised, and the calculated density of finds in the individual samples does not indicate the presence of such finds.

TAB. 23 | Mikulčice-Kopčany. Matrix of data based on the chi-squared test aimed at the testing of the impact of large and small weeds on the fortified area of the Mikulčice stronghold and its peripheries.

Areas	big weed	small weed	SUMA
M	192	274	466
O	919	822	1741
SUMA	1111	1096	2207

The results of the taphonomic analyses (method 1 and 2) show that in the fortified areas of the acropolis, the outer bailey and in Mikulčice-Trapíkov there were residues of cleaned storage, waste from cleaning and waste from the fine sieving. In Kopčany, only waste from fine sieving was present in both areas.

It is important to stress, that crop processing waste – containing various proportions of chaff, straw (and weed seeds) – can be left in the fields, fed to the animals, and used as temper in daub or pottery. Chaff and straw can also burn without any trace. This can lead to a loss of part of the information and it can cause erroneous interpretation. The final evaluation of the results from the archaeobotanical taphonomic analysis should, therefore, be confronted with other types of archaeological evidence, e.g. study of daub, especially the character of the ingredients of the clay, and archaeozoology (species spectrum, abrasion of teeth, isotope analyses).

7.6.5 Discussion of the results of the taphonomic analysis in a supraregional context

The aim of this chapter is to find out if the results of taphonomic analysis of the samples from the agglomeration of Mikulčice are specific or if the observed trends are typical for the whole early medieval period in Bohemia and Slovakia – more precisely for sites which have a "central character". For this purpose, archaeobotanical assemblages (Dreslerová et al. 2013; Hlavatá 2008; Hajnalová, unpublished data)[54] from various early

54 I would like to thank M. Hajnalová for kindly providing me with unpublished data from Moravia and Slovakia.

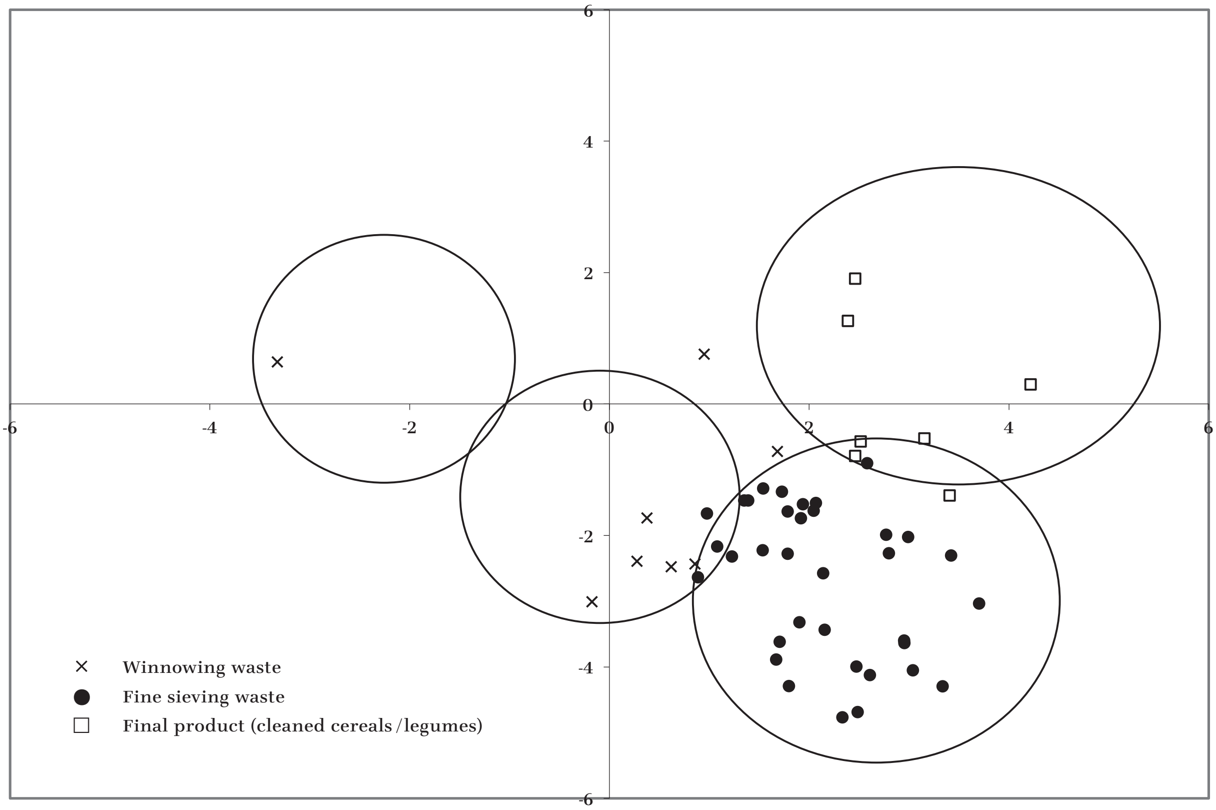


FIG. 43 | Discriminant analyses and classification of Early Medieval assemblages from Moravia and Slovakia using ethnographic model/data from the Greek island of Amorgos (JONES 1984).

medieval sites were evaluated using identical taphonomic analyses. The evaluated assemblage contained 22,902 finds of crop seeds and weeds from 237 samples from 10 sites [TAB. 24].

The evaluated samples come from the sites in north and the south Moravia and south-west Slovakia and from the Great Moravian fortified centres/strongholds (Bíňa, Devín-Hrad and Nitra-Palánok) and open rural settlements (e.g. Brankovice, Slavonín and Topolany). Samples dated from RS2 to RS4.

Method 1 was applied to the analysis of 50 samples which met the criteria (3,531 charred seeds from 128 weed species). They came from all the sites except for Kostice-Zadní hrúd, RS3 phase which did not have the sufficient number of PMR.

The results of the discriminant analysis of this assemblage [FIG. 43] differ from the Mikulčice stronghold. Eight samples (16 %) were classified as waste from the winnowing stage, absent in Mikulčice. Contrary to the results from Mikulčice and Kopčany, most samples are classified as waste from fine sieving (35 samples, 70 %) while the amount of samples classified as final products is substantially lower (7 samples, 14 %). Samples from coarse sieving are missing.

The distribution of individual types of waste and products (cleaned grain) in the assemblage from Mikulčice differs from their distribution in other sites [FIG. 44].

When comparing assemblages from individual sites [TAB. 25], it is clear that if there are final products (cleaned grain) found on the site, there is also waste from the early stages of crop processing – winnowing and fine sieving (Kostice-Zadní hrúd, RS4, Nové Zámky and Devín-Hrad). The only exception is the site of Nitra-Palánok where the early stages are missing. Waste from fine sieving not accompanied by other products is found in Brankovice, Hurbanovo and Bíňa.

There is no clear trend in data from Slovakia and south Moravia, which could be attributed to the time factor or the character of the site. In general, the samples from the earlier and later stages of crop processing were found in RS2, RS3 and R4 and were also discovered to an equal extent in open settlements and in the strongholds.

Method 2 could be applied to more samples. The criteria for the inclusion were met by 64 samples – 18,814 charred PMR, 11 taxons of crops (both cereals and legumes) and 125 taxons

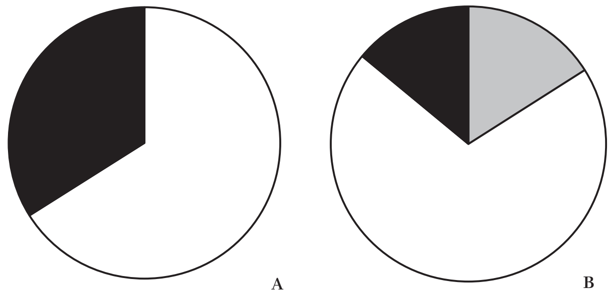


FIG. 44 | Proportion of the products classified in method 1 as wastes and final product in the assemblage from the Mikulčice agglomeration (A, n = 53) and from other Early Medieval sites (B, n = 50).

TAB. 24 | Basic information on the archaeobotanical samples used for comparison with the material from the Mikulčice agglomeration.

Area	Samples Σ	PMR Σ	Dating
Kostice-Zadní hrúd	25	215	RS3
Kostice-Zadní hrúd	123	5952	RS4
Topolany	4	59	RS3
Slavonín	6	38	RS3
Brankovice	25	374	RS3
Hurbanovo	2	64	RS2
Bíňa	7	794	RS2
Nové Zámky	26	9060	RS2
Devín-Hrad	8	2442	RS3
Nitra-Palánok	1	505	RS3

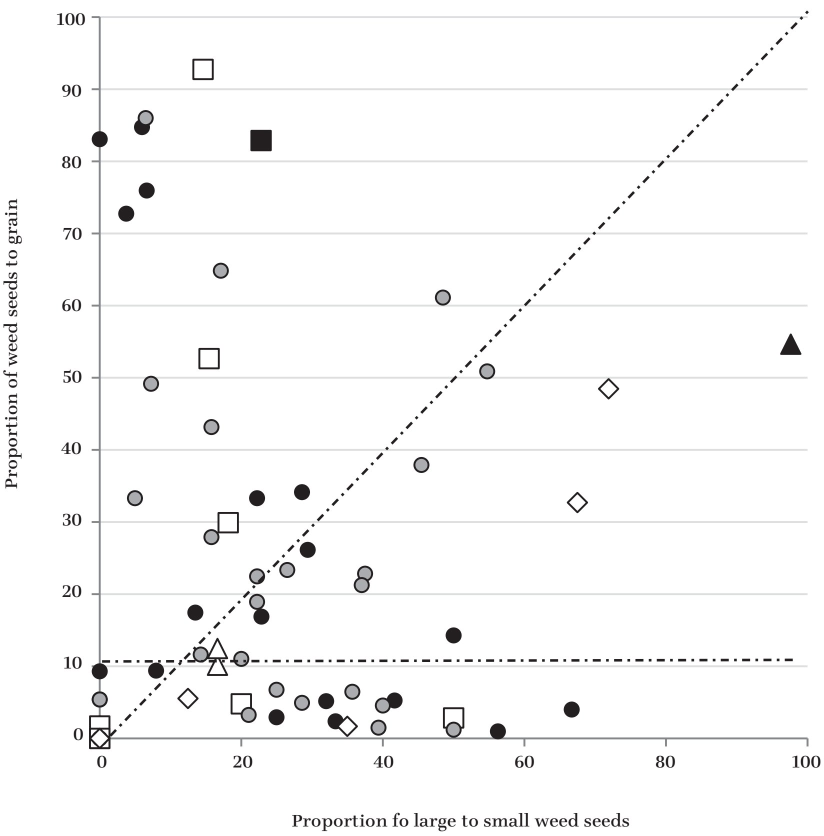


FIG. 45 | Wastes and products from early and late crop processing phases based on correlation of the proportion of the seeds of cultivated crops and the categories of field weeds [FIG. 41] for Early Medieval sites in Moravia and Slovakia. Each symbol is specific for a location.

TAB. 25 | Number of samples classified as waste from the different phases of crop processing and as a final product by method 1.

Area	Winnowing waste	Coursed sieving waste	Fine sieving waste	Products
Kostice Zadní hrúd RS3	.	.	.	.
Kostice Zadní hrúd RS4	5	.	9	2
Topolany	.	.	1	1
Slavonín		.	.	.
Brankovice	.	.	3	.
Hurbanovo	.	.	2	.
Bíňa	.	.	3	.
Nové Zámky	2	.	16	1
Devín-Hrad	1	.	1	2
Nitra-Palánok	.	.	.	1

TAB. 26 | Characteristics of and information on the classification of samples in method 2 used for the comparison with the material from the Mikulčice agglomeration.

Area	Storage of untresh spikelets Σ	Semi-clean storage Σ	Waste from processing of tresh spikelets Σ	Waste from semi-clean storages Σ
Kostice-Zadní hrúd RS3	.	.	.	2
Kostice-Zadní hrúd RS4	9	2	7	3
Topolany	.	.	.	.
Slavonín	.	.	.	.
Brankovice	1	.	.	.
Hurbanovo	.	.	1	.
Bíňa	4	.	3	.
Nové Zámky	9	.	7	9
Devín-Hrad	3	.	.	2
Nitra-Palánok	.	.	.	1

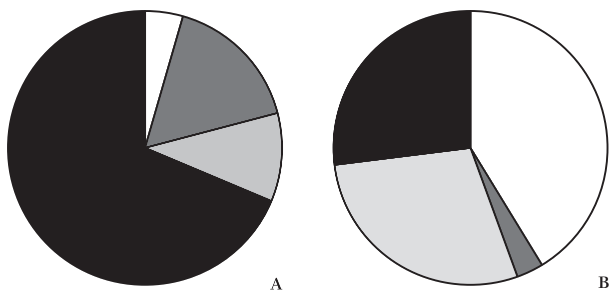


FIG. 46 | Proportion of the products and wastes as classified by method 2 from the Mikulčice agglomeration (A, n = 67) and other Early Medieval sites (B, n = 64).

- Storage of untrest spikelets
- Semi-clean storage
- Waste from the processing of treshed spikelets
- Waste from semi-clean storage

of weeds. The criteria did not meet the samples from Topolany and Slavonín.

The results [FIG. 45] are again different from the results of the material from Mikulčice. Samples are located more on the left side of the plot and contain more samples of "uncleaned" products and more samples of waste from cleaning (upper left part). No samples from Mikulčice and Kopčany were classified as such. "Uncleaned" product was classified in 26 samples from almost all sites except for Brankovice and Nitra-Palánok. Waste from cleaning is the second most frequent category (18 samples). "Cleaned" product was found only in two samples from Kostice-Zadní hrúd, RS4 phase and the waste from cleaning in 15 samples from all the sites except for Bíňa and Brankovice.

To summarise, the waste from earlier stages of crop processing was found at five sites and date to all three phases – Kostice-Zadní hrúd (RS4), Brankovice, Bíňa, Nové Zámky and Devín-Hrad [TAB. 26]. Waste from hand-sorting the final product was found at three sites – Kostice-Zadní hrúd (RS4), Nové Zámky and Devín-Hrad. Fully clean (weed-free) product was found in assemblages from Kostice-Zadní hrúd (RS3) and Nitra-Palánok.

The proportions of various types of products and waste, as studied in method 2, are in the samples from the agglomeration of Mikulčice and other early medieval sites and are even more different than in the previous method [FIG. 46]. The main difference is that the samples from Mikulčice and Kopčany do not contain many samples from the initial phases of crop processing, while in the other assemblage, these are quite common. The difference is also in the distribution of clean products which were found mainly in Mikulčice.

By studying the Mikulčice data in a wider regional context, we can see that our assemblage is specific. Both methods proved that the assemblage from Mikulčice-Kopčany differs from the finds in other sites and also from other fortified sites. However, most similar to Mikulčice are the assemblages from the Great Moravian central sites of Nitra and Devín-Hrad.

8 Economy

As mentioned earlier, the present understanding is that the Great Moravian central sites, such as Mikulčice, were not autarchic, but were dependent on the import of foodstuffs of plant (and also possibly animal) origin. It is, therefore, crucial to ascertain the origin of the staple crops recovered in Mikulčice. It has to be determined if they were grown locally, and possibly by the inhabitants of this early medieval settlement, or whether they were imported from further afield, from the "rural hinterland". To address these issues, we focus on determining whether the site or some of its parts, can be described as places of production and/or consumption and by determining the workforce needed for the production of recovered plant food products.

These questions have a greater significance since it is assumed that in the Early Medieval period there was a tendency towards agricultural and economic specialisation. Various archaeological sources have been seen as evidence that between the 7th and 9th centuries, the social structure has changed; the emerging "social elite" prompted the establishment of non-agricultural settlements and enhanced the long distance trade and contacts (Hladík 2014, Macháček 2007). This would be impossible without the production of surplus that allowed society to feed the elite or other social elements not directly involved in the production of foodstuffs. Central settlements from the Great Moravia period, such as Mikulčice, were identified as the places of residence of the elite (craftsmen, religious elite, political elite, Klanica 1987; Poláček 2008a; Dresler/Macháček 2008; Mařík 2009; Hladík 2014).

In this chapter, the PMR assemblages from individual sites within the Mikulčice and Kopčany agglomeration are evaluated against the two ethnographic models. The first model – classifying the site as a place of consumption or production – was created by G. Hillman (1981, 1984) and G. Jones (1984), the second – addressing the issue of the necessary workforce mobilisation – was created by D. Q. Fuller and C. J. Stevens (2009). Both models use the results of the previous taphonomic study but evaluate the obtained information from the economic perspective.

8.1 MODEL 1

According to G. Hillman (1981, 1984) and G. Jones (1984) the production and consumption areas can be differentiated based on the presence or absence of by-products (waste) from the early stages of crop processing. At production sites, where the entire sequence from harvest to storage took place, the by-products or waste from the early phases of crop processing (such as winnowing) would be present. While at consumption sites, which acquired the crops elsewhere, these would be absent.[55]

8.1.1 Model 1 application

The model uses the results of method 1 of the Taphonomic analyses. We have not analysed the samples again here, but have transposed the results (presented in [tab. 21 and fig. 39]) to entire areas or the agglomeration zones.

8.1.2 Model 1 results

According to the results of the taphonomic analyses there are (to date) no archaeobotanical assemblages in Mikulčice or Kopčany that document the presence of the remains of the early stages of crop processing. Out of 53 analysed contexts that could be included in the Discriminant analysis, 35 are classified as waste from fine sieving and 18

55 Note that in some cases, straw or chaff (i.e. waste from winnowing) could have been brought into consumption sites as an important commodity – e.g. animal fodder, bedding, daub ingredient etc. (cf. Hajnalová 2012, 112).

as the final product. The waste from fine sieving is also documented in all the examined areas of the Mikulčice agglomeration (the acropolis, the extramural area, outer bailey site and peripheral area). According to the original interpretation made by G. Hillman (1981, 1984) and G. Jones (1984), the waste from the fine sieving is part of the later stages of the process, and therefore can be found on consumption sites. M. Hajnalová (2012, 112) argues that in certain cases, fine sieving residues can be found at both consumption and production sites and are therefore irrelevant for economic interpretation. The remains of the final cleaned product (cereal store) and the waste from cleaning (hand-picked large weed seeds) were found in the acropolis (in the settlement pits situated below the stone buildings in Area 88 and 86 and in the layers of the fortification in Area 98), outer bailey (Area 103) and in Mikulčice-Trapíkov (Area M17).

8.1.3 Model 1 summary

The results of model 1 indicate that all the examined contexts and structures in the excavated areas at the acropolis, the outer bailey, the extramural area and the agglomeration periphery can be considered as places for the consumption of crops.

8.2 MODEL 2

This model draws on the first of the three important elements of agricultural production – the ability to mobilize the necessary workforce. The other two elements of production, which should be available in a complex and/or well organised society, are the surplus of production and presence of so-called cash crops (Fuller/Stevens 2009).

The amount of agricultural labour that has to be available for the production of necessary staples varies greatly. On the scale (and means) of production which is a continuum, on one end is the small-scale production where the labour is shared by a small number of individuals (e.g. one family or a household, *sensu* domestic mode of production) and on the opposite end is the large-scale production, which requires the coordinated labour of an ethos beyond the extended household or family (e.g. specialised production). In between, there is the transitional medium-scale production of medium-sized communities (ethos) e.g. of the extended family.

Fuller and Stevens (2009) argue that the organisation and hierarchy of the society also influence the organisation of the workforce for agricultural activities. On one side are the societies where the organisation of labour and subsequent product ownership has a communal nature, while on the other are hierarchised societies where labour is organised from the top down and the product is owned by the upper ruling institution (Fuller/Stevens 2009). These authors also stress that in every agricultural community, the time of the crop harvest is the most stressful period of the year and the most demanding on the workforce.[56] Large and centrally or communally organised communities are able to organise a sufficiently large group of people that can not only harvest but also process the crops, and carry out the processing in the later stages, immediately after the harvest. Therefore, the samples found on such sites would contain the remains of storages almost void of impurities. On the other hand, the samples from areas where only a small (or medium-sized) community of a single household was involved in the harvest and crop processing, would contain crops that were not fully processed and the assemblages would have a higher proportion of weed seeds or other impurities (Fuller/Stevens 2009, 41–42).

Fuller and Stevens (2009) assume that the PMR at archaeological sites mostly represent the waste from cleaning the stored crops. Based on the ratio of weed seeds to crop seeds and the ratio of small and large weed seeds, they differentiate between two main types of sites. The first are sites that originally stored unprocessed or only partially processed crops (e.g. at best coarsely sieved) – the result of the effort of a small (or medium-sized) community incapable of mobilising sufficient labour at the time of harvest. The second type is the sites that stored thoroughly cleaned crops – the results of the effort of a large and/or well organised community.

8.2.1 Model 2 application

In model 2, we have not analysed the samples again although we have transposed the results from "Taphonomic Processes – 7.6.5 Method 2 – Crops to weed seeds presented in [tab. 22 and fig. 42] to entire areas or zones of the agglomeration.

56 Ethnography has documented that in dry climatic circumstances, the entire process and sequence of post-harvest processing (or its larger part) can be completed entirely in the field at the time of harvest. In higher moisture climates, when it's raining during the harvest, it would be necessary to move under a roof or leave the processing of the crops for later (Hillman 1981, 1984).

8.2.2 Model 2 results

The model 2 results indicate that the assemblages from Mikulčice and Kopčany consist mostly of waste from the last cleaning of the final product. They are present in all areas – the acropolis, the outer bailey, the extramural area and the agglomeration periphery. The remains of the product itself – the cleaned storage (Hajnalová 2012, Obr. 6.7) are the second most common category. These occur in equal measure in the acropolis, the outer bailey and in the extramural area. However, they were also present in the peripheral area of the agglomeration at Mikulčice-Trapíkov, but were absent in Kopčany. Unprocessed crops that are waste from cleaning only partially-cleaned storages are less frequent. These types of products are documented in Kopčany-Kačenáreň and Mikulčice-Trapíkov (Area M17) as well as in the acropolis (Area 96 and 98) and the outer bailey (Area 89).

FIG. 47 | Mikulčice-Trapíkov. Daub fragment with imprint of wattle.

8.2.3 Model 2 summary

Based on the results of model 2, we can observe that in the Mikulčice acropolis, the residues of both partially and also fully processed crops (waste and storages) are approximately equally present. In the other areas, both types are also present but their ratio varies and is usually dependent on the number of studied samples. In the outer bailey (Area 103), in the area with the most numerous samples, both types of products (storages) are present, as well as the waste from the processing of well-cleaned storage. Only the waste from the cleaning of partially processed crops is absent. The interpretation of sites with an insufficient number of samples, which in addition are poor in PMR, might have been misleading and so is not discussed here.

Interpreting these results in the light of the scale of production and the ability to mobilise the workforce, it seems that the community that generated these crop storages and/or the waste from their cleaning was able to secure a sufficient workforce to proceed during the post-harvest crop processing to its final stages. This means that the labour force involved was outside of the scope of a single household or a wider family. It indicates that the crops were a product of a well-organised community with many members.

Archaeological evidence (grave goods, architecture, space organisation, etc.) is seen as an indicator that the community at the Mikulčice settlement agglomeration was a hierarchical and centralised society (Macháček 2007). As the community of Mikulčice was numerous, it is plausible to suggest that at least some of the members were involved in the production of foodstuffs. However, it is possible that during the harvest period, even the members that usually weren't involved in agriculture (such as craftsmen), had to assist with field labour. In addition, it is of this author's opinion, that the early medieval rural communities of the hamlets and villages, most probably representing single households or a wider family, were unable to mobilise a sufficient workforce beyond their subsistence needs during the harvest time.

8.3 ARCHAEOBOTANICAL ECONOMIC MODELS

Because archaeobotany works with plant remains, which is a specific type of "material" culture, it also uses different and specific methods to detect the various economic activities or subsistence strategies. In this context, economy or economic activity means a strategy based on the manner in which an individual society resolves its existential issues and the scarcity of available resources.

In the previous chapter, the archaeobotanical samples are described as remains consisting of waste or products of the individual stages of crop processing sequence. This information can be used for the economic interpretation of individual areas, i.e. characterisation of their food supply strategy. As far as plant-based foodstuffs (cereals and pulses) production and consumption is concerned, archaeobotany is able to determine the production and the consumption zones, areas or entire settlements.

Another model, created by M. Jones (1985, 120–121), is based on archaeological data and utilises a radically different logical premise than previous ethnographic models. The author of the model builds his argumentation on the premises that at a production site where the crops are in abundance their remains will be numerous, while at a consumption site, which gets its plant foods through commerce, they are handled with care and not wasted; the remains of the crops will be scarce. Then it follows that assemblages from the production site will be characterised by the dominance of finds of crops (grain and seeds of pulses) and the samples will have a high density of plant remains per litre of sediment. The assemblages from the consumption site will only have a small amount of finds, low density of plant macro-remains per litre of sediment and will be dominated by seeds of wild species and cereal chaff. However, the application of this model to east-central Europe is problematic, because samples rich in finds (grain, weeds, chaff) are only rarely found in archaeological contexts mostly due to soil preservation (dry, not waterlogged sediments). Also, his model was applied to material dated to the Iron Age where the dominant cereals are glume wheat, which produces a lot of chaff remains. The density of the finds and the categorisation of samples into "rich" and "poor" grain or weeds were only used for the taphonomic analysis to assess the density of individual contexts or areas.

It is important to mention that the simplified division of sites solely into production sites and consumption sites can be misleading since it does not reflect the entire range of possible economic strategies. This was pointed out already in 1992 by M. van der Veen (1992, 99). According to her, this complex problem cannot be solved even by categorising the sites according to the volume of production/consumption (e.g. into sites producing for their own needs, sites producing a surplus for trade or sale – small consumption sites like "herder settlements" or large consumption sites such as cities).

In 2006, van der Veen together with G. Jones made a new attempt to address the interpretation of archaeobotanical assemblages in order to find a better method or arguments. In their case study, they re-examine archaeobotanical data assemblages from the Iron Age settlements in the United Kingdom, which were already economically classified by M. Jones (1984), C. Campbell (2000) and C. J. Stevens (2003). In this economic assessment, they add the information concerning the amount (density) of cereal grain to the information concerning the classification of samples into stages of crops processing. The results were correlated with the archaeological data on the geographical and temporal dispersal of the two types of storage facilities (grain pits, above-ground granaries) and fortified settlements. The sites were then divided into two groups based on the amount of charred cereal grains and the waste from cleaning. Sites containing a high number (density) of cereal grain charred by accident (storage burnt in situ was excluded from the analysis) were identified as "large-scale" production sites. Sites with samples containing charred chaff and weed seeds were identified as "small-scale" production sites. This classification is based on the assumption that every settlement produces a certain amount of crops for its own consumption/needs, and therefore cannot be strictly classified as a production or consumption site. When we apply this method to the site, which acts as an over-communality centre such as Mikulčice, where the governing, military, administrative and religious elite of the Early Medieval society were concentrated, then it can be classified in the "large scale" category.

The other important element of the (agri)culture is animal husbandry (Campbell 2000). The ratio and composition of animal husbandry to arable farming, as well as the type of fodder and its production or import, is a key factor when determining the economic strategy (economics) of a settlement. Unfortunately, the available results of the archaeozoological analysis from Mikulčice have so far focused only on the range of species and the ratio of individual species of consumed fauna (Kratochvíl 1980a, 1980b, 1980c, 1980d, 1980e, 1980f, 1981a, 1981b, 1982c, 1982a, 1982b; Chrzanowska/Krupska 2003, 109–119; Chrzanowska/Januszkiewicz-Załęcka 2003, 121–138).[57]

Taphonomic archaeozoological analyses and subsequent economic interpretations, *inter alia* of local herding vs. import of meat or other animal products, are the subject of new research currently underway and are not yet available.

57 For the assessment of animal bones of horses, birds and other wild animals, see Chrzanowska/Krupska 2003a; Mlíkovský 2003; Zawada 2003.

8.4 ECONOMICS OF MIKULČICE IN THE WIDER REGIONAL CONTEXT

8.4.1 Storage of agricultural supplies in Mikulčice

Several researchers have addressed the manner of crop storage and storage facilities in Mikulčice. The results of their research were most recently summarised by M. Hladík (2014, 172–173). At the fortified areas of Mikulčice, as well as at the sites in the outer bailey and on the periphery of the agglomeration, no archaeological structures that could be considered to be storage (grain) pits were found. The closest documented grain pits (granaries) were found in the Mikulčice-Podbřežníky site, three kilometres away (Mazuch 2008, 165–181), and in Mutěnice-Zbrod site, nine kilometres from the acropolis in Mikulčice (Klanica 2008, 185). Based on the absence of grain pits in the central area, M. Hladík (2014, 173) assumes that the crops for the centre were produced and stored at these and other similar open (agrarian) settlements in the hinterlands of the central settlements.

This argument, however, poses several problems. First of all, as M. Hajnalová points out and discusses in further detail (Hajnalová 2012, 30–32, 119–120), grain and other agricultural products can be stored in a wide range of both static and mobile structures. M. Hajnalová reminds us that apart from the grain pits, other well documented crop storage utensils are ceramic vessels. She continues that more difficult (or sometimes impossible) to document are the above ground elevated structures (granaries). Archaeobotanical literature states that the elevated granaries and other large-volume types of elevated crops storage facilities are usually used at sites with unfavourable conditions for digging the pits (e.g. unsuitable bedrock, which is the case of areas in the Mikulčice acropolis and its environs), or at sites where there is the necessity to access the crops daily (van der Veen/Jones 2006). In traditional practice, documented by ethnography and in historical records, grain pits, which need to be hermetically sealed, were used for **long-term** grain storage (cf. Kunz 2007). Therefore, certain authors (archaeologists) conclude that the storage pits were mostly used to store crops intended primarily for sowing. M. Hajnalová stresses that these authors do not realise that this contradicts ethnographic observations and historical works, which prove that the storage pits were mainly used to store (sometimes surplus) product used for consumption and that the germinating ability of this product was usually significantly reduced (cf. Fenton 1983, 586; Sigaut 1988, 22). Nevertheless, there are sporadic mentions confirming that a portion of the grain stored in grain pits was used for sowing (Kunz 2007; Pleinerová 2000). However, in the context of storing seed grain in pits, it is important to consider the species of crops that were being cultivated in Early Medieval fields.[58] For winter crops (wheat, rye, barley), the time of seed storage between harvesting and sowing would be **one or two** months, which would not have necessitated the use of a storage pit. In the case of spring crops (millet, oats, spring barley), the storage period would be longer than six months and could, therefore, hypothetically be useful. There are, however, disadvantages as mentioned above. Based on the available information, we can assume that the Early Medieval grain pits, such as the grain pits in Mikulčice-Podbřežníky and Mutěnice, could have been used for the long-term storage of grain intended for consumption (local subsistence, surplus product, export). However, we have to keep in mind that after the grain pit is opened, it was necessary to immediately remove all the grain and either use it or store it somewhere else (van der Veen/Jones 2006).

At Mikulčice stronghold, necessary staples and grain could have been stored in elevated structures (granaries) made of wood, in various containers from perishable materials (such as woven containers sealed with mud, wooden chests) or ceramic vessels. Among artefacts from Mikulčice-Trapíkov, there were a large number of various fragments from baked clay – interpreted as probably representing the remains of kilns (for example, for drying cereals). Other fragments represent daub plaster on wicker. The main difference between these two types of finds is in the amount and nature of the temper material in the clay. Fragments from "kilns" contain an abundance of organic material (grass leaves and stems, cereal chaff, cereal grains). In "construction daub", the temper was only inorganic and the fragments often bore imprints of smaller diameter wicker [fig. 47]. This type of artefact could represent the remains of lighter architecture (inner walls/partitions), elevated granaries, or from smaller household equipment e.g. storage chests made from wicker and sealed with a layer of mud (e.g. so-called "*susak*") known from the territory

58 Archaeobotanical material from Mikulčice and Kopčany includes crops today sown both in autumn (wheat, rye, possibly barley) and in spring (common millet, possibly barley).

of the wider Carpathian basin in the recent past as a container for the storage of the grain (e.g. Hajnalová 2012, Obr. 2.14).

8.4.2 Mikulčice-Kopčany and other sites

In 2008, E. Hajnalová and M. Hajnalová published a paper that discussed the subsistence strategy of the Early Medieval centre at Nitra Castle and contemporary open settlements in its hinterland. Due to the long-term and (relatively) intensive archaeobotanical research of the examined region of Nitra, they were able to assemble an assemblage of 59,753 carbonised seeds (Hajnalová/Hajnalová 2008), which is several times higher than the PMR assemblage from Mikulčice agglomeration or the assemblages from other contemporary sites (see the chapter 6 General results). They have managed to prove the conclusive differences between the presence of different kinds of products and by-products of crop processing in the Nitra Castle and the settlements in its hinterland. In the fortified area of the Nitra Castle hill, there were a higher number of samples identified as final (well-cleaned) storage, whereas in the settlements in the hinterland, the waste from the crop processing was more numerous. In the light of the discussed economic models, Castle Hill was classified as a place of consumption and/or "large scale handling of the crops" while the rural sites were classified as the places of production and/or "small scale" economy.

When using the results of the taphonomic analysis of early medieval sites from the region to assess the status of "producer" or "consumer" or the community "able-" or "unable to mobilise work-force during the harvest time" (or the "small" and "large scale") it is clear there is a variety. In all three analyses, Mikulčice (and Kopčany) differ from the rest but they are the most similar to the fortified central settlements at the Devín and Nitra sites, whereas other fortified settlements (such as Bíňa) or open villages (such as Kostice-Zadní hrúd) seem to be focused on production. This difference can be a reflection of the different functions and the nature of economic activities but may also be biased by distorted and uneven, less intensive and unsystematic sampling methods.

The evaluated body of archaeobotanical data appears to produce (to an extent) contradictory results. On one hand, the communities of all the Mikulčice agglomeration areas were identified as (exclusive) consumers of arable crops. On the other hand, archaeobotanical data clearly indicates that the community producing and processing the crops found at Mikulčice agglomeration must have operated and been organised beyond the scope of a single household or a wider family, and therefore exceeded the size of any Early Medieval community of a rural hamlet or village in the region. The most likely candidate of the available workforce was the agglomeration itself. Archaeological evidence (grave goods, architecture, space organisation, etc.) is seen as an indicator that the community at Mikulčice settlement agglomeration was hierarchical and centralised, and thus was able to mobilise and organise the production of foodstuffs. It is plausible to suggest that at least some of the members were involved in the production of foodstuffs. The number of people during the harvest period must have been high in order to secure the processing crops further in the sequence, thus it might be speculated that, at this time, even those members that were not usually involved in agriculture (such as craftsmen) had to assist with field labour. The absence of straw and chaff in charred and waterlogged material, which are the by-product of the early stages of crop processing (and therefore should have been present) might have different reasons:

1) The entire sequence of crop processing, from threshing to fine sieving, was carried out directly in the field, or in other, unexamined parts of the settlement.
2) This waste was originally present but was utilised in another manner, such as in daub (as documented at Trapíkov), fodder or bedding for livestock (cf. Campbell 2000)
3) And were completely burnt in the fires (Boardman/Jones 1990).

To verify our findings, we next examine the ecology of wild plants that can provide clues to the environments the plants originated from and we correlate the findings with local data on geology, soils and geomorphology.

9 Ecological attributes of wild species

There are two main “traditional” approaches to studying the ecology of plants. The first is the study of the ecology of individual species (autecology). The second is the study of the relationships between the plant communities and their environment and (synecology, phytosociology or plant sociology). Their principles and results are often used for interpretation or archaeobotanical assemblages (for discussion on their positives and negatives see e.g. van der Veen 1992, 101–109).

The analyses of the ecological indicator values of wild species documented in archaeological assemblages help to create the image of the conditions in which these plants grew in the past. The reaction of species to edaphic (pH, soil moisture, soil nitrogen), climatic (temperature, light, continentality) and biotic (crop height, time of germination and flowering) and anthropogenic (time of sowing, disturbance/tillage, harvesting height) factors can also be used in the reconstruction of past arable practices and methods. It has been pointed out, among others, by van der Veen (1992, 105–107) that the use of ecological data on modern plants to past weed communities and subsequent archaeological reconstruction is problematic. The main problem lies in the very nature of the bioarchaeological material recovered from archaeological excavations of past human settlements and cemeteries. While it is possible to assess the relationship between plants and humans, it is difficult (or problematic) to assess the relationships between plants themselves or between plants and their environment (cf. Jones 1983; van der Veen 1992, 102). The ecological conditions of the environment can only be reconstructed (assumed) when multiple species, that have similar ecological requirements, are found in one sample/context (van der Veen 1992, 109). As the ecological requirements of species change in dependence on the geographical or climatic gradient (and local conditions), these types of analyses must be based on local ecological studies that provide local information on the ecological requirements (or indicator values) of individual species (van der Veen 1992, 109).

This chapter focuses on the analyses of the species reaction to the abiotic and biotic attributes of their environment. The attributes of the environment are detected from the analyses of species requirements. For attributes where local data existed, for example, analysis of soil factors such as pH, soil moisture and soil nitrogen, local data for the species of Carpathian flora was used (Jurko 1990; for the application to archaeobotany, see for example Hajnalová 2012, 134–138). If local ecological data on certain characteristic was absent – such as for the response of species to temperature, light and the continentality of the environment – the information on so-called *ecological indicator values* of H. Ellenberg (1979) described for the species of the western part of Central Europe was used.

9.1 MULTIVARIATE STATISTICS II

As in the chapter 7.3 Multivariate statistic I, the same methods and procedures[59] were used in the analysis of the ecological attributes of wild plant species. The DCA (detrended correspondence analysis) in the CANOCO software was used to study and characterise the wild species sub-assemblage and subsequently to select the samples suitable for ecological analyses.

9.1.1 Selection, standardisation and transformation of data II

Unlike in the study of taphonomy, which was primarily based on charred PMR, in this case, the species preserved by all three methods of preservation – charring, mineralisation and waterlogging – are evaluated. The original matrix of the

59 For the methodology, see the chapter 4.5.2 Statistical analysis methods.

TAB. 27 | The DCA analyses performed for taphonomic examination of the samples.

Analysis	Variable	Preservation	Standartization
DCA10	Wild species	Charred/mineralized/watterlogged	Presence/absence
DCA11	Reduced only to frequent	Charred/mineralized/watterlogged	Presence/absence

samples was adjusted by merging the samples from the same context. This was done to secure the samples with a low amount of PMR or species that were rare in the assemblage would not be excluded from the analysis. Such a reduced and more compact data matrix is also easier to handle and interpret when evaluating and comparing e.g. larger settlement areas.

The ability of plants to produce seeds (their numbers) varies not only among the species (for example, *Agrostemma githago* usually produces 2500 seeds, while *Sisymbrium officinale* produces 730,000 and *Chenopodium album agg.* more than 100,000 seeds (Čvančara 1962, 209), but also in the same species grown in different conditions. This is why we do not base the ecological analysis on the quantitative representation of the finds of a given species, i.e. on the amount of seeds from species with a specific characteristic. The average value or weight of the given ecological category would be significantly influenced by the number of finds/seeds. The data matrix has been transformed by the use of information on the presence or absence of a species/taxa. The evaluation is based on the number (or proportion) of taxa with a particular ecological attribute in the sample. By using this method, one of the main discriminants – the number of the finds is removed – and all wild species become equal in the analysis. The transformed presence/absence data matrix was used in all types of ecological analysis.

9.1.2 Detrended correspondence analysis (DCA) II

To understand the structure of the data and to assess whether all samples can be used in the analyses or some have to be omitted, the detrended correspondence analysis was again selected[TAB. 27].[60]

The DCA analysis was conducted using two matrices (one full and one where rare taxa and samples with less than 10 finds were omitted).

In the graphic output, individual samples are represented by pie charts (one pie chart represents one context), in which different slices express the portion (%) of species of any classified category. The size of the pie charts demonstrates the size of the sample, which is the number of PMR (larger circle – sample with a higher number of PMR).

9.1.3 Phytosociological factors

Based on the information on the association of species with particular plant communities they were assigned to a wider ecological group category (or broadly designed biotope in which they are commonly found), which reflect the environmental conditions and the human influence. Individual species were assigned to an ecological group according to the information on their most common modern occurrence (according to Eliáš et al. 2010). Even if there are flaws in using such associations for the evaluation of archaeological plant data, see for example the discussion in A. Bogaard (2004) and van der Veen (1992), it is commonly used in archaeobotanical practice.

The species with a narrow ecological valence that is associated with a limited number of similar conditions and/or plant communities are the most suitable for assessing whether a particular biotope was present in the environments of previous landscapes. Non-specific indifferent species, which occur in very different conditions, have a different predictive value and were also included in the analyses. The taxa classified into higher taxonomic units like family or "type" which cannot be evaluated ecologically was excluded.

Wild species present can be assigned into nine group categories, each reflecting the biotope and economic activity, which was (presumably) responsible for the occurrence of the remains of the plant taxon in the archaeological context. Woody plants that are comprised of finds of seeds from trees and shrubs are not usually used economically. Gathered fruit represents the seeds and nuts of woody plants usually gathered for consumption. Field weeds are species grown in the fields alongside the cultivated crops. Meadows comprise species of semi-natural or successive stages of permanent grasslands. Ruderals are species growing in places substantially changed by

60 See the chapter 7.6 Taphonomic analyses.

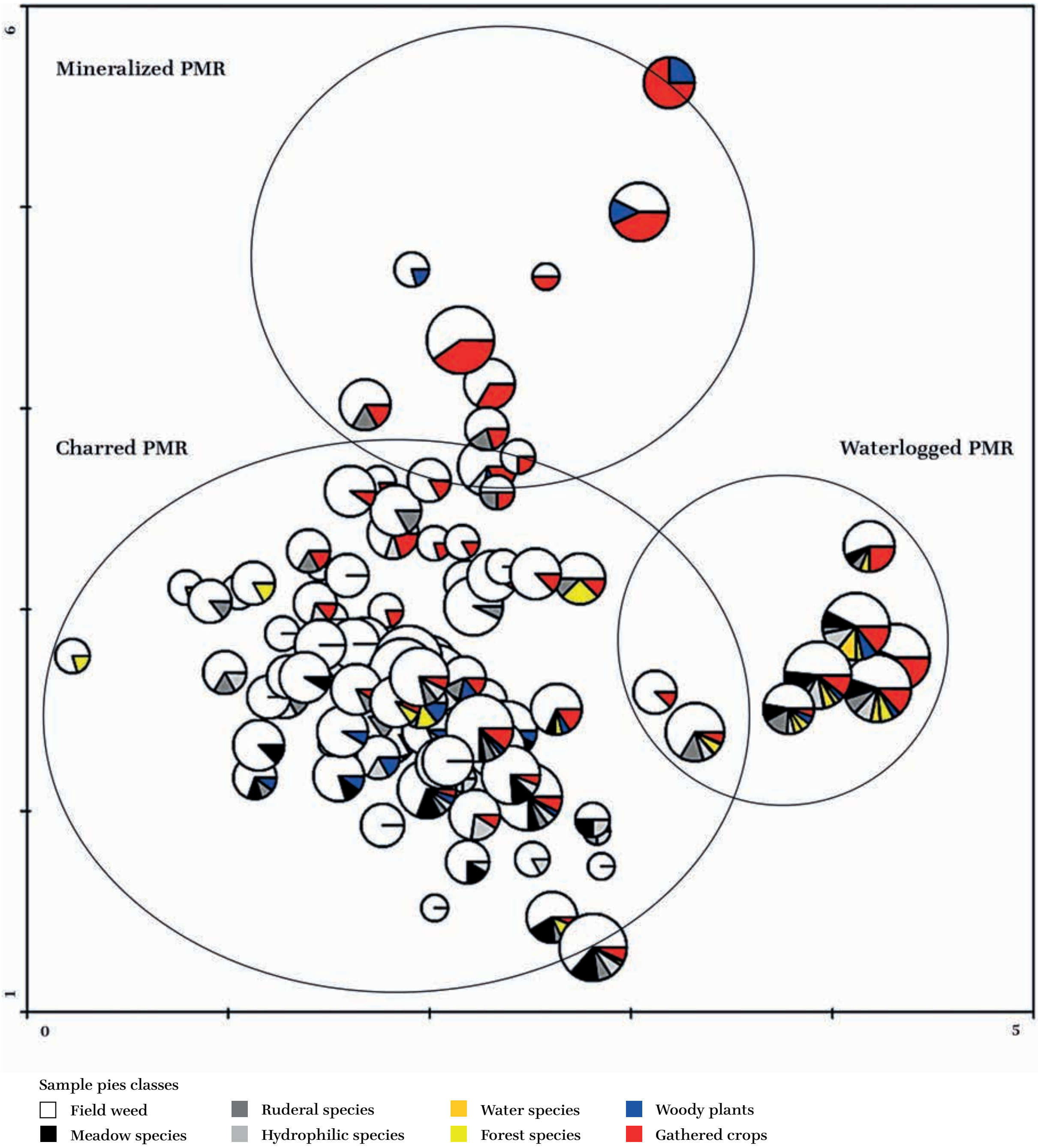


FIG. 48 | Mikulčice-Kopčany. DCA10 – Detrended correspondence analysis of all charred, mineralised and waterlogged wild plants using presence /absence values species classified to main biotop categories with a focus on biotopes of wild species.

anthropic activities. Hygrophilous are a species of very damp, swampy biotopes. Water plants grow in slow flowing and stagnant waters. Forest species are herbs, grasses (and shrubs) of the forests.

The most important variable in the DCA10 [FIG. 48] differentiating samples is the preservation of the PMR, despite that the information about the preservation of the taxa was not analysed as a variable. Field weeds dominate the assemblage of charred PMR samples. In many samples, the field weeds account for 100 %, whereas the species of other categories is less than 30 %. The charred assemblage includes to a lesser extent, species of meadows, ruderal and water biotopes. Seeds from gathered fruits are less numerous but found in all researched areas of the agglomeration. Surprisingly, in this category were the finds of woody plants without a clear economic function.

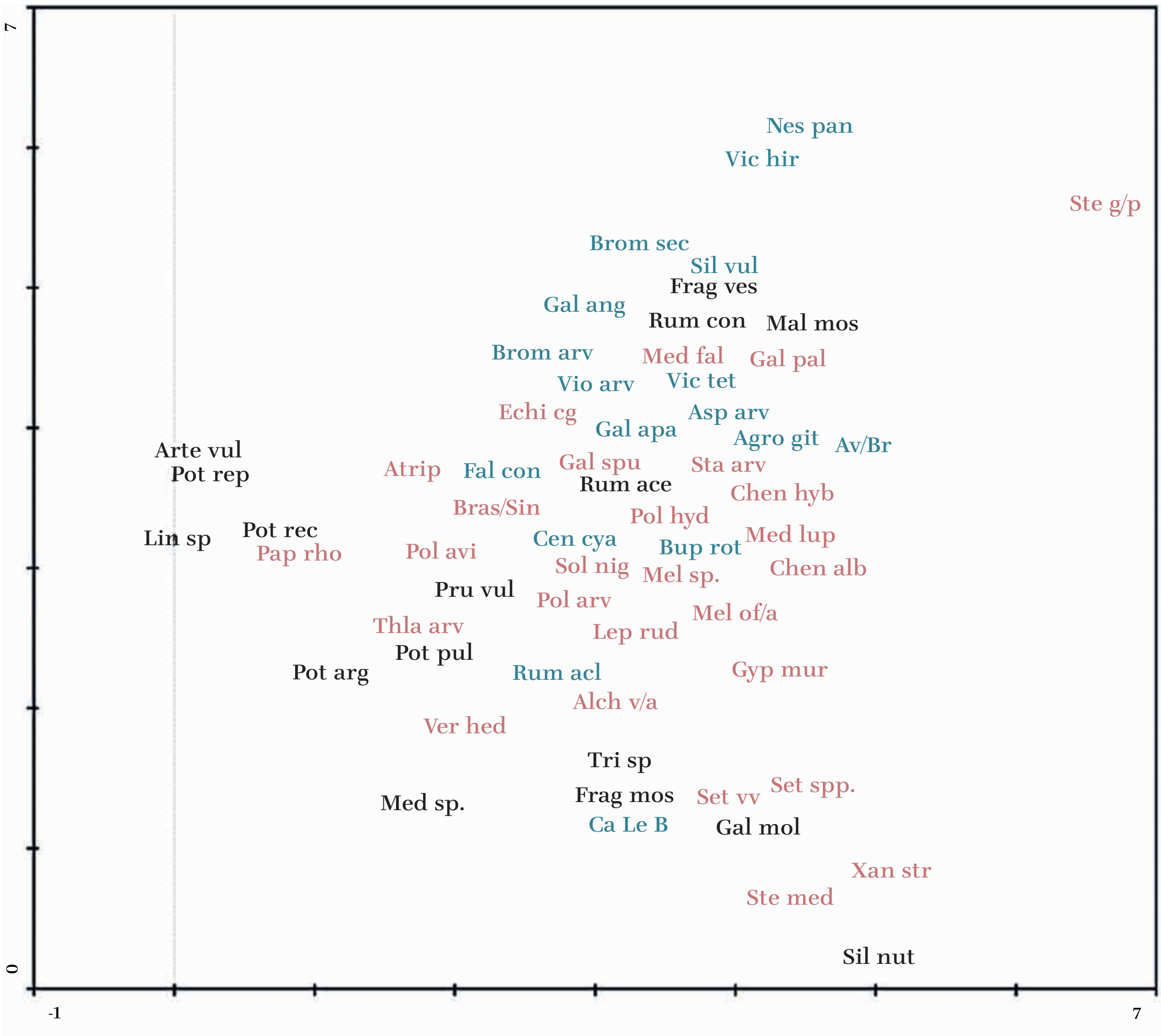


FIG. 49 | Mikulčice-Kopčany. DCA11 - Detrended correspondence analysis of charred, mineralised and waterlogged wild plants using presence/absence values, rare species and poor samples are excluded. Species plot. Captions: blue – spring crops, red – winter crops, black – untypical field weeds.

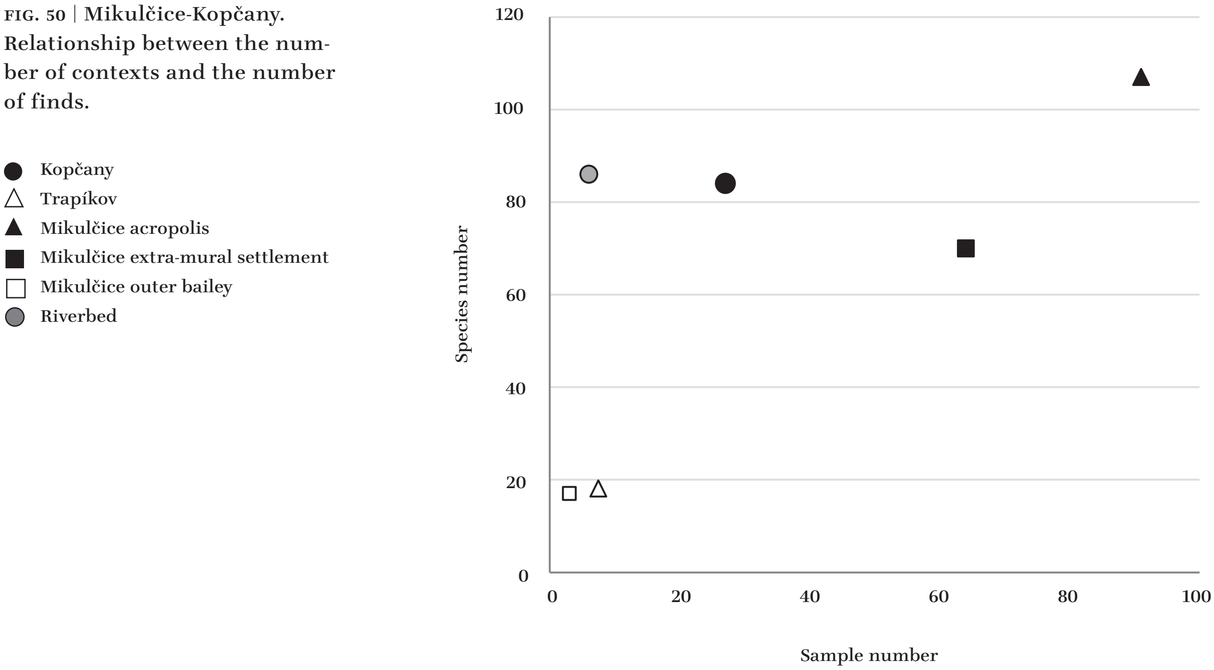
Field weeds are also present in the assemblage of mineralised samples although in individual samples they rarely reach 50 %. Meadow and hygrophilous plants and gathered fruits are more common and account for 40–50 %. Similarly, in waterlogged samples, field weeds constitute in most cases between 40–50 %. In difference to the charred and mineralised samples, the proportion of ruderal, meadow, hygrophilous and water species, as well as gathered fruits, is much more significant.

In the DCA11, only species considered as "weeds" (see also DCA8) were analysed.[61] In archaeobotany, the analyses of field weeds in combination with information about the "dominant" crop in the sample is used to determine the crops' affiliation with specific weeds and subsequently to determine arable practice such as the time of sowing or harvesting height (cf. HAJNALOVÁ 2012; KOČÁR 2013). Unfortunately, in Mikulčice and Kopčany, the samples are very "mixed"; it is not possible to define the "dominant" crop (see chapter 7.3 Multivariate statistics I) so we cannot address similar questions.

The results of the DCA11 show, that even if there is a continuum, the samples containing weeds associated with summer crops cluster at the bottom part of the plot while winter annuals associated with crops planted in the autumn are concentrated in the upper part of the plot [FIG. 49]. However, there are species which "group"

61 The reduction of data in the multivariate analysis is used for eliminating biases and for better detection of "trends".

FIG. 50 | Mikulčice-Kopčany. Relationship between the number of contexts and the number of finds.



wrongly. For example, *Echinochloa crus-galli* which is today considered to be an indicator of crops sown in the spring among weeds and is today associated with winter crops such as *Agrostemma githago*, *Bromus arvensis* and *Galium aparine*. This indicates that species with different germination times are either significantly mixed in the samples or that weeds in early medieval Mikulčice were associated with different crops/seasons than today. The first scenario seems plausible. It is most likely that this stems from the very character of the samples in which various products/waste from the processing of various crops are mixed. It is, however, clear from the analysis that some crops were sowed in the spring and others in the autumn. We can also speculate that the weeding of the winter (autumn sown) crops in spring was applied, thereby stimulating the growth of summer annuals (WASYLIKOWA et al. 1991).

9.2 AUTOECOLOGICAL ANALYSIS OF WILD SPECIES

The following analyses focus on the evaluation of the ecological characteristics of wild species from the individual archaeological contexts in relationship to climatic, soil and biotic conditions/factors of the environment. It also attempts to ascertain whether any changes in time and space can be recorded in the data [TAB. 34].

The aim of the analysis is to reconstruct the conditions of the environment in which the recorded taxa grew and then 1) characterise and situate in space the exploited areas and 2) to reconstruct the arable farming practices used.

The presence/absence of the species with a given ecological attribute was used in the basic data matrix. The proportion (percentage share) of species with a given attribute was calculated for the evaluated sample (a specific area – part of the agglomeration). Methods of simple descriptive statistics are applied to the evaluated the results.

The samples represent the entire areas designated to their archaeological classification according to the "centre-periphery" model (Mikulčice-acropolis, Mikulčice – outer bailey, Mikulčice extra-mural settlement, Mikulčice-Trapíkov, Kopčany and the riverbed in Mikulčice) and the character of deposits from the archaeological and natural layers. Only taxa that are sufficiently classified enter the analysis – primarily herbs, grasses and shrubs. Woody plants were excluded from (most of the) analyses because of their wide ecological niche.

The areas differ in the number of evaluated species. To a large extent, this reflects the method and intensity of sampling and preservation of PMR. The logical presumption that in the areas with a small number of available samples there are fewer (finds and) taxa, and where the number of samples is high that the species are more numerous holds only partially true for the Mikulčice agglomeration [FIG. 50]. For example, in Kopčany and the riverbed, the two locations with a relatively small number of sampled contexts, a high number of species is recorded. For other evaluated locations, the rule of fewer samples – fewer species

(Mikulčice – extra-mural settlement, Mikulčice-Trapíkov) and more contexts – more species (Mikulčice-acropolis, Mikulčice – extra-mural settlement) applies.

9.2.1 Climatic factors

The reaction of individual plant species to climatic factors such as light, temperature and continentality have been studied by H. Ellenberg (1979) and is expressed by "indicator values". The indicator values for light characterise the occurrence of species in relation to the relative intensity of light during the summer months. The interval that characterises this relationship ranges from L1 – full shadow plants to L9 – full light plants. The indicator values for temperature reflect the distribution of plants along the geographical gradients of the latitude and the altitude. The temperature values range from T1 – cold, boreal or alpine climate to T9 – very warm, Mediterranean climate. The indicator values for continentality refers to the distribution of a species according to the general climate, degree of continentality and an emphasis on maximum and minimum temperatures. The indicator values range from K1 – eu-oceanic with, present only in the western part of Central Europe to K9 – eu-continental, scarcely present in Central Europe.

The method of descriptive statistics was used. The percentage shares of the occurrence of species with a specific attribute were calculated. Ellenberg's indicator values were used as the determinant for classifying the species into individual ecological groups. The percentage representation of species with a specific attribute regardless of the conservation method (charred, mineralised and waterlogged) was evaluated for each of the three climatic factors. As the different methods of preservation reflect different taphonomic processes and different (not only) settlement activities in early medieval Mikulčice these were taken into account when interpreting the results.

To characterise the exploited areas of the landscape (or situate them in it), the individual factors are evaluated separately for the groups of field weeds, meadow, ruderal and forest species. In the comparison and interpretation of the results, the number of taxa evaluated in individual areas was also taken into account.

9.2.1.1 Light

Among the field weeds, in that areas that have a higher number of field weed taxa (Kopčany, Mikulčice acropolis, outer bailey and riverbed) the half-light plants (L7) are dominant (up to 40 %). This is followed by the plants between half-shadow and half-light (L6). The occurrence of plants between half and full light (L8) and with full light (L9) is also relatively high as they reach approximately 20–30 % in almost all areas. The half-shadow (L5) field weeds are rare and only documented in the acropolis in 2 % of the cases. In summary, the field weeds present are mostly light-loving species [fig. 51a]. In terms of arable practices, such conditions can arise if for example the crops are sown with larger spaces in between (wider lines, sparser stands) or the crops have lower stems, thus producing less shade (Hajnalová 2012, 136). Crops can be sparse and sparser crop stands can reflect more extensive methods (e.g. sparser sowing on a larger area) or less fertile soils (acidic, sandy, too dry/moist, M. Hajnalová pers. comm.). It can also indicate that fields were not shaded by the trees but were located in an open landscape (cf. Dreslerová/Hajnalová/Macháček 2013, 844).

Species of meadows (grasslands) are similar to field weeds in their reaction to light, despite a lower number of taxa. The half-light plants (L7) are dominant, although their percentage share is lower (20–30 %). On the other hand, plants between half and full light (L8) and of full light (L9) are more common. They reach up to 60 % in the acropolis and make up 30 to 50 % in the other areas [fig. 51b]. The high number of light-loving species in this group stems from the nature of meadow plants, populating areas of the landscape which (for various reasons) remain treeless. The presence of plants between half-shadow and half light (L6), indicates thicker stands and/or shading by (solitary) trees or shrubs.

In the evaluated assemblage, much like in today's communities, the ruderal species have the highest number of species (9) indifferent to light (Li) and the rest are mainly from open sunlight stands. Ruderal species can be divided into species a) settling exclusively in ruderal biotopes, waste sites, alongside roads, fields and watercourses and usually do enter meadows, forest or fields, for example, *Hyoscyamus niger*; b) found also outside of ruderal biotopes, for example *Stellaria pallida* which enters into grass-lawns (Chytrý 2010). Among ruderals, plants between half and full light (L8) are the most numerous. However, there is also the half-shadow species (L5) documented in the acropolis [fig. 51c]. Ruderal species that are bound to human settlements and pathways can be used to reconstruct the environment of the settlements. If we argue that the ruderal species captured in the samples from

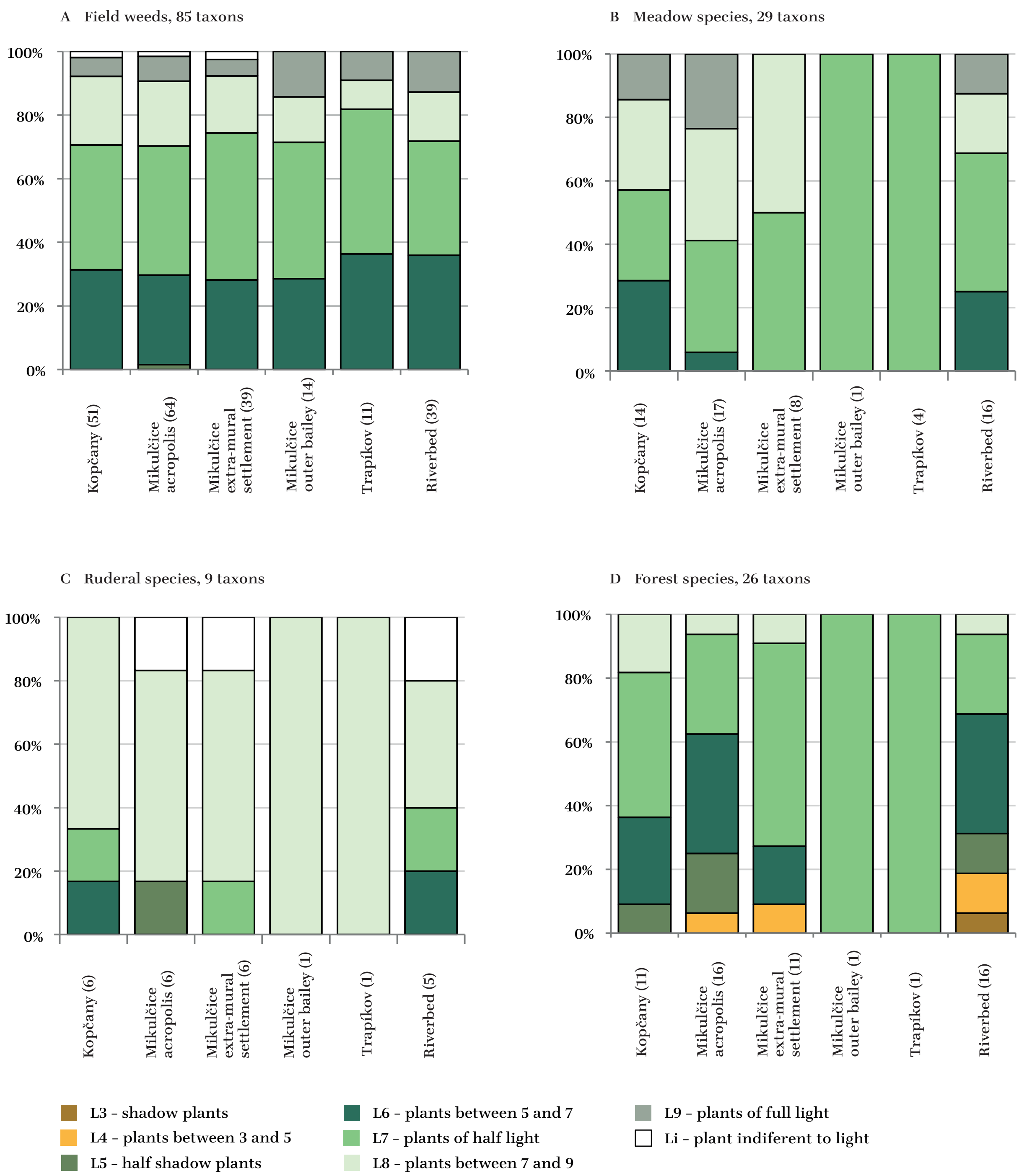


FIG. 51 | Mikulčice-Kopčany. Requirements for light of the species of fields, meadows, ruderals and forests. The number in parentheses is the number of evaluated taxa.

the acropolis in Mikulčice most probably originate from the settlement in this area and reflect the flora of local (burned) waste sites and stands, then the high portion of half-light and full-light species indicates that it could not have been as densely built-up during the Great Moravian period as current archaeological reconstructions suggest (Poláček/Hladík/Mazuch pers. comm.). In densely built up areas, the species indifferent and/or well adapted to shading would prevail.

Forest species from Mikulčice divide in their requirements for light into two groups. The first represent shadow tolerant species such as shadow plants (L3), between shadow and half-shadow (L4) and half-shadow plants (L5). The second group are species of plants between half-shadow and half-light plants (L6), half light plants (L7) and between half-light and full-light plants (L8). Among the finds from Kopčany and the outer bailey of Mikulčice, light-loving forest plants dominate, whereas in the acropolis and riverbed the species from the more shaded forest prevail [FIG. 51D]. The finds from areas at Mikulčice-Trapíkov and the extra-mural settlement of Mikulčice cannot be objectively evaluated due to the low number of forest taxa. The taxa present show an even distribution of plants from shaded and sunlit stands. To summarise, for the requirements for light by the forest herbs and shrubs, which are the plants of the second and the third forest stage, it is clear that both shaded forests with thick vegetation and more open "thin" forests were present and exploited in the vicinity of the Mikulčice agglomeration.

9.2.1.2 Temperature

The assemblage of field weeds is dominated by species with requirements for higher temperatures – species of intermediate to mostly warm climate (T6), – mostly warm climate species (T7) and – species between a warm and a very warm climate (T8). Species indicating a cold climate are absent. The coldest recorded are species of an intermediate climate (T5), which are present in all researched areas but at a maximum rate of 10–25 % [FIG. 52A]. It can, therefore, be assumed that the fields from which the PMR originate were situated in warm (and sunny) areas of the landscape.

In the assemblage of meadow species, the proportion of species of a mostly warm climate (T7) is even higher, reaching in all areas up to 30–40 %. As in the field weeds, the intermediate climate species (T5) are among the "coldest" [FIG. 52B]. The high representation of warm climate species indicates that meadow ecosystems were, similar to fields, situated in the warmest areas – for example, on heat accumulating substrates, biotopes protected from the wind and exposed to sunlight.

Apart from warm climate taxa (T6), species of the mostly cold to intermediate climate (T4) and species that are indifferent to the temperature (Ti) occur in ruderal species [FIG. 52C]. Even though this observation is based on a very small group of species (max. 6 taxa in one area), it indicates a somehow colder character of ruderal biotopes and is in contradiction to the results expected from the evaluation of light requirements.

The areas with a higher number of forest taxa have a higher occurrence of intermediate climate (T5) and indifferent species (Ti). Warm loving species, for example, plants between an intermediate and warm climate (T6) are less frequent. In Kopčany, Mikulčice acropolis and the riverbed, warm (T7) and warm to very warm climate (T8) forest species occurred [FIG. 52D]. It is clear from the results that there is a relationship/connection between the lower temperatures and the shading of the biotope in the evaluated assemblage. The "coldest" forest/woody species, i.e. (T5) are half-shadow plants (L5) such as *Prunus padus*, half-shadow to half-light plants (L6) such as *Corylus avellana, Rubus fruticosus* and *Rubus ceasius* or half-light plants (L7) such as *Cornus sanguinea, Prunus spinosa* and *Solanum dulcamara*. The listed species are almost exclusively lower woody plants or shrubs that mainly grow in semi-open forests or at the forest edges. Most forest herbs that are present are indifferent to both temperature and light (for example, *Viola reichenbachiana*). However, there are also species with higher requirements for temperature and low requirements for light in the assemblage (for example, *Ranunculus lanuginosus* T6, L3, *Cerasus avium* T5, L4). It follows that even though the Mikulčice forests were lighter in the early Middles Ages than today, they were still the coldest place in the surrounding environment.

9.2.1.3 Continentality

In all areas, oceanic climate species are the most numerous. The oceanic climate is characterised by small differences in temperatures during the day and the year and a higher rainfall, which is evenly spread throughout the year. The continental climate is characterised by large temperature differences between days and nights as well as between summer and winter and a low rainfall. As the factors of continentality and temperature are closely related, it is not surprising that they show a similar trend.

The oceanic to suboceanic climate plants (K2, K3 and K4) and intermediate climate species (K5) are the most common among the field weeds, reaching between 20 to 40 %. The subcontinental to continental climate plants (K6, K7 and K8) do not exceed 20 % [FIG. 53A]. Still, their proportion among field species is the highest in the evaluated assemblage. On the level of discussion, M. Hajnalová connects the higher occurrence of continental species with the more open and less shaded biotopes at the nearby early medieval site at Kostice-Zadní hrúd (cf. DRESLEROVÁ et al. 2013, 839).

In the assemblage of meadow species, continental species were only documented in Kopčany and the Mikulčice acropolis and reached

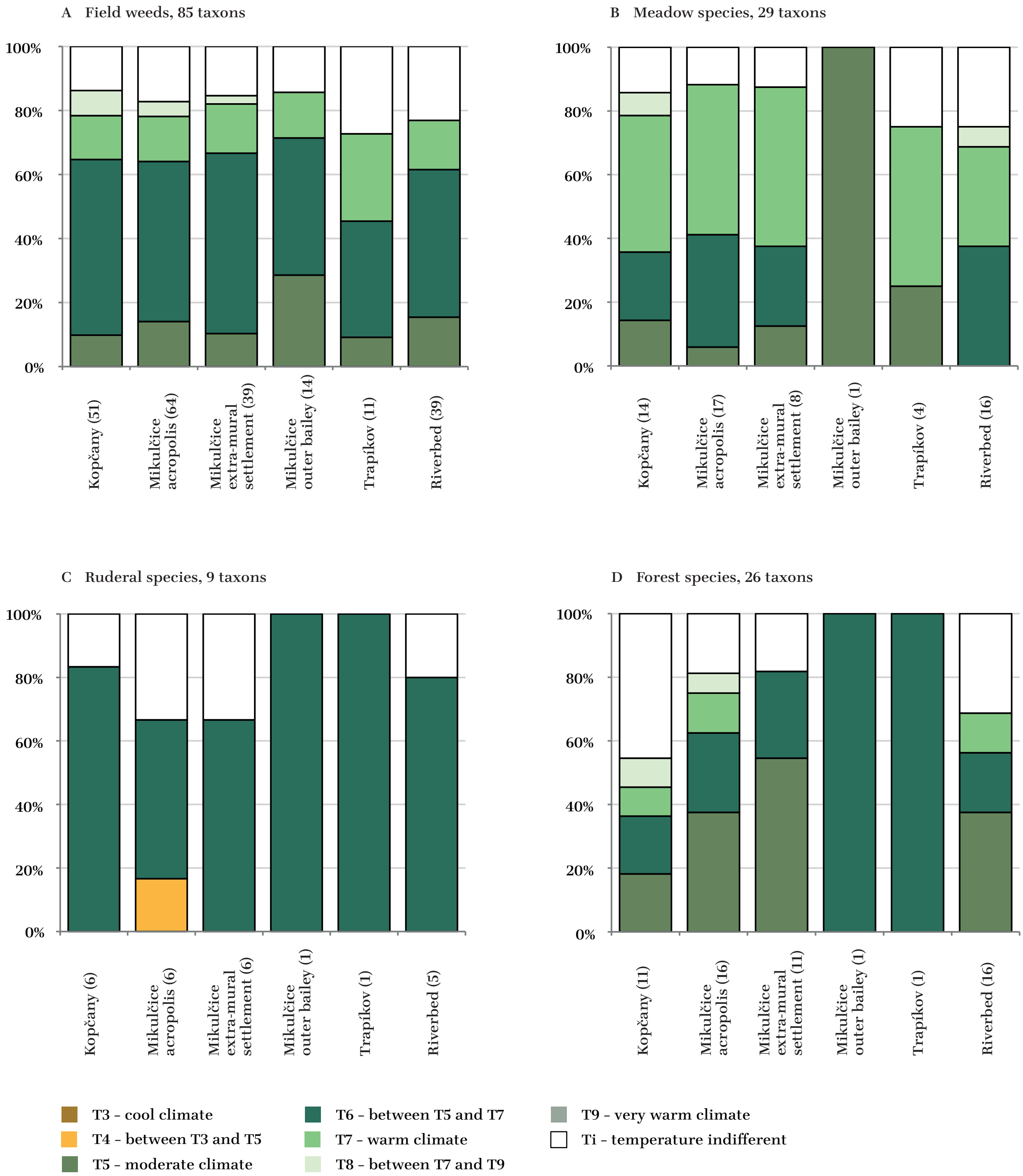


FIG. 52 | Mikulčice-Kopčany. Requirements for temperature of the species of fields, meadows, ruderals and forests. The number in parentheses is the number of evaluated taxa.

a maximum of 22 %. The assemblages from all areas are dominated by intermediate and oceanic climate species [FIG. 53B]. Meadow species, much like field weeds, indicate a rather oceanic character of the climate in the researched area in the early Middle Ages.

Ruderal plants are also inclined towards an oceanic climate. These mostly include oceanic to suboceanic climate plants (K3), which reach up to 50 % in most areas. In Kopčany, there are also some subcontinental to continental climate plants (K7). The highest proportion of species is plants that are indifferent to climate (Ki) [FIG. 53C].

Forest species assemblages from Mikulčice-Trapíkov and the Mikulčice extra-mural settlement were not evaluated due to an insufficient number of taxa. In the other areas, oceanic to suboceanic climate (K3) and suboceanic climate species (K4) are the most abundant. Forest plants for a continental climate are absent and the occurrence of indifferent plants (Ki) is also low [FIG. 53D].

9.2.2 Soil factors

Each species is assigned an indicator value according to A. JURKO (1990), which characterises the relationship of the given species to soil moisture (Pv), soil reaction (Pr) and soil nitrogen (Pd).

Soil moisture is influenced for example by the level of groundwater and the soil structure. The values of soil moisture range in the interval Pv1 (very dry stand) up to Pv6b (water and submerged plants). Among the most significant factors that influence the soil pH values are the bedrock (and its pH), rainfall, pH of the groundwater and the vegetation. The interval of values ranges from Pr1 (highly acid soil) to Pr5 (alkaline soil). The amount of nitrogen in soil significantly influences the fertility of soil. A. JURKO (1990) assigns values to species in the range from Pd1 (very poor soil) to Pd5 (very rich soil).

The values of soil characteristics were used as the determinant for species classification into individual groups. Species were included in the analysis regardless of the conservation method, i.e. charred, mineralised and waterlogged. Soil factors are evaluated in the same way as climatic factors.

9.2.2.1 Soil moisture

In the assemblage of field weeds, fresh soil (Pv3) and dry soil species (Pv2 and Pv2.5) are represented with the highest percentage share. While in Kopčany and the Mikulčice acropolis there are more dry soil plants, other areas have a higher representation of fresh soil plants more suitable for agriculture. Moist soil plants (Pv3.5 and more) usually do not exceed 20 % [FIG. 54A]. In summary, field weeds in assemblages from the early Middle Age Mikulčice and Kopčany indicate that plots of arable land were situated on dry, dry to fresh and fresh soil (altogether 60 to 70 %), i.e. in places with a low groundwater level and in locations that were not periodically waterlogged or flooded.

The assemblages of meadow species differ from field weeds in their soil moisture requirements. While weeds are inclined more towards soil with average soil moisture values (slightly closer to dry soil), meadow plants are more inclined towards border values such as extremely dry or extremely moist soil. The most numerous (25–38 %) are the species of very dry and dry soil (Pv1.5), while moist to wet soil (Pv4, Pv4.5 and Pv5) reach 30–40 % in individual areas [FIG. 54B]. It follows that meadows were situated in the landscape in locations less suitable for arable farming, such as on significantly dry or drying-out soil and also on significantly wet, possibly waterlogged or periodically flooded locations.

Despite very small assemblage, ruderal species show similar soil moisture requirements (Pv2.5) to field weeds. The documented ruderal species indicate biotopes of dry to fresh soil [FIG. 54C]. Species of significantly moist or waterlogged soil are absent. Based on the spectrum and requirements of ruderal species, it can be assumed that all settled areas were located in the drier (elevated) places within the floodplain.

In the forest herbs and shrubs assemblage, there are mostly fresh soil species (Pv3). The proportion of moist to wet soil plants (Pv4 and Pv4.5) and very dry and dry soil (Pv1.5 and Pv2) is between 10–20 % in individual areas and some categories [FIG. 54D]. The requirements of forest plants for soil moisture indicate that the forests or woods in the vicinity of the Mikulčice-Kopčany agglomeration, exploited during the early Middle Ages, were situated primarily on medium moist soil and to a lesser extent on moist (waterlogged) and dry soil.

9.2.2.2 Soil nitrogen

Requirements of field weeds for soil nitrogen indicate that arable plots were situated on a wide spectrum of soil types [FIG. 55A]. The most common (altogether 50–70 %) plants are for poor to medium rich soil (Pd2.5), medium rich (Pd3) and medium to rich (Pd3.5) soil. In almost all areas there is a documented occurrence of weeds for poor to very poor soil (Pd1.5) and very rich (Pd5) types of soil. However, both of these categories do not exceed 5 %. Plants for "extremely" poor or rich soil are absent only from Mikulčice-Trapíkov. A relatively high representation of field weed species such as *Chenopodium album agg. Polygonum lapathifolium, Polygonum persicaria, Chenopodium hybridum, Galium aparine, Hyoscyamus niger* and *Solanum nigrum* and, simultaneously, a low number of poor soil species, for example, *Asperula arvensis*, is seen as evidence indicating the application of methods for securing higher soil fertility (e.g. manuring).

The requirements of meadow species for soil nitrogen offer a better insight into the

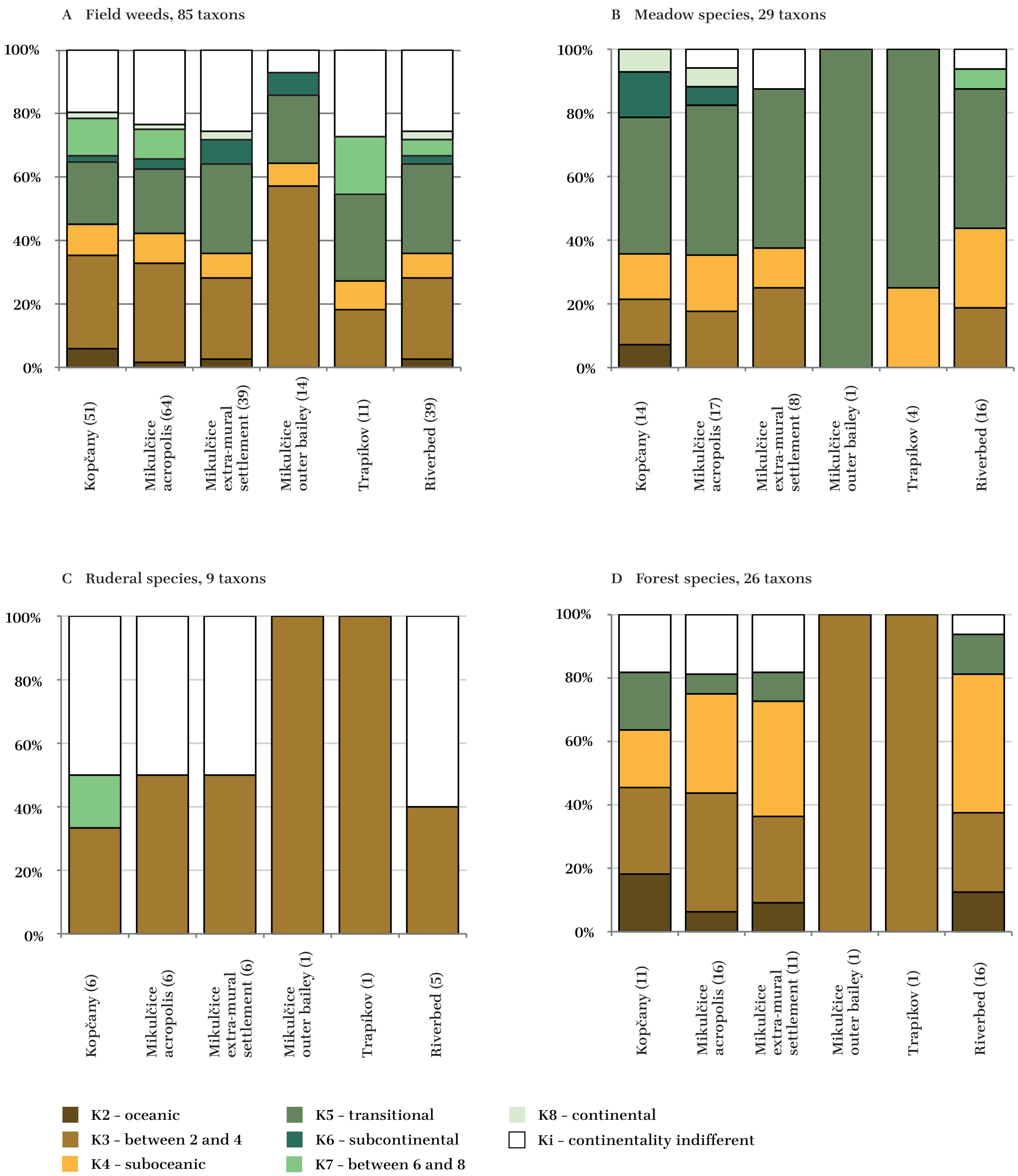


FIG. 53 | Mikulčice-Kopčany. Requirements for continentality of the species of fields, meadows, ruderals and forests. The number in parentheses is the number of evaluated taxa.

"real/natural" quality of the soil, as field weeds do. While nitrogen on early medieval arable plots can be the result of artificial anthropogenic activities (manuring, cultivation of legumes, fallowing), human induced improvement of the quality of the soil under meadows is not expected.

Among meadow plants, taxa for poor (Pd2), poor to medium (Pd2.5) and medium rich soil (Pd3) are documented respectively [FIG. 55B]. It is, therefore, possible that meadows were: 1) either situated in areas less suitable for arable farming or 2) if they were situated on the same soil as fields, the quality of soil in the fields was improved artificially.

The ruderal species naturally occur on soil enriched with nutrients through various

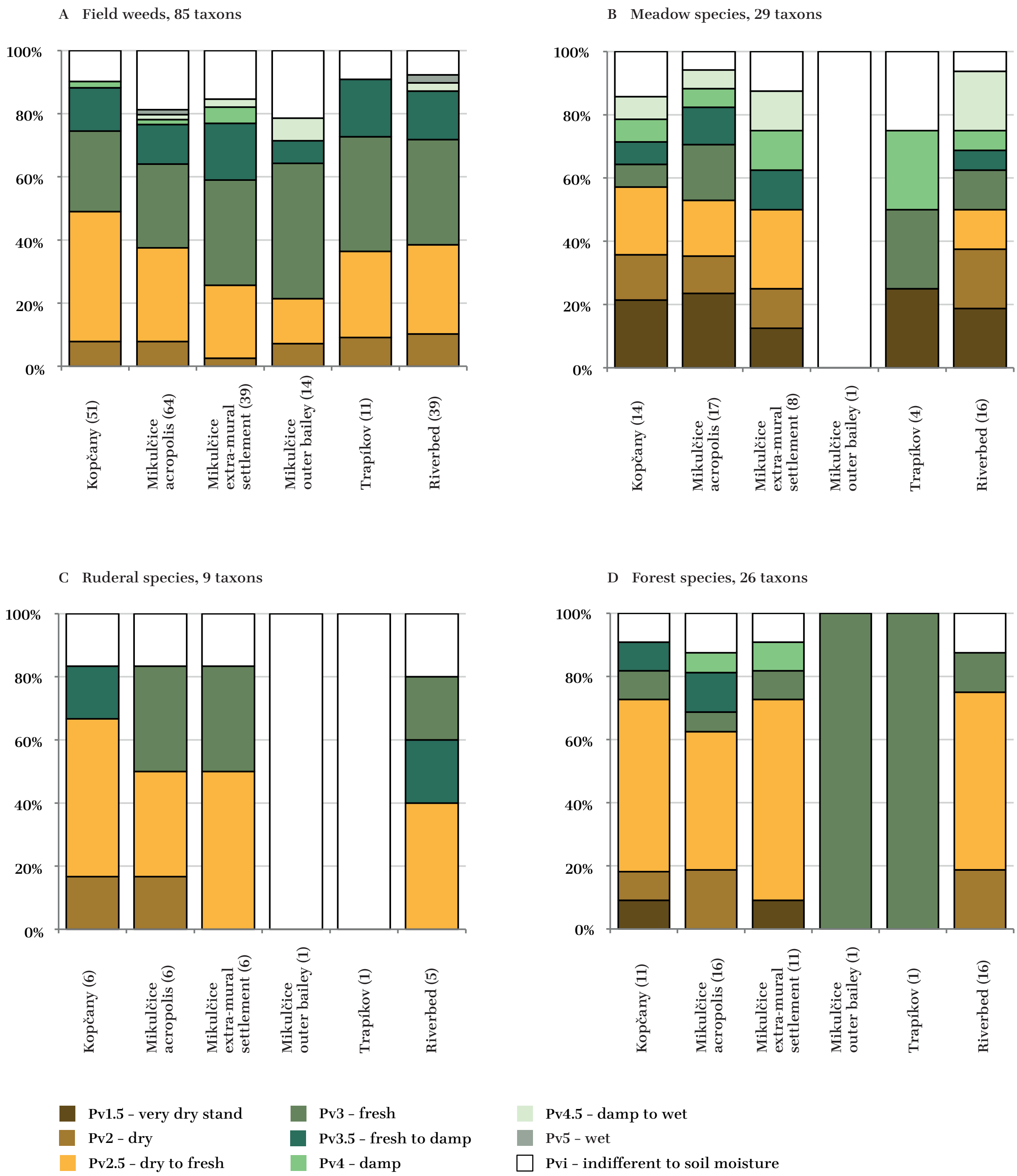


FIG. 54 | Mikulčice-Kopčany. Requirements for soil moisture of the species of fields, meadows, ruderals and forests. The number in parentheses is the number of evaluated taxa.

activities by man (e.g. accumulation of decomposing organic waste), where the degree of enrichment depends on the character of the activity and the force of the human impact. Among the evaluated ruderals from the Mikulčice-Kopčany agglomeration, there are mostly medium to rich soil plants (Pd3.5), followed by plants for rich to very rich soil (Pd4.5, [FIG. 55C]). The nitrogen content of the soil is the highest in the group of ruderal plants from early Middle Age Mikulčice.

The forest species requirements for soil nitrogen differ from the previous groups [FIG. 55D]. Forest herbs and shrubs indicate that forests were mostly situated on medium to rich soil (Pd3.5). Species of plants from such soil are documented in all researched areas and make up 30 to

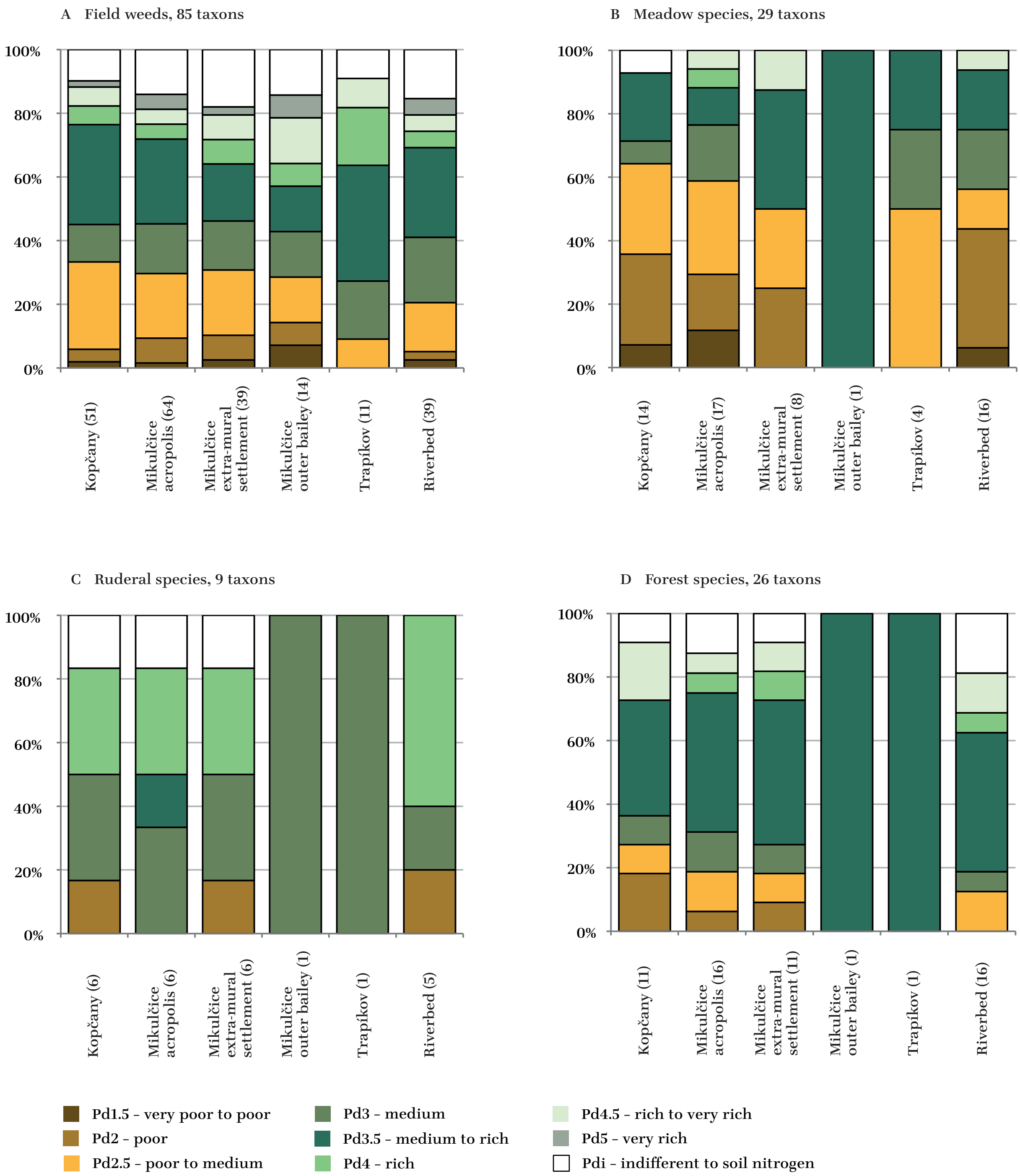


FIG. 55 | Mikulčice-Kopčany. Requirements for soil nitrogen of the species of fields, meadows, ruderals and forests. The number in parentheses is the number of evaluated taxa.

50 %. Forest species for poor and/or rich soil also occur but only to a limited extent (5–20 %).

9.2.2.3 Soil reaction

In the group of field weeds, half of the species are indifferent to the reaction (Pri), i.e. they can grow on all types of soil – acidic, neutral and basic. At the same time, most pH sensitive species (40–60 %) are plants with different gradients of acid soil: very acid to acid soil (Pr1.5), acid to mildly acid (Pr2.5), mildly acid (Pr3) to weakly acidic or even neutral (Pr3.5). The remaining ratio of plants with different gradients of neutral (Pr4) and neutral to basic or basic soil (Pr4.5 and Pr5) differs in individual areas [FIG. 56A]. To summarise, the plots of arable land from which the crops (and weeds) from Mikulčice and Kopčany originate, were situated on soil with different reactions (pH) although acid soil prevails.[62]

In their requirements to soil reaction, the meadow species behave differently than field weeds [FIG. 56B]. Among the soil pH sensitive species, the most abundant are neutral plants (Pr4) followed by plants for mostly weakly acid soil (Pr3). Similarly to field weeds, half of the taxa are plants indifferent to soil pH (Pri).

In a very small group of ruderal species [FIG. 56C], the proportion of indifferent species (Pri) is even larger (70–80 %). The remaining taxa are plants for weakly acid (Pr3), weakly acid to neutral (Pr3.5) and neutral soil (Pr4).

Forest species are also mostly indifferent to pH (Pri, 50–60 %) and pH sensitive species are mostly plants for neutral (Pr4) or weekly acid to neutral (Pr3.5) soil [FIG. 56D].

To summarise, the pH reaction of species differ only slightly among the evaluated groups of plants. The most abundant in all assemblages are plants indifferent to soil reaction, possibly due to unstable or changing soil pH (see the discussion below). Soil pH sensitive taxa incline mostly towards the soil for acid or acid to the neutral spectrum of the scale, with the exception of meadow plants, which incline more towards the neutral and basic soil. The similarities in the requirements of plants for fields and meadows, forests and ruderal stands is seen as an indicator that they were situated in a similar environment or the same part of the landscape (discussed below).

9.2.3 Summary of the analysis of climatic and soil factors

By comparing the requirements of wild species for climatic (light, warmth and continentality) and soil (soil moisture, soil nitrogen and soil reaction) factors, the following can be observed in the evaluated groups.

9.2.3.1 Fields

The assemblages from Kopčany, Mikulčice-acropolis and the outer bailey are very similar in the field weeds requirements for climatic conditions. It is, therefore, plausible to suggest that the fields from which these plants originate were situated on similar stands in the landscape and were farmed using similar arable practices. These arable plots can be characterised by sparser vegetation (e.g. larger distances between crop plants might be the result of extensive sowing on large plots, cultivation of crops with lower stems) on stands in an open landscape and not shaded by trees.

The requirements of field weeds for soil moisture and soil nitrogen allow us to place the fields in places with a lower level of groundwater – on fresh (semi-moist) and dry soil. The soil pH sensitive plants mostly indicate the exploitation of acid or neutral soil (basic soil species are rare. Such soil is found in the close vicinity of the locality within the floodplain of the Morava river valley. This is why it is very likely that early medieval crops found in Mikulčice and Kopčany were cultivated near the site. The results of the soil nitrogen analysis, in combination with previous results, indicate that methods of fertilisation to improve or maintain the quality of arable soil were used.

9.2.3.2 Meadows and pastures

The results of the analyses of climate factors show that meadow plants are similar to field weeds although there are more light and temperature demanding plants. The grassland communities were not just small enclaves situated in the forest openings but formed extensive stands. Mollusc analyses indicate that these grasslands resembled a short-herb step. The requirements of the meadow species for pH, soil moisture and soil nitrogen indicate that meadows were situated on soil of a medium to low quality, on drying-out and dry as well as wet and waterlogged soil.

9.2.3.3 Ruderal settlement species

There is the notion in archaeology that the finds of ruderal plants most likely represent the remains of local vegetation at the settlements and they got into the samples as a result of sanitary or other settlement cleaning activities (burning waste, burning the vegetation from the ditches and along the paths…). If this is the case, than the indicator values of ruderal plants show the early medieval settlement as open or sunlight. The largest ratio (still only 18 %) of shade-tolerant species comes from the central part of the stronghold – the acropolis. This can indicate a larger extent of shading of the ruderal stands by taller buildings

62 For an evaluation of field weeds in a broader context, see the chapter 9.2.4 Soil reaction – the key to the solution of multiple archaeological questions.

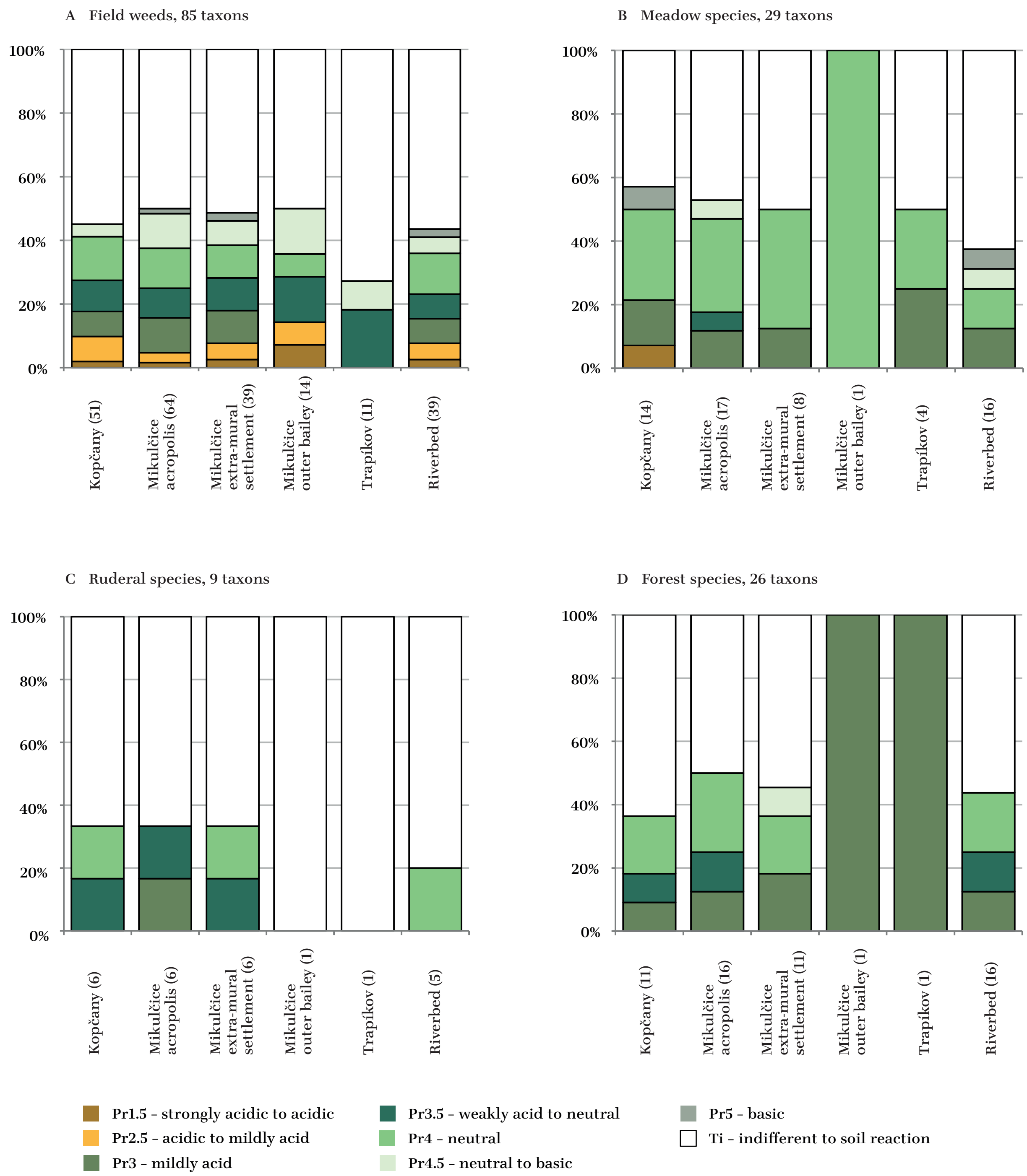


FIG. 56 | Mikulčice-Kopčany. Requirements for soil reaction of the species of fields, meadows, ruderals and forests. The number in parentheses is the number of evaluated taxa.

or trees. The soil moisture factors indicate that all evaluated areas of the settlement agglomeration were situated on dry soil. Soil rich in nitrogen, whose content increases through human activity, are a natural biotope for ruderal species. This is why it is not surprising that ruderal species from the Mikulčice-Kopčany agglomeration show the highest requirements for soil nitrogen. Their requirements for pH, towards acidic soil, are similar to the previous groups.

9.2.3.4 *Forest*

Forest herbs and shrubs are, like the previous groups, mostly plants from light and warm stands. Plants from warm shaded stands in thick forests are rare. This indicates the existence and exploitation of mostly open sunlight forests. Exploited forests or woodlands covered the areas on fresh (semi-moist) usually medium rich soil. No species indicates the exploitation of forests on extremely dry or wet (waterlogged) soil although some indicate forests on very rich or very poor soil. The soil reaction, much like with the previous groups, shows a higher affinity towards various acidic to neutral soil types. The PMR finds from the forest biotope support the theory of the occurrence of a hard-wood riparian forest in the area of the Mikulčice agglomeration during the Great Moravian period (Opravil 1972). The plant remains from forest taxa come mostly from the sediments of the riverbed (Area 93) and indicate that the local forest was only periodically flooded (Látková/Hajnalová 2014, 105).

9.2.4 Soil reaction – the key to the solution of multiple archaeological questions

The requirements for soil conditions, especially the soil reaction (but also soil moisture and nitrogen) of the plant taxa recovered from Mikulčice and Kopčany is the best source of information for:

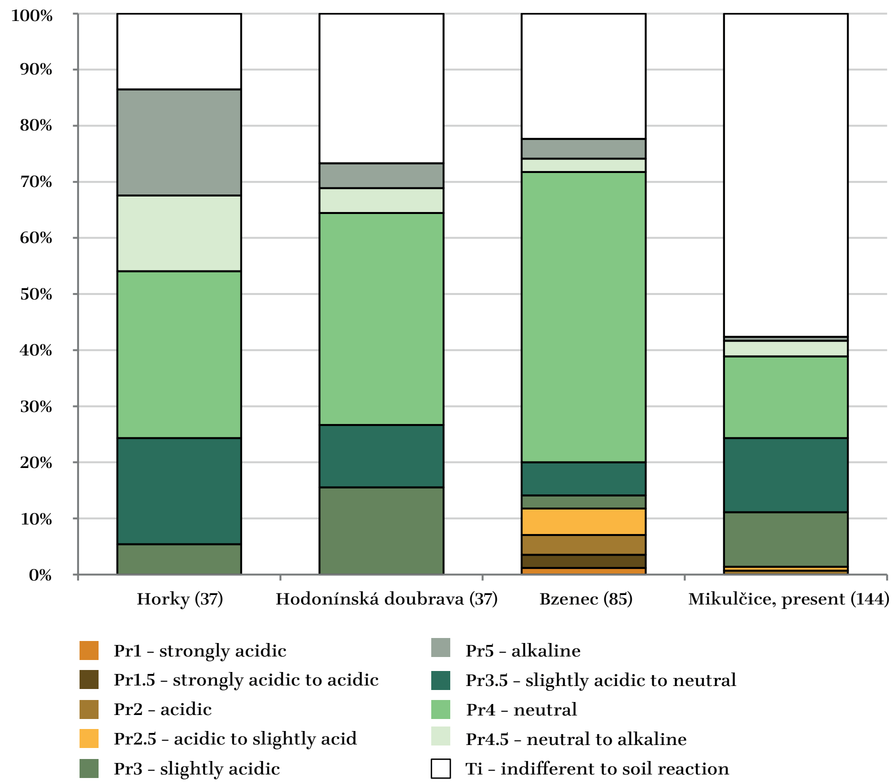
1) Reconstruction of the local soil conditions in the area of the Mikulčice-Kopčany agglomeration during the early Middle Ages.
2) The situation of plots of arable land on which recovered crops, which nourished the population of this stronghold, were cultivated.

During the early Middle Ages, in the area of southern Moravia, the settlement was concentrated on elevated places within the Morava river valley (cf. Hladík 2014, 70n). The fortified hillforts and surrounding open settlements were situated on sand dunes and aggradation banks (gravel or sand islands) within the floodplain, which for several centuries has been regarded as a relatively hostile, regularly flooded environment. This is why the issues of relief development and the characteristic of the soil are often discussed when addressing the questions of the subsistence strategy of these sites (Hladík 2014, 36; Macháček et al. 2007, 306). Local geological studies presume that the height of the elevated places could reach 6 to 8m in the early Middle Ages (Havlíček 2004, 16). Their gradual lowering began in a geologically earlier period and is related to the periodic floods (Macháček et al. 2007, 289). Sedimentation of alluvial deposits in the floodplain triggered the development of new soil types, which continues up to today (Břízová/Havlíček 2002; Macháček et al. 2007, 297). According to free geological sources (*www.geology.cz*), at the present time the floodplain is a mosaic of different soil types – gleyic mollic fluvisols, haplic fluvisols, gleyic fluvisol, fluvic gleysols and arenic regosols. The higher river terrace where the residential area of the modern Mikulčice village is situated is covered by arenic chernozems and modal chernozems, which developed on loess substrate (according to *www.geology.cz*). Today (and throughout written history) the majority of plots of arable land are situated on alkaline or neutral (never acidic) chernozems. This is also why in archaeological papers, the agricultural (crop producing) hinterland of the Mikulčice stronghold has been placed in these areas (cf. Poláček 2008a; Hladík 2014, 166).

Soil is a dynamic system susceptible to constant development. It is, therefore, possible that the soil in the early medieval period might have been different than today. The least affected characteristic is the soil reaction. For the most part, it depends on the attributes and pH of the substrate or the bedrock on which the soil was or is formed. To a lesser extent, it is influenced by the level and the pH of groundwater, the presence of ferrous minerals, vegetation cover and the management or farming (P. Dlappa pers. comm.). It usually holds true that alkaline soil is formed on alkaline substrates, neutral on neutral and acidic on acidic substrates. The occurrence of acidic soil on alkaline or neutral substrates is rare in east Central Europe. There is an area in the Slovak part of the Morava river floodplain where in the past the *soil with a neutral reaction has been documented on substrate formed by acidic sand*. Today, the soil in the locality once again has an acidic reaction. P. Dlappa assumes that the change of soil pH was the result of the change of the groundwater level. In the time when the soil had a neutral to alkaline reaction, the groundwater level was much higher than today (P. Dlappa pers. comm.).

In the area of the Mikulčice agglomeration, the bedrock is formed by sandy sediments with an acid reaction (Balátová-Tuláčková 1976), which is why the occurrence of an acidic reaction soil is not surprising. The waters of the Morava River are currently neutral to slightly alkaline with pH values ranging between 6.8 and 7.1 (Balátová-Tuláčková 1976). If the level of groundwater has a higher occurrence of a neutral reaction, the soil could be expected to at least be in some places (see above).

FIG. 57 | Requirements of plant taxa from Horky, Hodonínska doubrava, Bzenec, and Mikulčice (current state of vegetation) for soil reaction. The number in parentheses expresses the number of taxa in individual areas.



When confronting the results of analyses of the requirements of plants from early medieval Mikulčice and Kopčany for soil reaction with the information on geology (spatial distribution of substrates, soil types, past and present groundwater levels) it is possible to situate the early medieval fields (as well as meadows, forests and ruderal stands), from which the PMR discovered in Mikulčice and Kopčany originate, into the Morava river floodplain – most probably to the close vicinity of the settlements. The dominance of acid-tolerant and indifferent species in the assemblages of field, meadow, forest and ruderal species from all evaluated areas of Mikulčice agglomeration contradicts the previous hypothesis, which places the agricultural hinterland – mostly arable land – on the neutral to basic chernozems outside the river valley.

To verify the new hypothesis, four studies were selected from the published botanical literature that provides floristic data on meadows situated on different soil types in the region of the Lower Morava Valley. The species data were subject to ecological analysis identical to the analysis of the archaeological material.

The first location is the Nature Reserve **Horky** (Podešva 2008), which represents an ecotone biotope located between arable land and vineyards at the edge of Milotice village (Hodonín district). The bedrock is formed by "histosol clays" partially covered with loess on which the arenic chernozems and regosols developed. In the past, the area was partially used as pasture and partially as a mowed meadow. The nature reserve is a unique biotope of a sub-Pannonian steppe community of plant and animal species, which today represents an islet in the middle of intensively cultivated land (Podešva 2008). The analysis from this location (Podešva 2008) included 37 botanical taxa [TAB. 35]. The second location is a protected Area of European Significance – **Hodonínská doubrava** (Hodonín district) is situated between municipalities of Hodonín, Mutěnice and Dubňany. The substrate is mostly formed by blown sands on basic tertiary deposits on which arenic chernozems and cambisols developed. The location represents a large forest with a diverse mosaic of species and communities. There are forest pools and xerothermic communities on elevated places with rich herb stands next to moist, shaded biotopes (Cibulka 2014). Thirty-seven taxa were evaluated from the botanical records of herb-rich forest openings [TAB. 36]. The third location is the National Natural Monument **Váté písky** near Bzenec (Hodonín district), which stretches along the Břeclav–Přerov railway between the stations of Rohatec and Bzenec. The bedrock is formed by the sands of the Morava River, which were deposited during the Pleistocene and in some places are up to 30 metres thick. In the past, this location was used as pasture. The grazing management triggered the movement of the sand dune and thus it was decided at the beginning of the 19th century that the area should be forested. As a result, the size of the biotope decreased (Hoskovec 2008). The analysis from this biotope included 85 botanical taxons [tab. 37]. The final evaluated location is the flora of the **Mikulčice-Valy** Archaeological Monument itself (Brzicová 2014) where 160 botanical taxa were found (Brzicová 2014), of which 144 are included in the analysis [tab. 38].

The selection and classification of species based on the requirements for soil pH and the method of evaluation were the same as in the archaeological assemblages. The species requirements for soil pH from these locations [fig. 57] demonstrate that:

1) Locations situated on the terraces further away from the watercourse (Horky and Hodonínská doubrava) have the highest proportion of neutral and alkaline species (Pr4 to Pr5). Acidophilous species make up from 5 to 15 % and at most species are weakly acidic soil (Pr3). They differ most from the archaeological data.
2) The Bzenec location with a higher portion of acidophilus species is more similar to the archaeological data from Mikulčice and Kopčany. Váté písky near Bzenec is situated on arenic regosols, which were formed on aeolian sands (sand dunes) of the Morava River. This is why the presence and the higher proportion of more acidophilus species is not surprising. The main difference between this and archaeological assemblage is the low percentage of indifferent (PRi) and the high percentage of neutral (Pr4) species. The proportion of species indifferent to soil pH makes up 15 to 25 %, similarly to the Horka and Hodonínská doubrava.
3) The requirements of plant taxa from the Mikulčice archaeological monument are the most similar to local archaeological data. Similarities can be observed in the percentages of indifferent species (Pri) which have a representation of over 50 % and in the high proportion of species of very acid to weakly acid soil (Pr1 to Pr3). Plants from neutral (Pr4) and alkaline soil (Pr4.5 and Pr5) are as in the archaeological assemblage, documented only in a small proportion (1–2 %).

The high similarity in the plant requirements for soil pH in the archaeological material from Mikulčice and Kopčany and the species of current vegetation of the National Cultural Monument in Mikulčice situated in the river's floodplain (and the dissimilarity with the localities situated on chernozems or aeolian sands) is seen as evidence supporting the hypothesis regarding the situation in the fields during the early Middle Ages in the area of the river floodplain and in the vicinity of the stronghold.[63] A large proportion (50 %) of species indifferent to pH in the current meadows as well as in the archaeological field, meadow and forest archaeological assemblages proves that as in the past, even today the floodplain is subject to dynamic changes (such as fluctuation in groundwater level, changes in moisture or soil pH) which the plants had to, and still have to, adapt to.

Based on the ecological analysis of archaeological data and its confrontation with geology, pedology and the results of the ecological analysis of modern vegetation in the region, the earlier hypothesis of the situation of the fields, meadows/pastures and forests exploited by the residents of the early medieval Mikulčice-Kopčany stronghold into a broader more distant area of the river terraces can be rejected. It cannot be ruled out, however, that part of the crops and the associated weeds (e.g. plants of basic soil) came from this area.

The comparison of the results of the identical analyses from the contemporary and nearby site of Kostice-Zadní hrúd near Pohansko stronghold (Dreslerová et al. 2013) is enlightening. In the RS3 phase, a large share of species indifferent to soil pH (up to 60 %) is documented and other classified species are mostly weakly acidic or neutral (Dreslerová et al. 2013, 840). Considering that Zadní hrúd is situated right at the border of the floodplain and the landscape with fertile chernozems, it is surprising that most field weeds indicate the exploitation of stands in the acid environment of the floodplain. It is currently the only other location available from which we might formulate a hypothesis that despite locations of the settlement on chernozems majority of arable land exploited during the Great Moravian era was situated in the river floodplain. This could indicate that 1) in the early Middle Ages, the floodplain had a different character than today, 2) that soil in the floodplain were more fertile than soil in the river terraces (e.g. due to dry

63 Currently, the arable land stretches all the way to the new archaeological base built at the Mikulčice-Trapíkov excavation area, which still lies in the Morava River floodplain. Also in the past and until the archaeological excavations in 1960s under the supervision of J. Poulík, part of the fortified area was used as intensively farmed arable land.

climate, which is drier than today), when chernozems dried out due to the shortage of rainfall, and as a result of insufficient irrigation, they became unusable for farming). It is also noteworthy that in the RS4 phase of Kostice-Zadní hrúd, when the climate change brings heavier rainfall (M. Hajnalová pers. comm.) a proportion of acidic and indifferent species decreases in favour of plants from neutral and alkaline soil (Dreslerová et al. 2013, 840). This could indicate a change in the location of arable land, i.e. the shift of fields from floodplain to chernozem areas and further from main watercourses.

There are many ways how to estimate the area of agricultural land for feeding a population of a certain size in the past. Such reconstructions often start with (objective) estimates of the population size, the yields of the grown crops, and the conditions of the given environment and climate (Hajnalová 2012, 154). Based on the ethnographic data, it can be assumed that a family unit of 4–6 members need 0.3 to 1 ha of arable land (Bogaard 2004, Dreslerová 2011, Hajnalová/Dreslerová 2010). When using this information and the current estimates for the population of Mikulčice ranging from 1000 to 2000 inhabitants (Klanica 1987, 128; Poláček 2008a, 265–266; 2008b, 24–25; Poulík 1975, 151; Stloukal/Vyhnánek 1976, 40–42) then the area of arable land needed to sustain this population would be between 60 and 400 ha. In simple modelling, such an area would be demarcated as a circle with a radius of 437–1128 m.

If the arable land makes up 40 % of the environment exploited for basic households needs, the size of the entire area (including meadows, pastures and forests) for the Mikulčice stronghold can be estimated as a circle with a radius of 1100–2820 m.[64]

The situation of arable and other agricultural land into the closest vicinity of the village is primarily important because of its control and protection. The necessity of its accessibility with regards to time is also equally important. There are up to 30 various activities that need to be carried out regularly throughout the year in the field (Hillman 1984, 1); ploughing, harrowing, sowing, tillage, manuring and harvesting are just some of the most labour demanding. Anthropological analyses from Mikulčice suggest that at least a certain group of the Mikulčice stronghold population were employed in farming activities. Especially with women, significant changes were noted in the area of ligaments and muscles, which indicate that individuals were regularly exposed to a high physical load or hard manual labour (Havelková et al. 2011).

64 See for example L. Poláček (2008a, 265-266).

9.2.5 Biotic factors

One of the most important factors that influence the composition of weed communities of fields and gardens is the type of crop grown. Each crop creates specific conditions to which field weeds must adjust. Biotic factors, such as the time of germination and flowering or the existence of species (phytosociology), have been used in archaeology to reconstruct methods of arable practices, i.e. identification of the time of sowing, harvesting and the intensity of agricultural activities.

To address this question, it is first necessary to exclude from the data matrix any species that might have originated form other than farming activities. To avoid any misinterpretations, only finds preserved in charred form were selected and from those, only the taxa considered as possible weeds from fields and gardens were evaluated (for reasons and argumentation, see the results of the taphonomic analyses).

9.2.5.1 Flowering period

Species that have a long germination period (some annuals but also some perennials) usually also have a longer flowering period. Species with a longer flowering period react to the soil disturbance by producing more than one generation within one vegetation season unlike species with a short flowering period, which are not capable of that. Long flowering species also much easier regenerate after the disturbance by spring tillage or ploughing (Bogaard et al. 2001). Species with a later offset of flowering (from July) are at a disadvantage in the fields for winter crops, which is why they most commonly occur in crops sown in spring. It is vice versa for those species flowering before spring or in early spring, which usually already germinate before the spring ploughing and are typical for fields for winter crops (Charles et al. 2002; Bogaard 2004, 83).

Information on the flowering period is taken from A. Jurko (1990). The percentage share was counted using the same method as for evaluating climatic and soil factors (see the chapter 9.2 Autoecological analysis of wild species).

The results show that species which flower from the end of spring (Fk4) and from midsummer (Fk5) are the most common [fig. 58]. Species flowering before spring (Fk1) and from late

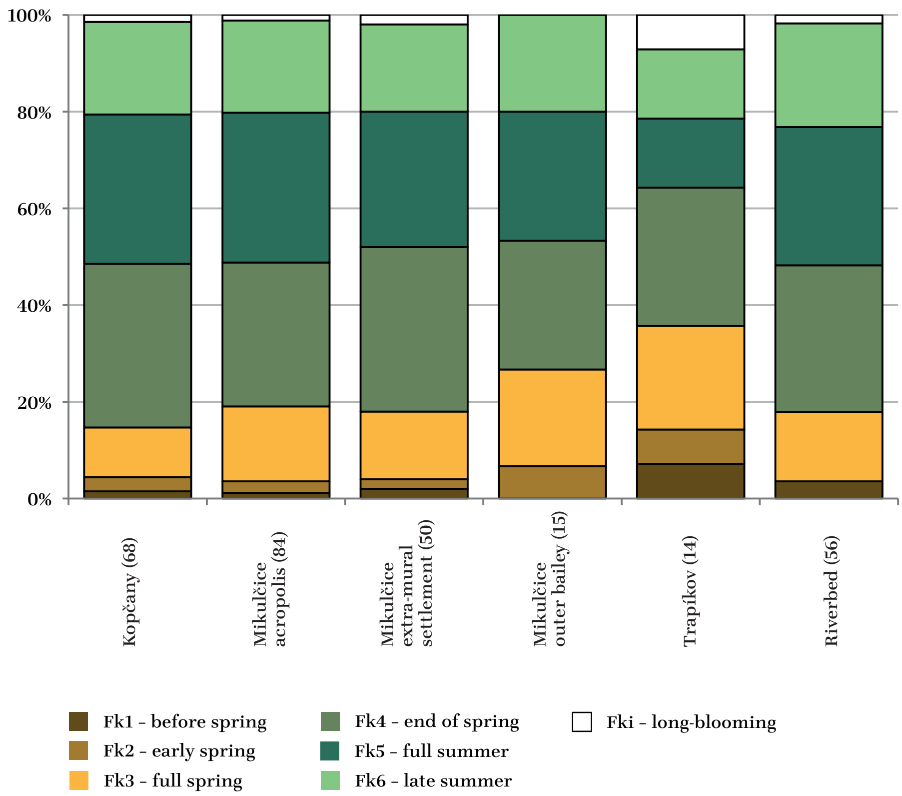


FIG. 58 | Mikulčice-Kopčany. Offset and the length of the flowering period of the species of fields, meadows, ruderals and forests. The number in parentheses is the number of evaluated taxa.

summer (Fk6) are less common. The differences between individual areas are smaller than in previous ecological analyses. There are also similar results for the assemblages of charred remains from "usual" archaeological contexts from the settlement areas (Kopčany, Mikulčice-acropolis and Mikulčice-outer bailey) and charred remains from the riverbed. The presence of very early flowering weeds (Fk1 and Fk2) is only documented at the Mikulčice extra-mural settlement and at Mikulčice-Trapíkov, where the highest portion of long flowering species (Fki) is evidenced.

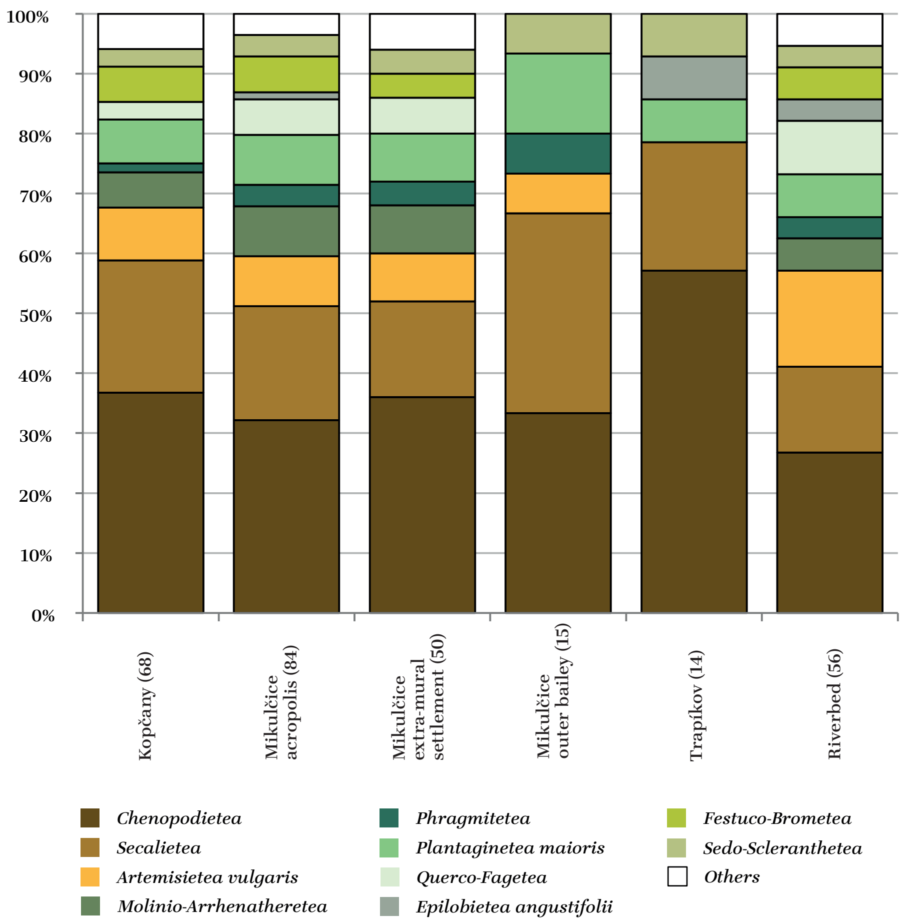
Relatively low numbers of species flowering early in the spring and their absence in areas of the Mikulčice-acropolis, the fortified outer bailey and Kopčany indicate that recorded weeds were grown on the fields where spring crops were grown or from fields for winter crops where intensive farming methods (spring tillage, weeding) were used. The application of intensive cultivation methods results in the occurrence of species that flower late in spring or over a long period. These species are able to regenerate after the disturbance of the soil in early spring. The presence of long-flowering or late-flowering species might also be caused by a long life cycle of winter crops (e.g. wheat or rye). Unfortunately, the highly mixed character of the samples from Mikulčice and Kopčany prevents the determination of the affiliation of different crops of (groups) of weeds (see chapter 7 Taphonomic analysis and origin of archaeobotanical samples) and it is not possible to specify whether different crops were cultivated under a different intensity or regime.

9.2.5.2 Phytosociological analysis of wild species

The association of weed species with the *Chenopodietea* and *Secalietea* phytosociological classes can also be used to detect the time of sowing or management of the crops (cf. van der Veen 1992; Bogaard 2004).

The *Secalietea* class is (today) characterised by species that occur mostly in fields with crops sown in the autumn. Annual species that germinate very early in the spring or perennials often occur in such fields (Ellenberg 1988, 628). In the *Chenopodietea* class, species that grow primarily in fields for spring crops or in root crops occur. Ruderal biotope species are also fairly common (Ellenberg 1988, 628). The *Secalietea* and *Chenopodietea* class differ in their species requirements for temperature during germination and their life cycle. According to H. Ellenberg (1950), the different composition of weeds in winter and spring fields is caused by multiple factors. The most important of these seems to

FIG. 59 | Mikulčice-Kopčany. Association of plants of fields, meadows, ruderals and forests with phytosociological units. The number in parentheses is the number of evaluated taxa.



be the life cycle of the plants and farming methods, which differ significantly with these two ecological classes.

Species from Mikulčice that could not be associated with these two classes could be classified within communities of the ruderals (*Artemisietea vulgaris*), wet and mesophilic meadows and pastures (*Molinio-Arrhenatheretea*), reed communities of wetlands (*Phragmitetea*), trampled and trodden biotopes (*Plantaginetea maioris*), oak woodlands (*Querco-Fagetea*), forest openings (*Epilobietea angustifolii*), xerothermic steppe grasslands (*Festuco-Brometea*) and pioneer communities of shallow soil (*Sedo-Scleranthetea*). Species that could not be classified within these communities remained classified in the "other" category (*Scheuchzerio-Caricetea fuscae, Trifolio-Geranietea sanguinei, Betulo-Adenostyletea, Bidentetea tripartiti, Salicetea purpureae, Quercetea-robori-petraeae, Isoeto-Nanojuncetea* and *Erico-Pinetea*). The species in this category do not exceed 5 %. It was possible to assign charred PMR from all areas to all the listed communities.

Information on the phytosociology of given species was drawn from the works of J. Dostál and M. Červenka (1991, 1992).

Species of the *Chenopodietea* class dominate in the examined PMR assemblage in almost all of the researched areas with the exception of the Mikulčice extra-mural settlement, where the ratio of *Chenopodietea* and *Secalietea* species is equal [FIG. 59]. Considering that crops mostly cultivated as winter cereals, such as rye also occur in the examined assemblages, the high number of *Chenopodietea* species can be the result of spring tillage or weeding the fields (results similar to the evaluation of the flowering period). The higher representation of the Secalietea class species in Kopčany, the Mikulčice-acropolis and the Mikulčice-outer bailey might indicate that part of the (winter sown) crops were cultivated under more extensive farming methods.

Among others, the species of meadows and other grassland communities *Artemisietea vulgaris, Molinio-Arrhenatheretea, Plantaginetea maioris* and *Festuco-Brometea* were most common. The occurrence of these species in the fields might indicate that arable plots were closely bordering meadows or pastures (Eliáš et al. 2010; M. Hajnalová pers. comm.). The presence of species from wetland communities indicate that some fields were situated in the vicinity of

Hight category	Total ratio %	Field weed species %	Meadow species %	Ruderal species %
up to 30 cm	21.81	15.45	5.45	0.90
31–60 cm	33.63	25.45	3.63	4.54
above 61 cm	48.18	29.09	10.90	4.54

TAB. 28 | Mikulčice-Kopčany. Percentage of the height categories of plant species.

a watercourse, in places with a higher groundwater table or in the vicinity of wet and mesophilous meadows, while other fields were situated on dry soil and in the vicinity of xerothermic "steppe" meadows. The share of these two categories is almost identical in the areas of Kopčany, Mikulčice-acropolis and Mikulčice-outer bailey. Such diversity indicates that fields were situated on different locations in the landscape.

9.2.6 Anthropogenic factors

The composition of weed communities (and archaeobotanical assemblages) is strongly influenced by cultivation methods such as the degree and the timing of soil disturbance (tillage, weeding) and the height of the harvesting of the crops. In this analysis, the species used were the same as in previous analysis.

9.2.6.1 Ploughing and tillage

Depth and time of ploughing, harrowing, spring tillage and weeding of the crops also influence the composition of weed communities. Repetitive or vigorous application of this method requires more energy and the combination of other labour demanding activities (e.g. manuring) represents intensive farming practices. The deep(er) ploughing started in the La Tène period and is connected with introduction of iron ploughing and tillage equipment (Hajnalová 2000; 2012, 150). Iron ploughs, which enabled deeper disturbance of the soil, were also used in the early Middle Ages. Application of intensive methods of farming results in the decrease of perennial and the increase of annual weed taxa also in archaeological samples. Vice versa, increased numbers of perennials indicate a lower level of soil disturbance and therefore use of extensive farming methods.

The ratio of annuals to perennials differs in the examined areas of the stronghold [FIG. 60]. In the Mikulčice acropolis, the outer bailey and the riverbed, their ratio is equal. In other locations, the number of annuals is slightly higher although the percentage of perennials still reaches up to 40 %.

If the ratio of annual and perennial species in archaeological assemblages is considered as an indicator of the intensity of farming, then the fields supplying Kopčany, Mikulčice-Trapíkov and partially also the Mikulčice extra-mural settlement were farmed intensively. The fields producing for the central parts of the agglomeration – the acropolis and the outer bailey were cultivated extensively (e.g. cultivation of larger plots with less labour per unit of land usually situated further from the settlement; cf. Jones/Halstead 1995).

As it is not possible to assign groups of weeds to the individual types of crops (see chapter 7 Taphonomic analysis and origin of archaeobotanical samples), it is also not possible to specify whether a particular crop type was cultivated under an intensive or extensive regime. Still, it is clear that some crops and/or fields in early medieval Mikulčice were cultivated more intensively than others.

9.2.6.2 Harvesting height

There are many summaries in specialised archaeological literature that address the methods of harvesting cereal crops in the past and are based on historical written or iconographic sources (mostly) from the later periods of the Middle Ages (Beranová/Kubačák 2010). In addition, the information is also provided by ethnography and ethnobotany (cf. Hajnalová/Dreslerová 2010; Fuller/Harvey 2006). The sources document a wide range of cereal harvesting techniques. They can be divided into two main categories – harvesting with or without tools and harvesting low or high on the stem. Reaping tools can be made from various materials (wood, stone, bone, metal). Among the most common are e.g. harvesting knives, sickles, scythes and mesorias. If no tools are used, crops can be harvested by uprooting (pulling the entire plant) or by breaking off the cereal ear (cf. Hajnalová 2012, 148). On the territory of Moravia and Slovakia the recovered tools indicate that during the early Middle Ages, iron sickles or "short" scythes were used for cereal harvest (Borzová 2009). The numerous and varied assemblage of sickles and scythes

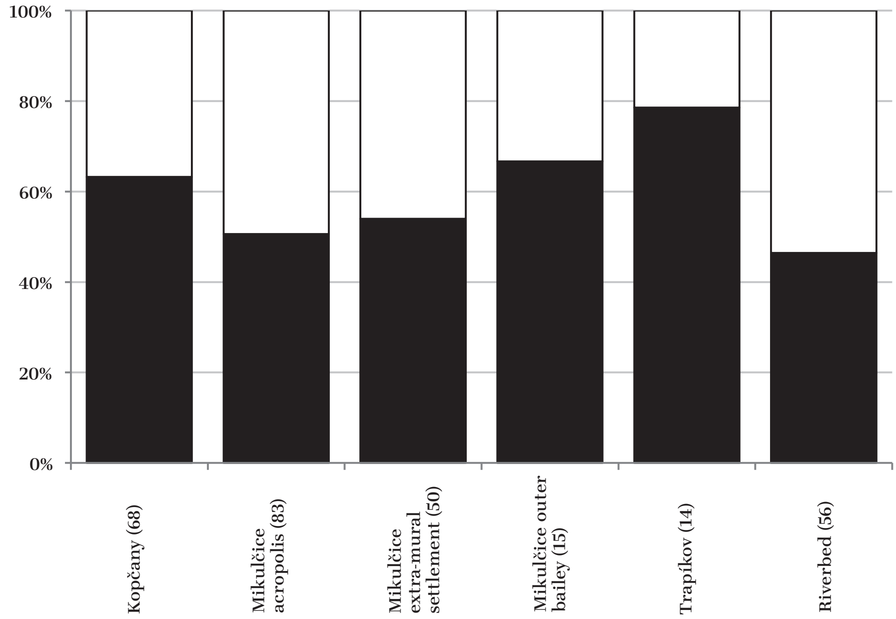


FIG. 60 | Mikulčice-Kopčany. Life form of plants of fields, meadows, ruderals and forests (the number in parentheses expresses the number of taxa).

is also known from Mikulčice (Poláček 2003b; Hladík 2014). The crops can be harvested low to the ground – when for example straw is needed or higher up on the stem when only cereal ears with short stalks are collected. Harvesting close to the ground by knife/scythe/sickle or reaping by pulling the entire plants results in the presence of low-growing species such as *Arenaria serpylifolia, Lepidium ruderale, Veronica hederifolia* and *Viola arvensis* in the harvested crop (and in archaeobotanical samples). In crops harvested higher on the stem – or just under the ear – the low-growing species will be absent. The information on the height of the weed species present in the archaeological samples can be used to detect the height of harvesting of the crops in the past (cf. van der Veen 1992; Hajnalová 2012, 148–149).

The presence of seeds from climbing species and at the same time the presence of fragments of roots or the basal internodes of cereal straw is characteristic for uprooting the plants/cereals (Hillman 1981, 49–51). There are no finds of straw and chaff from Mikulčice and Kopčany, so it is therefore not possible to stipulate if this method was used. The numerous finds of iron sickles and scythes suggest that the crops were harvest by cutting the crops with these tools.

Out of the evaluated 110 taxa [FIG. 61], 24 are low-growing species with a maximum height of 30cm. In the medium height category (from 31–60 cm) there are 37 species, and in the tall category (above 61 cm) there are 49 species. The graphic output shows that very low plants with a maximum height of 15 cm are absent from the assemblage. The medium-high species (approx. 30 cm) and higher (above 61 cm) dominate. The same result is also observed in species that today are considered as meadow and ruderal plants [TAB. 28]. The results indicate that cereals were harvested mostly higher on the stem (from 20–30 cm). A small portion of low growing species indicates that some crops were harvested low. At present, we cannot ascertain which species might have been harvested this way. In the recent past, the valued commodity in Slovakia was long rye straw, which was used for roofing and basketry. Straw can also be used in daub, to fill mattresses, as bedding for animals and as an insulating material.

The harvesting of cereals higher on the stem simplifies and speeds up the consequent processing of the crops (threshing, raking) because less straw and chaff needs to be eliminated. However, part of the straw and weeds remained after harvest in the field. This stubble could have been grazed by domestic animals. However, the higher the stubble the more difficult it is to plough. This difficulty can be overcome by burning the stubble field. Leaving a large amount of straw in the fields significantly reduces the supply of straw as a commodity.

9.2.7 Summary of ecological analyses

The aim of this chapter was to use the evaluation of the ecological attributes of wild species to reconstruct arable farming methods used at Mikulčice and Kopčany, characterise the local environment on and around the site during the early Middle Ages and by doing so, to verify the hypothesis of local production of staple (cereal and pulse) crops.

Due to the mixed character of the samples (a mixture of various crops in every sample), it was impossible to say whether some farming methods, such as the time of sowing, the intensive/extensive cultivation, etc., are only bound to certain type(s) of crops.

For arable practices, the results are summarised in the order in which the activities were carried out during the agricultural year. The ratios of perennial species and species sensitive to soil disturbance against the annuals indicate that ploughing was relatively shallow or not repetitive. We could not ascertain whether the crops that today are usually sown in the autumn (bread wheat, rye, barley) and in the spring (millet, pulses) were cultivated as such in early medieval Mikulčice and Kopčany. However, the high numbers of perennials with the balanced ratio of the species from *Chenopodietea* and *Secalinetea* classes indicate that certain fields/crops were cultivated under more intensive and extensive regimes. The data indicates that fields that supplied the central parts of the stronghold were cultivated by more extensive techniques, while the crops found at peripheral parts indicate more labour demanding intensive methods. The quality of arable soil has been maintained. At extensively farmed plots, this was probably achieved by short fallowing (supported by a higher number of perennials and meadow plants). This was done at fields under intensive care by investing more labour (manuring, repetitive tillage), and in both cases, also by suitable rotation of crops. Multiple ecological factors confirmed the placement of fields at the river valley floor (the floodplain) and to the vicinity of the stronghold. The wider varieties of biotopes on mostly acid and dry soil were present and exploited. Parts of the crops were harvested low as indicated by low growing weeds although the majority appear to have been cut higher on the stem.

When comparing the individual areas, most analyses show similarities between Kopčany, the Mikulčice acropolis and Mikulčice outer bailey assemblages. These similarities indicate that the fields which supplied these parts of the agglomeration were situated and cultivated in a similar manner and that Kopčany and the central part of the stronghold had a similar subsistence strategy, which was different from the Mikulčice-Trapíkov and Mikulčice extra-mural settlement. Due to the mixture of anthropic and natural sediments, the assemblage from the riverbed has a category of its own although the character of the finds is most similar to the central part of the agglomeration, which it demarcates. As differences between the two occupation phases – before and after the building of stone architectures (churches) – were not noted, it is assumed that the environmental conditions, economic activities and the subsistence strategies were the same.

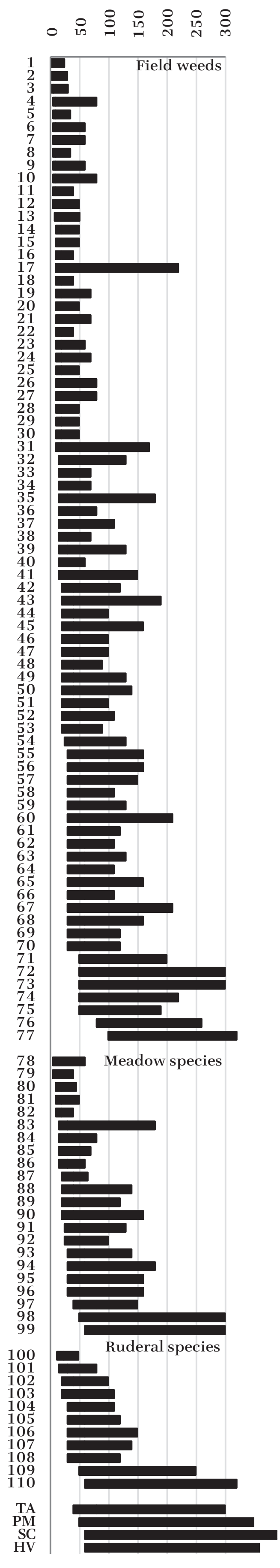


FIG. 61 | Mikulčice-Kopčany. The height of crops and potential weeds. Captions: TA – common wheat, PM – millet, SC – rye, HV – barley.

10 Conclusion

The aim of this study was to evaluate and interpret the finds of plant macroremains recovered from early medieval contexts in the Mikulčice-Kopčany settlement agglomeration – a unique early medieval central site. The analyses were aimed at reconstructing the economy, specifically the supply and subsistence of the stronghold by foodstuffs of plant origin and to verify the archaeological notion of the non-autarkic character of this centre. The data assessed came from 16 archaeobotanically researched excavation areas – two in Kopčany and fourteen in Mikulčice and comprise of an assemblage of charred, mineralised and waterlogged plant macro-remains (n = 26,994) recovered from 946 samples collected between 2005 and 2013. The samples represent different types of archaeological contexts – graves, settlement pits, sunken houses, residues of aboveground constructions, layers from the fortification ramparts and ditches, churches, etc. – and from the deposits of the river palaeochannel. For evaluation and interpretation, the samples from individual structures or areas were combined into a smaller number of units that, according to the results of previous archaeological research, had a different function and were home to different economic activities.

The range of crops recorded in the assemblage from Mikulčice and Kopčany fully corresponds with the data for the early medieval period in east Central Europe. Five species of cereals (common wheat, rye, millet, barley and oat) and five species of pulses (except lentil and pea), which were common at early medieval sites, in addition to Celtic bean, bitter vetch and grass pea (*Lathyrus sativus*) were found. For grass pea, this was the only early medieval record from Czech at the time of discovery. As for fibre and oil crops, then hemp, flax and poppy were found. Our results confirm the earlier findings of E. Opravil concerning the range of cereal and pulse crops consumed in Mikulčice[65] but also demonstrate substantial differences in their numbers (proportion) and ubiquity (frequency of occurrence) – the variables seen as indicators of "economic importance". Mikulčice clearly differs from other contemporary sites due to the broad variety of, at that time, luxurious and exotic fruits, nuts, vegetables – such as peach, grape vine, domesticated plum and apple, walnut and cucumber. Finds of "luxury" plants dated to phase RS3 of the early medieval period are known only from Prague (Čulíková 1998, 2001a, 2001b, 2005), and to a lesser extent from Žatec (Čech et al. 2013). Such finds are unknown from contemporary sites in Slovakia (E. Hajnalová 1989, 2001) although are known from Cracow (Klichowska 1964; Mueller-Bieniek et al. 2015) and Wolin (Latałowa 1999) in Poland. The numbers of different luxury plants increase in the following RS4 phase in Žatec, Olomouc and Prague[66], and are seen as evidence of a different "higher" status of these sites. It has been argued that in Mikulčice, these finds support the evidence of the presence of a social elite, which is also documented by the extensive building of religious and secular stone architectures and the presence of other luxury items made for precious metals and found in many graves.

The different types of cereal and pulse crops that come from different settlement areas in Mikulčice and Kopčany differ in the requirements for environmental conditions and care. Based on the ecological characteristics of field weeds and other plants that can be associated with crops and their cultivation, we were able to reconstruct some of the arable practices. From a wide spectrum of wild plants recovered, not all are today considered field or garden weeds. When selecting "the right" species for the reconstruction of agriculture practices – those which can clearly be associated with the cultivation of crops – the samples were first analysed using statistical and taphonomic analyses methods. Based

65 Opravil 1962, 1972, 1978, 1983, 1998, 2000, 2003.

66 Čech et al. 2013; Opravil 1994; Čulíková 1998 2001a, 2001b, 2005.

on the results, only species found in a charred form and of those only taxa that occurs today in fields cultivated by traditional non-mechanized methods were selected. Some of the species in this group are today considered to be the plants in meadows and ruderal communities. In addition, for the reconstruction of the early medieval environment, all wild species from the meadows/pastures, forests and ruderal stands were evaluated.

Cultivation of fruit trees such as peach and apple and the cultivation of grapes requires special care – trimming and for the grapevine, also repeated tillage. They also require protection from animals at least in the early years as they would not survive unprotected in the wild. The question of where they grew – inside the fortified area, in special garden nurseries or orchards situated elsewhere – is to date unanswered.

Fields, meadows/pastures and forests are considered the most widely exploited natural resources around the Mikulčice stronghold. The most productive, and thus the most important among these, were the plots of arable land where the staple crops – cereals and pulses – were produced. The absence of "ancient" glume wheat, which can survive as "weeds" in fields under continuous agricultural use, indicates that the fields producing for the Mikulčice stronghold were established on new or, for some time, uncultivated areas. The frequent finds of species from grassland ecosystems might be seen as an indicator that the fields and meadows/pastures constituted a mosaic in the landscape and in some places was delimited by hedges. The analysis of the wild species requirements for soil pH, in particular, the high percentage of species of acid soil and species indifferent to soil reaction, suggests that the fields were located in the valley of the River Morava and probably close to the stronghold. Having the fields in the valley, which was probably not regularly flooded at that time, was probably a necessity in early medieval times. One of the reasons might have been the (temporary) infertility of local chernozem soil due to a lack of precipitation (Dreslerová et al. 2013). The situating of fields on soil that today would be considered lower-quality and less fertile than in the early Middle Ages seems to be an attempt to transfer fields to areas with a higher, but not too high, level of underground water. This could be one of the (many) reasons for the establishment of the early medieval centres directly in the valleys of larger rivers and not only in Moravia.

The presence of open landscape with meadows, pastures and other types of grasslands in the stronghold's closest hinterland is also evidenced by numerous finds of waterlogged plant macroremains. The species present indicate the presence of warm and dry (xerothermic) and moister (mesophilic) grasslands, a finding also supported by local palynological and malacozoological studies. Archaeobotany is currently not able to ascertain whether this grassland was grazed as pastures or cultivated and mowed for hay. Palynology also confirms the occurrence of grasslands in the vicinity of other early medieval Bohemian centres such as Libice (Mařík 2009) and Stará Boleslav (Čulíková 2003).

Archaeobotany attests that the forest provided wild fruits that were a source of vitamins and trace elements and had healing effects. There is evidence of the unusual use of wild fruit in Mikulčice. Finds of charred hornbeam nuts are frequently found in samples with cereals. The reason for their presence in the samples and their origin in the locality remains unexplained. Ethnobotanical sources from Asia describe their use for oil, which is extracted by pressing the nutlets (Bui et al. 2014). Ecological indicator values of forest species indicate the presence and exploitation of mostly dry, light forest clearings and, to a lesser extent, of moist, shady stands. The palynological records from the areas of, or close to, early medieval centres show a significant proportion of open, deforested landscape,[67] which indicates intensive land-use. The forest as described by E. Opravil (1962, 1972, 2000), which consists of a mosaic of stands of more dense riparian hardwood forest, more open hornbeam woods, riparian softwood vegetation along the stream and large forest clearings is in line with the results of this study.

Archaeological papers based primarily on material culture reconstruct the relationship between the early medieval central seats (agglomerations) and the rural settlements as a system of strong dependence.[68] Within each central site, the areas of different economic and political function are demarcated. At Mikulčice, L. Poláček and M. Hladík (last in 2014, 166) use the information regarding different types of residential buildings (sunken houses vs. wooden above-ground buildings) among other factors, to differentiate between a "central" and a "peripheral" part. Like other authors, they consider the rural settlements situated farther away from the fortified area and situated on the terraces away from the river as the places where staple crops (cereals) were produced, and exchanged with the centre (the place

67 Macháček et al. 2007, 302; Svobodová 1987, 1990, 173–178; Unger 1992, 90; Jankovská et al. 2003.

68 Klanica 1987; Poláček 2008a; Dresler/Macháček 2008; Mařík 2009; Hladík 2014.

of consumption) for services, protection and other (unspecified) commodities. To assess to what extent the results of archaeobotanical analyses ascertain that the archaeological hypothesis for classification of areas of the Mikulčice stronghold were places for the production or consumption of crops, the archaeological hypothesis was statistically tested. The null hypothesis tested states that there are no differences in the types of products and by-products (waste) from crop processing between the different ("central" and "peripheral") parts of the agglomeration. The results of the statistical test show that in all the areas of the stronghold, only the remains from later crop processing stages were present and that there are no significant differences between them. Only in Mikulčice-Trapíkov were the finds of crops only partially processed.

According to the existing archaeological model, the communities which are able to proceed in a further crop processing sequence during the time of harvest – so as to store well cleaned crops void of weed and chaff impurities – must have had the ability to mobilise a sufficient workforce (either communally or by a central power) that operated on a scale beyond a single household or wider family unit (Fuller/Stevens 2009). If this holds true, then the community/communities that produced crops for the individual areas of the Mikulčice agglomeration were as such. No differences were found in the composition of samples from the earlier (end of the 8th to the first half of the 9th century) and the later phase of occupation (the later Great Moravian period). This might be the result of i.) the same subsistence strategy in times of the establishment of the central settlement during its greatest boom in the Great Moravian period; ii.) or that the time-period between these two phases was, in fact, short(er) or non-existent. Archaeobotanical analyses show that it is probable that (at least a large part of) the staple crops was cultivated locally by the central site itself. The notion that some of the inhabitants (mostly women) from the centre itself were subjected to heavy works (e.g. farming) and participated in food production, is attested by anthropology. The archaeological assumption that the staple crops for the stronghold were produced solely by the settlements in their hinterland can, therefore, be rejected. The early medieval rural settlements from the great Moravian period usually consist of no more than a few households, which is why they might not have been able to organise a sufficient workforce at the time of the harvest. At these sites, the residues of partially processed storages containing a higher portion of impurities would have been found. This is supported by archaeobotanical evidence from rural sites in the wider region of south-west Slovakia and southern Moravia. In future, it is necessary to test this further and by studying and correlating the results of (to date nonexistent) assemblages from the rural settlements situated nearby the Mikulčice stronghold.

The analyses of the ecological requirements of wild species support this interpretation by confirming the situation in the fields that supplied the stronghold into the river valley and not on the chernozem soil on the terrace.

Despite its substantial size, the collected assemblage cannot be considered as representative of the period and the region because there is a lack of "controlled" archaeobotanical data from the local rural settlements. Therefore, it is necessary to continue with archaeobotanical sampling and evaluation at the rural sites in the vicinity of Mikulčice and Kopčany. Based on these new analyses, it will then be possible to verify the postulated hypotheses.

Resumé

Zámerom tejto štúdie je hodnotenie rastlinných makrozvyškov (ďalej len RMZ) zo včasnostredovekých kontextov mikulčicko-kopčianskeho sídelného komplexu. Analýzy boli zamerané na lepšie pochopenie susbsistenčnej ekonomiky centrálneho sídliska, ktorá sa zaoberá zásobovaním potravinami rastlinného pôvodu, a zároveň mali verifikovat archeologické predstavy o neautarktnom charaktere tohto centra.

Hodnotené RMZ pochádzajú z rôznych častí sídelnej aglomerácie, ale aj zo širokej škály archeologických nálezových situácií a kontextov (napr. rez valom, hroby, sídliskové objekty: zahĺbené, budované na úrovni terénu, cirkevné a profánne stavby, riečne koryto), ktoré odrážajú okrem rôznych sídelných aktivít, aj antropogénne, alebo prírodné.

CHARAKTER NÁLEZOV

Spôsob konzervácie rastlinného materiálu, ktorým boli makrozvyšky najčastejšie zachované bolo zuhoľnatenie. Zuhoľnatené semená a diaspóry sa nachádzali na všetkých skúmaných plochách a všetkých typoch kontextov: v suchých aj vodou nasýtených vrstvách. Na druhom mieste sú nezuhoľnatené vodou konzervované RMZ. Tie sa nachádzali najmä v uloženinách zaniknutého riečneho koryta. V menšom počte boli tiež prítomné aj v iných v kontextoch na predhradí, kde v súčasnosti podzemná voda nezasahuje do archeologických kontextov, ale prítomnosť ílových vrstiev, ktoré prirodzene zadržiavajú vodu v sedimentoch, mohla spôsobiť ich zakonzervovanie. Mineralizovaný rastlinný materiál vo väčšine prípadov pochádza z objektov situovaných pod kamennými architektúrami, skúmanými počas revíznych výskumov kostolov. Je možné sa domnievať, že ich zakonzervovanie spôsobila prítomnosť malty a vápna, z ktorých vyplavené minerály a soli prestúpili okolité uloženiny. Okrem botanického materiálu boli vo vzorkách často prítomné aj rôzne typy iných ekofaktov a artefaktov. Bežné boli fragmenty zvieracích kostí (veľkých aj malých cicavcov, vtáčie a rybie kosti). Pomerne hojné boli aj nálezy rybích šupín, pravdepodobne rôznych druhov rýb. Kombinácia takýchto nálezov spolu s nálezmi pestovaných plodín a planorastúcich druhov indikuje prítomnosť bežných „kuchynských“ odpadov. Odpad z remeselných aktivít alebo z iných výrobných procesov bol vo zvýšenej miere zaznamenaný na polohe Kopčany-Kačenáreň, odkiaľ pochádza pomerne veľké množstvo drobných okují a fragmentov kováčskej strusky. Nálezy tohto charakteru sa na ostatných skúmaných polohách objavujú sporadicky a v nízkom počte, prípadne úplne absentujú.

PESTOVANÉ PLODINY

Z hľadiska zloženia pestovaných druhov je v pramennej báze doložené pomerne široké spektrum druhov tejto kategórie. Najpočetnejšími nálezmi pestovaných plodín sú obilniny a strukoviny. Medzi hlavné pestované obilniny možno na základe porovnania počtu, frekvencie výskytu, váhy a kalorickej hodnoty predpokladať dominanciu troch hlavných obilnín, a to: prosa, pšenice siatej a jačmeňa. Každá z uvedených plodín má iné nároky na prírodné podmienky, ako aj starostlivosť. Rovnako aj využitie daných obilnín je rôzne. Práve táto rozmanitosť druhového spektra využívaných plodín dokladá zvyky v stravovaní včasnostredovekého centra. Najpočetnejšou strukovinou na základe počtu semien je šošovica kuchynská. Zo starších nálezov z Mikulčického hradiska, ktoré hodnotil E. Opravil, je zloženie obilnín a strukovín podobné čo sa týka výskytu jednotlivých druhov. Proporčné zloženie je však podstatne odlišné. Druhou kategóriu pestovaných plodín z hľadiska početnosti a frekvencie výskytu sú nálezy semien a kôstok pestovaného ovocia a zeleniny. Semená tohto druhu sú prevažne vodou konzervované a pochádzajú z uložením výplne riečneho koryta. Pochutiny tohto druhu slúžili na spestrenie jedálnička elity, ktorá sídlila na hradisku. Z ovocných a zeleninových druhov sú doložené semená broskýň, viniča, orecha, jabloní, hrušiek, sliviek a uhorky. E. Opravil predpokladal na základe súčasných klimatických a pôdnych pomerov južnej Moravy, že práve táto oblasť je vhodná na pestovanie pomerne náročnejších druhov. Nálezy vinnej révy sa taktiež snažil E. Opravil hodnotiť v rámci dostupných metrických indexov, na základe ktorých on ako prvý vyslovil predpoklad, že v prípade mikulčických nálezov môže ísť o lokálnu či archaickú formu révy, pričom túto hypotézu podporujú aj nové nálezy hodnotené inými a novými metódami. Poslednou kategóriu pestovaných rastlín sú technické priadne rastliny. Všestranné využitie technických plodín bolo jedným z hlavných dôvodov ich pestovania v blízkosti hradiska. Z technických/priadnych plodín sú doložené v nálezoch druhy ako konopa siata, ľan siaty a mak siaty. Najpočetnejšia z uvedených druhov je konopa. Semená technických plodín sú zachované vo všetkých spôsoboch konzervácie, avšak najpočetnejšie sú doložené semená konopy vo vodou konzervovanom stave z výplne riečneho koryta.

PLANORASTÚCE DRUHY

Okrem pestovaných plodín bol doložený aj bohatý sortiment planorastúcich druhov. Tieto druhy dokladajú pomerne veľa rozmanitých biotopov, ktoré sa nachádzali v okolitej krajine včasnostredovekých Mikulčíc. O tom, že boli uvedené biotopy exploatované v období včasného stredoveku, hovorí aj prítomnosť RMZ planorastúcich druhov v archeobotanických vzorkách. V zložení planorastúcich druhov možno sledovať vo všetkých biotopoch ako poľných, lúčnych či lesných bylinných kultúr, dva protipóly. V prostredí poľných kultúr možno sledovať druhy viažúce sa na živiny bohaté pôdy s dostatkom vlahy, avšak v rovnakej miere sú zastúpené aj poľné buriny chudobných pôd. Podobne je tomu aj v prípade lúčnych či lesných bylinných porastov. Obe kategórie nálezov dokladajú suchomilnejšie, ale aj vlhkomilné druhy rastlín, ktoré majú od seba navzájom odlišné stanovištia. To dokladá rozmanitosť osídľovanej a explatovanej okolitej krajiny, odkiaľ sa dostávali semená do archeologických situácií a kontextov. Na základe toho je zrejmé, že v blízkosti centrálneho sídla sa nachádzali polohy, ktoré v obodobí včasného stredoveku neboli pravidelne zaplavované a ani podzemná voda v týchto miestach nedosahovala vysokú výšku. Pravdepodobne však boli osídlované aj menej výhodné polohy, v ktorých dochádzalo k občasným podmočeniam terénu.

TAFONÓMICKÉ PROCESY

Cieľom tafonomických analýz bolo identifikovať procesy, ktoré sa podieľali na formovaní archeobotanických súborov z Mikulčíc a Kopčian. Hlavným determinantom, ktorý má silný vplyv na skladbu RMZ v archeobotanických vzorkách, je proces pozberovej úpravy. Na zistenie pôvodu a určenie krokov procesu spracovania plodín, z ktorých vzorky pochádzajú, boli použité dve metódy. Ich výsledky sa vzájomne dopĺňajú, keďže každá z nich pracuje s inými premennými a vychádza z iných princípov. Pri použití prvej metódy, ktorá pracuje len s planorastúcimi druhmi (zuhoľnatené poľné buriny, lúčne a ruderálne druhy) sa klasifikovala len jedna skupina odpadov, a to odpady z jemného preosievania. Všetky ostatné testovacie jednotky boli klasifikované ako produkty. U vzoriek, klasifikovaných podľa tejto metódy za produkty, je možné, pri zhodnotení pomeru zŕn a burín v týchto vzorkách, predpokladať, že ide o nedokonale vyčistené zásoby pred finálnym ručným triedením. Na základe tejto metódy je zrejmé, že najpočetnejšie sú v súbore odpady z neskorších fáz procesu pozberovej úpravy – odpady z jemného preosievania a odpady z ručného čistenia. Tieto sa nachádzali najčastejšie na polohách v Kopčanoch, alebo v kontextoch, kde sa RMZ dostali sekundárne (napríklad: opevnenia, hroby). Odpady z ručného triedenia, t. j. vyberania veľkých semien burín z „čistých“ zásob pred konzumáciou, sa v rovnakej miere nachádzajú v staršom (jamy v superpozícií s kostolmi) aj mladšom horizonte osídlenia Mikulčíc. V druhej metóde podobne ako pri predchádzajúcej boli získané výsledky z analýz jednotlivých matíc takmer zhodné. Podobne ako v metóde 1 aj teraz sa väčšina vzoriek klasifikuje do neskorších krokov procesu pozberovej úpravy plodín. Za čiastočne vyčistené zásoby možno považovať 11 kontextov. Klasifikovali sa sem kontexty zo všetkých skúmaných areálov s výnimkou kontextov z Kopčian. Ako nevyčistené, nevymlátené a nepreviate zásoby klasov sú klasifikované len tri vzorky z akropoly a tri (štyri) vzorky z podhradia. Do skupiny odpadov z čiastočne vyčistených zásob sa klasifikovalo najviac analyzovaných vzoriek. Prítomné sú tu kontexty zo všetkých skúmaných areálov. Poslednú skupinu – odpady z (len) čiastočne spracovaných plodín – tvorí sedem kontextov. Tie pochádzajú z Kopčian (dva kontexty), Mikulčíc-Trapíkova (jeden kontext) a z akropoly (štyri kontexty). Na rozdiel od predchádzajúcej metódy sa v tejto klasifikovali produkty, medziprodukty z konečných fáz, ale aj odpady z úpravy z počiatočných fáz spracovania obilnín. Pomerne málo testovacích jednotiek bolo umiestnených v sektore, kde sa zhlukujú odpady z čistenia neupravených zásob (nevymlátené klasy). Najvyšší podiel hodnotených vzoriek sa koncentroval v časti odpadov z čistenia finálnych produktov. Pozoruhodné je, že sa nachádzali, ako

v periférií, tak i na akropole hradiska. Nemenej dôležité je aj zistenie, že kontexty klasifikované ako odpady z len čiastočne spracovaných zásob, sa vo väčšine prípadov nachádzajú v sekundárnych kontextoch.
Komparáciou archeobotanického rastlinného materiálu s dátami z literatúry a archeobotanickej databázy M. Hajnalovej bolo možné stanoviť, či je súbor vzoriek z mikulčickej sídelnej aglomerácie jedinečný, alebo sa nevymyká z obrazu, ktorý poskytujú iné lokality z včasnostredovekého obdobia. Respektíve či sa na lokalitách opevnených (a centrálneho charakteru) koncentrujú odpady a produkty z iných fáz procesu pozberovej úpravy plodín, ako na otvorených, neopevnených (tzv. vidieckych) sídliskách. Dáta z viacerých včasnostredovekých lokalít boli hodnotené identickými postupmi tafonomickej analýzy ako mikulčické nálezy. V oboch použitých metódach sa mikulčicko-kopčiansky súbor líši od nálezov z ostatných lokalít, taktiež aj od lokalít opevnených v porovnávacom súbore dát. Proporčný rozdiel kategórií v súbore vzoriek z mikulčickej aglomerácie a z ostatných lokalít svedčí o rozdielnom charaktere týchto dvoch súborov. Hlavným rozdielom je, že vo vzorkách z Mikulčíc a Kopčian sa RMZ, ktoré dokladajú počiatočné fázy procesu pozberovej úpravy, nachádzajú ojedinele, kým v druhom súbore sú v podstate bežné. Taktiež možno pozorovať rozdiel v zastúpení vyčistených zásob, ktoré sú početné najmä na polohách mikulčickej aglomerácie.

EKONÓMIA

Načrtnutá problematika veľkomoravských centier a povaha ich vzťahu k otvoreným osadám a hospodárskemu zázemiu, ako napríklad Mikulčice, ktoré sa označujú ako neautarktné, o.i. závislé od dovozu potravín rastlinného (a živočíšneho?) pôvodu, je hodnotená za pomoci ekonomických modelov. Dôležitým cieľom práce, hodnotiacej rastlinné makrozvyšky z takejto lokality, je odpovedať na otázky, či plodiny, ktoré sa tu našli, dopestoval niekto iný a boli sem dovezené z bližších či vzdialenejších oblastí, alebo či ich dopestovali samotní obyvatelia skúmaného sídliska. Ekonomické hodnotenie je zamerané na to, či je možné skúmanú lokalitu alebo jej areály považovať iba za miesto konzumácie alebo aj miesto produkcie poľnohospodárskych plodín. Pri použití modelu 1 doklady indikujú, že všetky skúmané kontexty a objekty v hodnotených areáloch – akropolu, podhradie, predhradie, i perifériu aglomerácie – je možné považovať za konzumné. Na základe výsledkov modelu 2 možno konštatovať, že na mikulčickej akropole, sú obe formy zásob a odpadov zastúpené približne v rovnakej miere. V ostatných areáloch sú taktiež zastúpené oba typy, avšak ich podiel varíruje a spravidla závisí od počtu hodnotených vzoriek z každej polohy. Na najpodrobnejšie a najrozsiahlejšie vzorkovanej ploche na predhradí, sú doložené oba typy zásob a odpady z úpravy dobre vyčistených zásob. Komunitu/y, ktoré vytvorili tieto zásoby (a odpady) je možné z hľadiska schopnosti mobilizácie pracovnej sily charakterizovať ako spoločnosť schopnú zabezpečiť dostatočnú pracovnú silu na to, aby dokázala uskutočniť proces pozberovej úpravy plodín až ku konečným fázam. To znamená, že sa na ňom podieľala pracovná sila, ktorá prekročila rámec tradičnej rodiny, či širších príbuzenských vzťahov. To svedčí o dobre komunitne organizovanej alebo silne centralizovanej a riadenej spoločnosti. Archeologická evidencia indikuje, že v mikulčickej sídelnej aglomerácii je možné vylúčiť existenciu egalitárnej komunity/spoločnosti. Nie všetci jej členovia sa v rovnakej miere podieľali na produkcií potravín. Minimálne v čase žatvy sa však museli aj tí, ktorí sa počas roka primárne poľnohospodárstvom nezaoberali (napríklad remeselníci), zapojiť do poľných prác.

Pri ekonomickej interpretácii výsledkov tafonomickej analýzy súdobých (nie mikulčických) lokalít hodnotených v tejto práci, je zrejmé, že Mikulčice (a Kopčany) sa z celkového trendu úplne vymykajú. Najviac sa im podobajú súbory z Devína a Nitry – opevnených centrálnych sídel. Ostatné opevnené sídla (napr. Bíňa), alebo osady (napr. Kostice-Zadní hrúd) sa javia ako produkčné. Tento rozdiel môže byť spôsobený tým, že ich funkcia a charakter ekonomických aktivít bol iný ako u Mikulčíc, ale aj tým, že nerovnaké (menej intenzívne a nesystematické) metódy vzorkovania, výsledný obraz o charakter hodnotených lokalít skresľujú.

EKOLOGICKÉ VLASTNOSTI PLANORASTÚCICH DRUHOV

Hodnotením a porovnaním nárokov planorastúcich druhov z hľadiska klimatických (svetlo, teplo a kontinentalita) a pôdnych (pôdna vlhkosť, pôdny dusík a pôdna reakcia) faktorov prostredia sa ukazuje pre hodnotené skupiny nasledovné:

Polia, z ktorých tieto druhy pochádzajú (z rôznych častí aglomerácie), boli situované na podobných stanovištiach v krajine a pravdepodobne boli obhospodarované rovnakým, resp. veľmi podobným spôsobom. Ten sa dá charakterizovať ako pestovanie redších porastov (väčšia šírka riadku, nižšie plodiny, väčšia rozloha polí) na stanovištiach nezatienených vyššou vegetáciou (lesom), t. j. v otvorenej krajine. Podľa výsledku získaného hodnotením pôdnej vlhkosti, bola väčšina polí situovaná na stredne vlhkých pôdach, resp. pôdach suchších, t. j. na miestach s nižšou hladinou podzemnej vody. Podľa nárokov druhov poľných burín na pH boli využívané rôzne pôdne typy (kyslé, neutrálne či zásadité). Takéto pôdy sa nachádzajú aj v okolí lokality, teda v priestore nivy rieky Moravy. Výsledok analýzy pôdneho dusíka, v kombinácii s predchádzajúcimi výsledkami ukazuje, že pravdepodobne boli na niektorých poliach využívané postupy pre skvalitnenie alebo udržanie kvality poľnohospodárskej pôdy (hnojenie). Na základe prítomnosti niektorých druhov sa zdá, že polia, ktoré boli zakladané na pôdach s nižšou kvalitou (bonitou), boli hnojené (resp. úhorované?).

Druhy trvalých trávnych porastov majú podobný trend ako poľné buriny. Je však medzi nimi vyšší podiel druhov náročnejších na svetlo a teplotu, t. j. menej druhov tieňomilných a viac druhov teplej klímy. Na základe tohto výsledku možno predpokladať, že netvorili len malé enklávy uprostred lesa, ale vytvárali v krajine rozsiahle, pravdepodobne nízkobylinné porasty. Nároky lúčnych druhov na pH, pôdnu vlhkosť a pôdny dusík indikujú, že lúky boli situované na pôdach s nižšou kvalitou ako polia. Zaberali v krajine pôdy vysychavé a suché, ako aj výrazne mokré a podmáčané, pravdepodobne periodicky zaplavované so slabo kyslou až neutrálnou pôdnou reakciou a celkovo chudobnejšie na dusík.

Výskyt ruderálnych druhov je úzko spätý s činnosťou človeka v krajine. K typickým stanovištiam patria plochy sídlisk, rumoviská, skládky odpadov, okraje ciest, chodníkov a vodných tokov. Na základe týchto nálezov možno väčšinu ruderálnych stanovíšť charakterizovať ako presvetlené až svetlé. Najväčší pomer tieňomilných druhov pochádza z centrálnej časti hradiska – z akropoly. To môže indikovať väčšie zatienenie týchto stanovíšť vyššími stavbami alebo stromami. Faktory pôdnej vlhkosti indikujú, že všetky hodnotené areály sídelnej aglomerácie boli situované na suchších pôdach. Prirodzeným stanovišťom pre ruderálne druhy sú pôdy bohaté na dusík, ktorého podiel v pôde sa zvyšuje v dôsledku ľudských aktivít. Preto nie je prekvapivé, že ruderálne druhy z mikulčicko-kopčianskej aglomerácie vykazujú vyššie nároky na pôdny dusík, ako druhy z iných stanovíšť. Z hľadiska ich nárokov na pH, podobne ako predchádzajúce skupiny, inklinujú ku slabo kyslím, respektíve kyslím, v menšej miere neutrálnym pôdam. Na základe podobnosti nárokov na pH u druhov ruderálnych, poľných a lúčnych možno predpokladať, že polia a lúky boli situované v blízkosti samotného sídla.

Lesné byliny a kry, tak ako predchádzajúce skupiny, inklinujú najmä k svetlým a teplým stanovištiam a menšia časť prislúcha k druhom teplých zatienených stanovíšť. To dokladá existenciu a exploatáciu lesov presvetlených (otvorených), v menšej miere lesov tienistých, s hustou vegetáciou. Na základe pôdnej vlhkosti možno situovať les v zázemí mikulčicko-kopčianskej aglomerácie na stredne vlhké pôdy. V súbore lesných druhov sa nenachádzajú také, ktoré by dokladali pôdy extrémne suché či vlhké, resp. podmáčané. Pôdny dusík indikuje, že exploatované lesy sa rozkladali najviac na pôdach stredne bohatých, v menšej miere chudobných a bohatých. Pôdna reakcia vykazuje podobne ako predchádzajúce skupiny vyššiu afinitu k rôznym kyslým, v menšej miere k neutrálnym pôdnym typom.

Komparáciou súčasných botanických dát a archeobotanického materiálu vzhľadom k ich nárokom na pôdne vlastnosti prostredia, najmä na pôdnu reakciu, sa u všetkých skupín javia ako najlepší zdroj informácií, na základe ktorého možno: 1) rekonštruovať charakter pôd na a v okolí mikulčicko-kopčianskej aglomerácie vo včasnomstredoveku, 2) pokúsiť sa situovať v krajine ornú pôdu, resp. polia, z ktorých úroda slúžila na výživu obyvateľstva v tejto osade centrálneho charakteru. Tradične sa pri riešení ekonomických otázok a subsitenčných stratégií v archeologických prácach hľadá poľnohospodárske zázemie v oblasti riečnych terás, ktoré prechádzajú intravilánom súčasnej obce Mikulčice.

Pôda ako dynamický systém podlieha neustálemu vývoju. Preto je pravdepodobné, že pôdy vo včasnom stredoveku mohli mať na určitom mieste iný charakter ako dnes. Ich pôdna reakcia sa však spravidla nemení. V najväčšej miere závisí od vlastností a pH podložia (materskej horniny), na ktorom sa pôdy vytvárali alebo vytvárajú. V menšej miere ho ovplyvňuje aj výška hladiny a pH podzemnej vody, výskyt železitých minerálov, vegetačný pokryv a spôsob obhospodarovania. V priestore nivy rieky Morava v okolí mikulčickej aglomerácie je podložie tvorené piesčitými sedimentmi s kyslou reakciou, preto je tu výskyt pôd s kyslou reakciou očakávaný. Hodnota pH vody rieky Moravy sa v súčasnosti pohybuje v intervale medzi 6,8–7,1, tj. má neutrálnu až mierne zásaditú reakciu.

V tomto kontexte, ako aj kontexte archeologickej hypotézy, o situovaní hospodárskeho zázemia (najmä polí) mikulčického centra do priestoru riečnych terás, je zastúpenie kyslomilných a najmä indiferentných druhov v súboroch poľných, lúčnych, lesných aj ruderálnych druhov zo všetkých hodnotených areálov mikulčickej aglomerácie prekvapivé. Vo vzťahu ku geologickým pomerom (podložie, hladina podzemnej vody) je možné včasnostredoveké polia a lúky, z ktorých pochádzajú RMZ nájdené v Mikulčiciach a Kopčanoch, situovať do priestoru nivy rieky Moravy, pravdepodobne do tesnej blízkosti osád. Prekvapivý výsledok prináša hodnotenie druhov súčasnej vegetácie archeologické lokality Mikulčice-Valy. Zastúpenie druhov súčasného (najmä lúčneho) pokryvu vo vzťahu k nárokom na pH pôdy sa najviac podobá včasnostredovekým. Vysokú podobnosť v nárokoch rastlín na pH pôdy v archeologickom materiáli z Mikulčíc a Kopčian a druhov súčasnej vegetácie v priestore NKP Mikulčice situovaného v nive rieky (a ich nepodobnosť s lokalitami situovanými na černozemiach alebo viatych pieskoch), je možné použiť ako argument podporujúci hypotézu o situovaní včasnostredovekých polí do priestoru riečnej nivy, do blízkosti centrálneho sídla. Až 50% výskyt druhov indiferentných na pH v súbore lúčnych a poľných druhov z včasného stredoveku aj v dnešnej vegetácii dokladá, že priestor nivy podlieha a podliehal dynamickým zmenám (ako fluktuácia hladiny podzemnej vody, zmeny vlhkosti, prípadne pH pôdy?), ktorým sa rastliny museli a stále musia prispôsobiť. Na základe ekologickej analýzy archeologických dát a ich konfrontácie s výsledkami ekologickej analýzy dát z dnešnej vegetácie nemožno podporiť hypotézu situovania polí, lúk/pasienkov a lesov exploatovaných obyvateľmi mikulčicko-kopčianskej aglomerácie do širšieho, resp. vzdialenejšieho priestoru riečnych terás. V najlepšom prípade je možné uvažovať, že z tohto priestoru pochádzala časť zásob (plodín).

Cieľom kapitoly Antropogenické faktory bolo, na základe hodnotenia ekologických vlastnosti planorastúcich druhov, pokúsiť sa v prvom rade o rekonštrukciu agrotechnických postupov a následne sa pokúsiť charakterizovať prostredie a spôsob exploatácie včasnostredovekej krajiny v blízkosti tohto centrálneho sídla.

Na základe podielu planorastúcich druhov rezistentných a senzitívnych na rozrúšanie pôdy, možno predpokladať nie príliš hlbokú orbu, respektíve nie všetky polia/plodiny boli hlbšie orané. Vzhľadom na sortiment obilnín, strukovín a planorastúcich druhov je zrejmé, že časť plodín bola vysievaná na jeseň a iná na jar. Vysoký podiel trvalých druhov a vyrovnaný pomer druhov tried *Chenopodietea* a *Secalinetea* však nedovoľuje potvrdiť hypotézu o intenzívnom obrábaní všetkých polí/plodín. Polia, ktoré zásobovali centrálnu časť osady, boli obhospodarované skôr extenzívnejšími technikami. Napriek tomu je evidentné, že orná pôda netrpela vyčerpanosťou. Tento stav možno dosiahnuť zlepšovaním kvality pôdy hnojením, úhorovaním, správnom rotáciou po sebe nasledujúcich plodín, alebo okopávaním. Práve v kontexte relatívne nízkeho zastúpenia dokladov intenzívneho hospodárenia (hnojenie, okopávanie), je možné predpokladať, že časť polí bola krátkodobo úhorovaná. Viacero ekologických faktorov potvrdilo situovanie polí priamo do samotnej nivy, do blízkosti hradiska/lokality, avšak na širšie spektrum stanovíšť. Výška planorastúcich druhov z poľných kultúr indikuje, že plodiny sa v prevažnej miere žali vyššie nad zemou, veľmi zriedkavo tesne pri zemi. Pri hodnotení jednotlivých areálov je u väčšiny analýz zaznamenaný podobný trend v súboroch z Kopčian, mikulčickej akropoly a mikulčického predhradia. Archeobotanický súbor z Kopčian teda naznačuje „ekonomickú stratégiu", podobnú centrálnej časti aglomerácie. Minimálne odzrkadľuje, že polia, z ktorých potraviny do týchto častí areálu prúdili, pochádzali z polí situovaných a obhospodarovaných podobným spôsobom. Iný trend je pozorovaný v súboroch z Mikulčíc-Trapíkova a mikulčického podhradia. Nakoľko nie sú ani zaznamenané rozdiely v čase – viď. staršie súbory z jám, situovaných pod kamennými architektúrami a ostatnými kontextami, je možné predpokladať, že subsistenčná stratégia lokality pred výstavbou kostolov mala charakter rovnaký, ako v čase existencie starších podkostolných jám.

Napriek pomerne rozsiahlej pramennej báze, ktorá je tu prezentovaná, je zrejmé, že dáta stále nemožno považovať za dostatočne reprezentatívne vo všetkých oblastiach skúmania vzhľadom ku skutočnosti, že stále chýbajú tzv. kontrolné dáta zo „skutočných" vidieckych osád vo vzdialenejšom zázemí (na riečnych terasách). S rozširujúcou sa pramennou báze by bolo možné do istej miery verifikovať závery predložené v tejto štúdii.

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Attachments

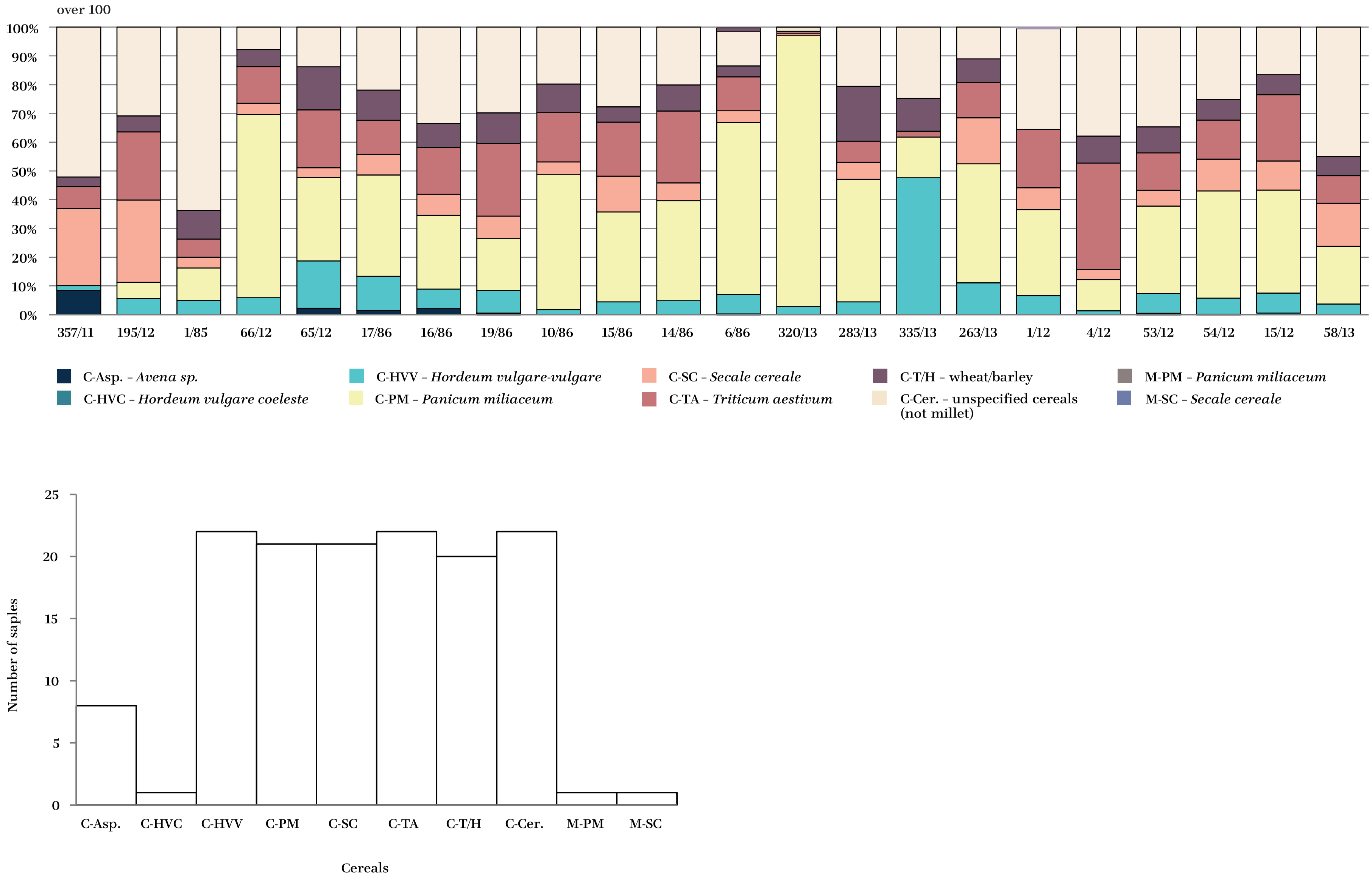


FIG. 62 | Mikulčice-Kopčany. Percentage of occurrence (top) and the frequency (below) of finds of cereals in the samples with n ≥ 100. Captions: C – charred, M – mineralised.

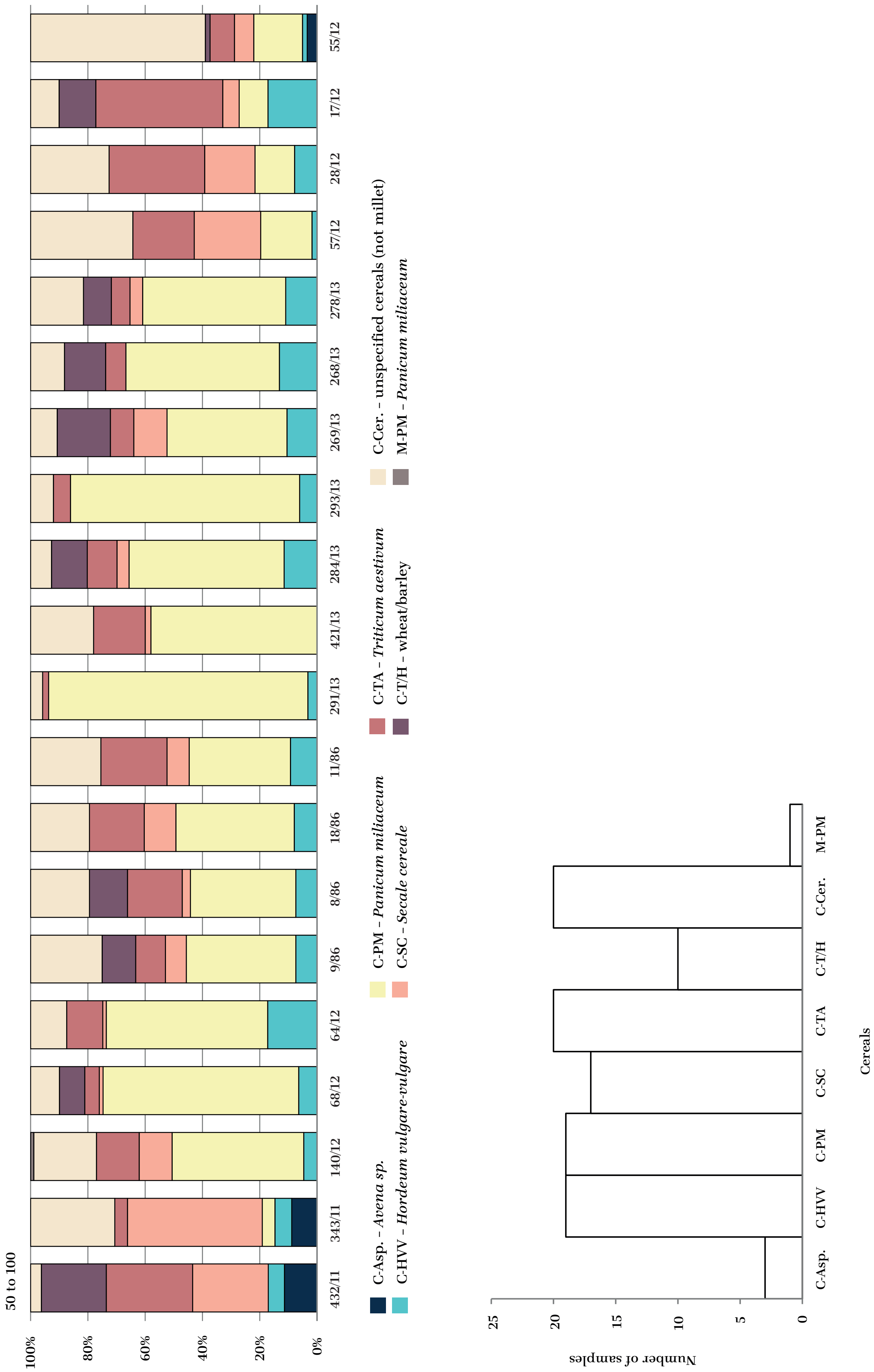


FIG. 63 | Mikulčice-Kopčany. Percentage of occurrence (top) and the frequency (below) of finds of cereals in the samples with n = 50–100. Captions: C – charred, M – mineralised.

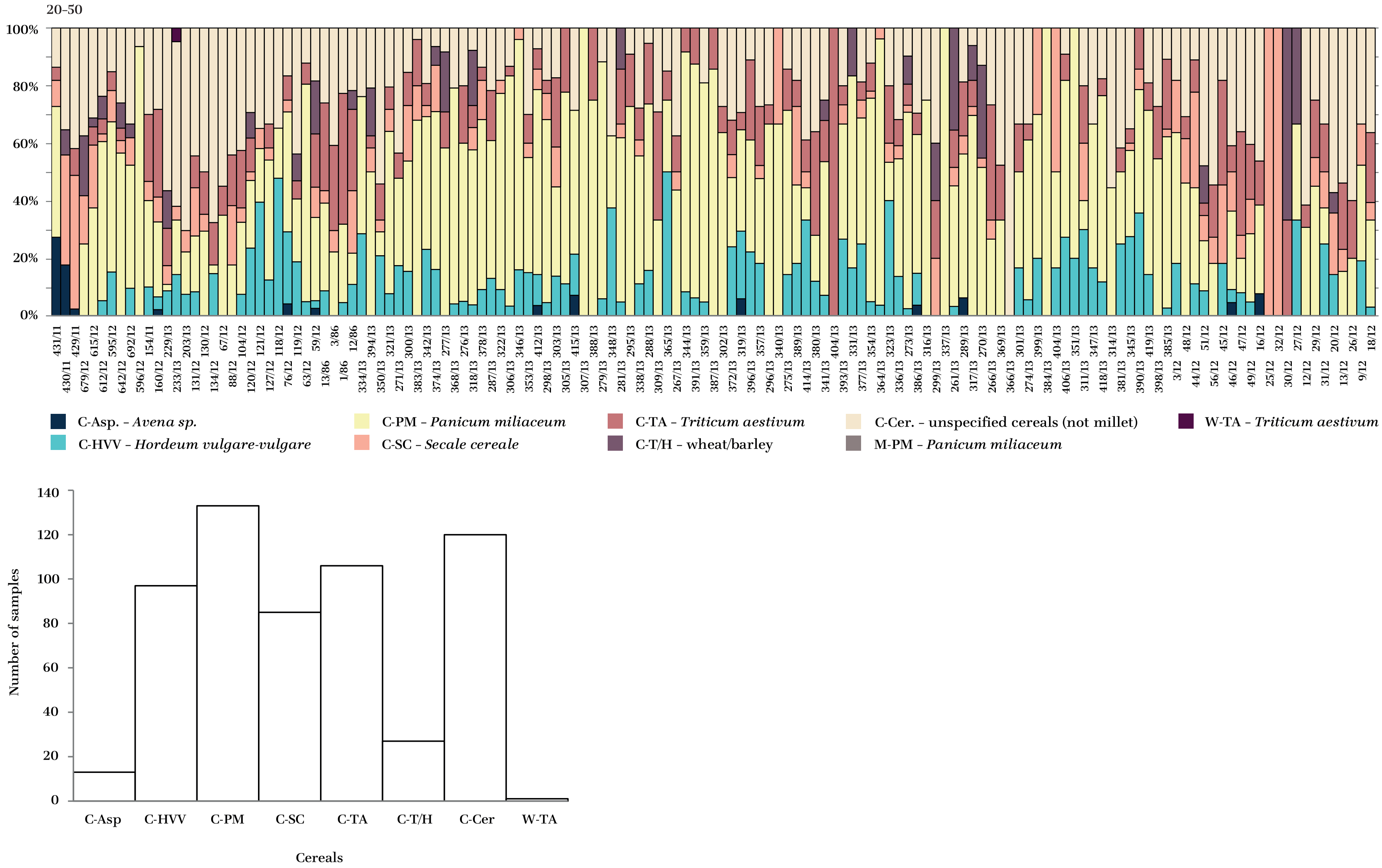


FIG. 64 | Mikulčice-Kopčany. Percentage of occurrence (top) and the frequency (below) of finds of cereals in the samples with n = 20–50. Captions: C – charred, M – mineralised, W – waterlogged.

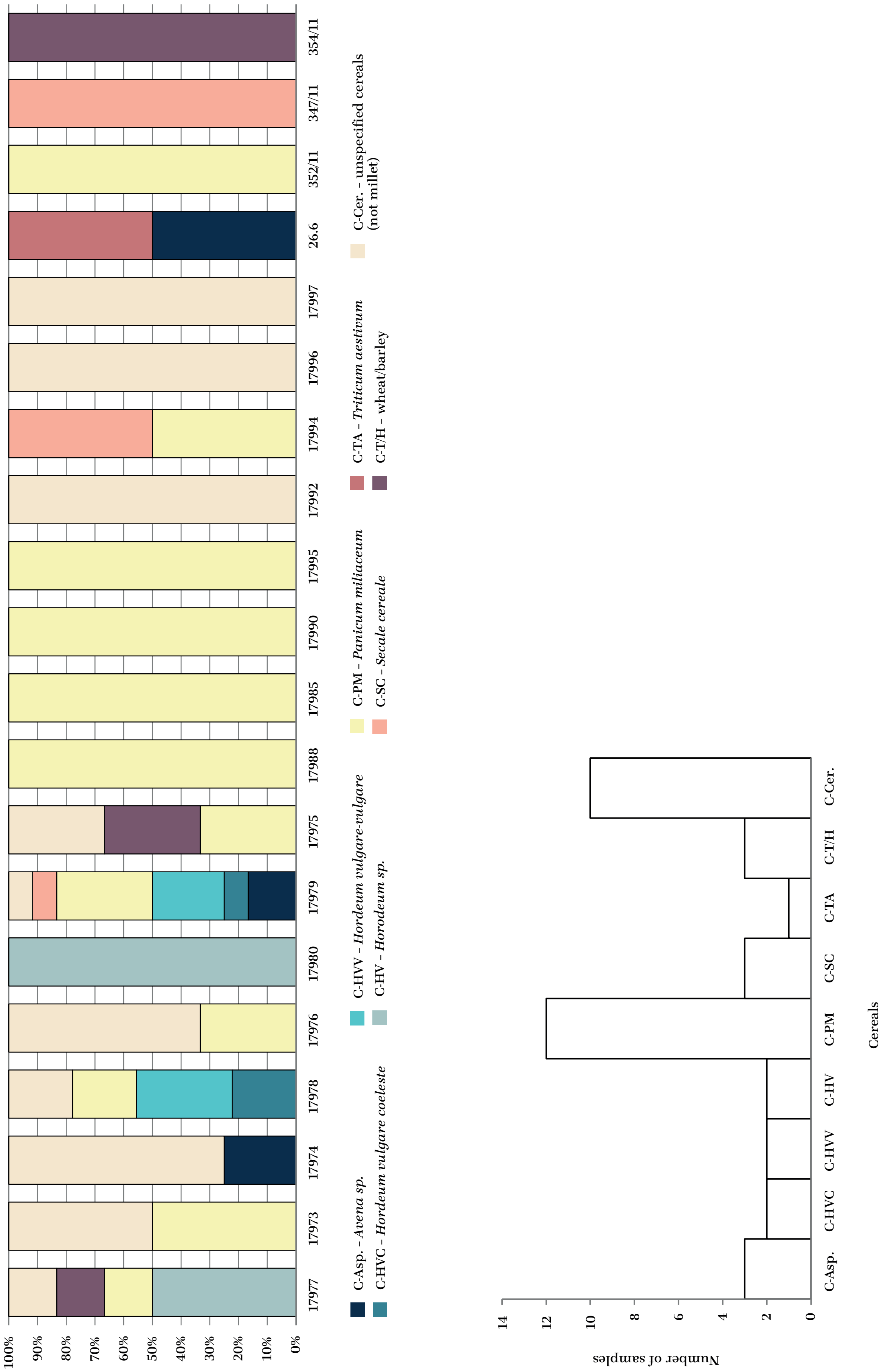
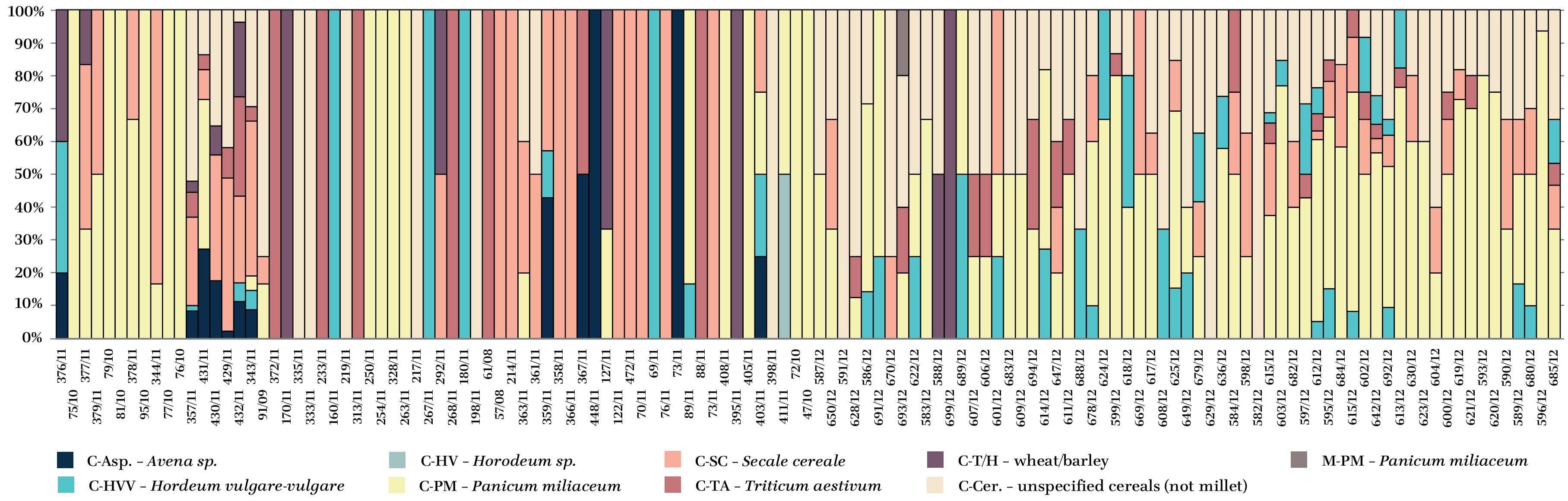


FIG. 65 | Kopčany-Church of St Margaret of Antioch. Percentage of occurrence (top) and the frequency (below) of finds of cereals in the samples with n = 65. Captions: C – charred.



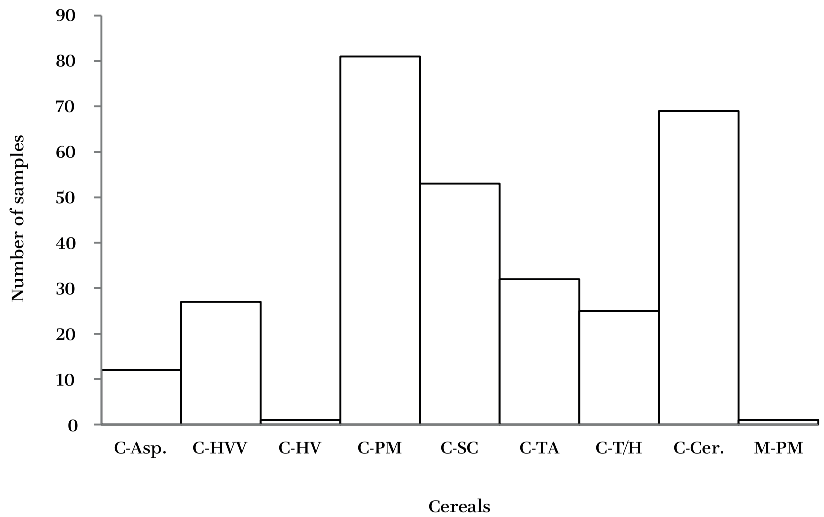


FIG. 66 | Kopčany-Kačenáreň. Percentage of occurrence (top) and the frequency (below left) of finds of cereals in the samples with n = 1081. Captions: C – charred, M – mineralised.

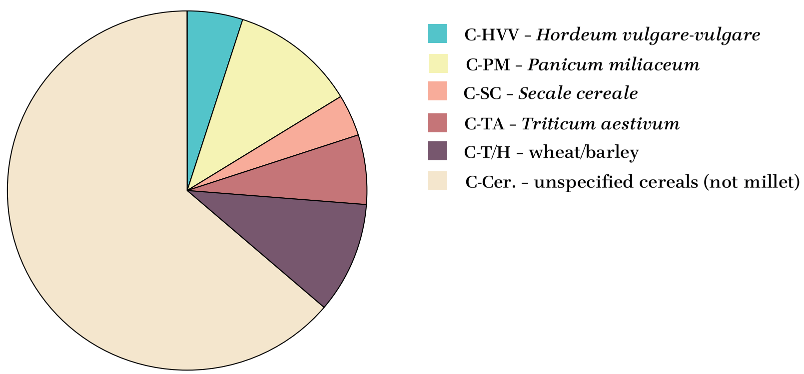


FIG. 67 | Mikulčice – Area 85. Percentage of finds of cereals in the sample n = 160. Captions: C – charred.

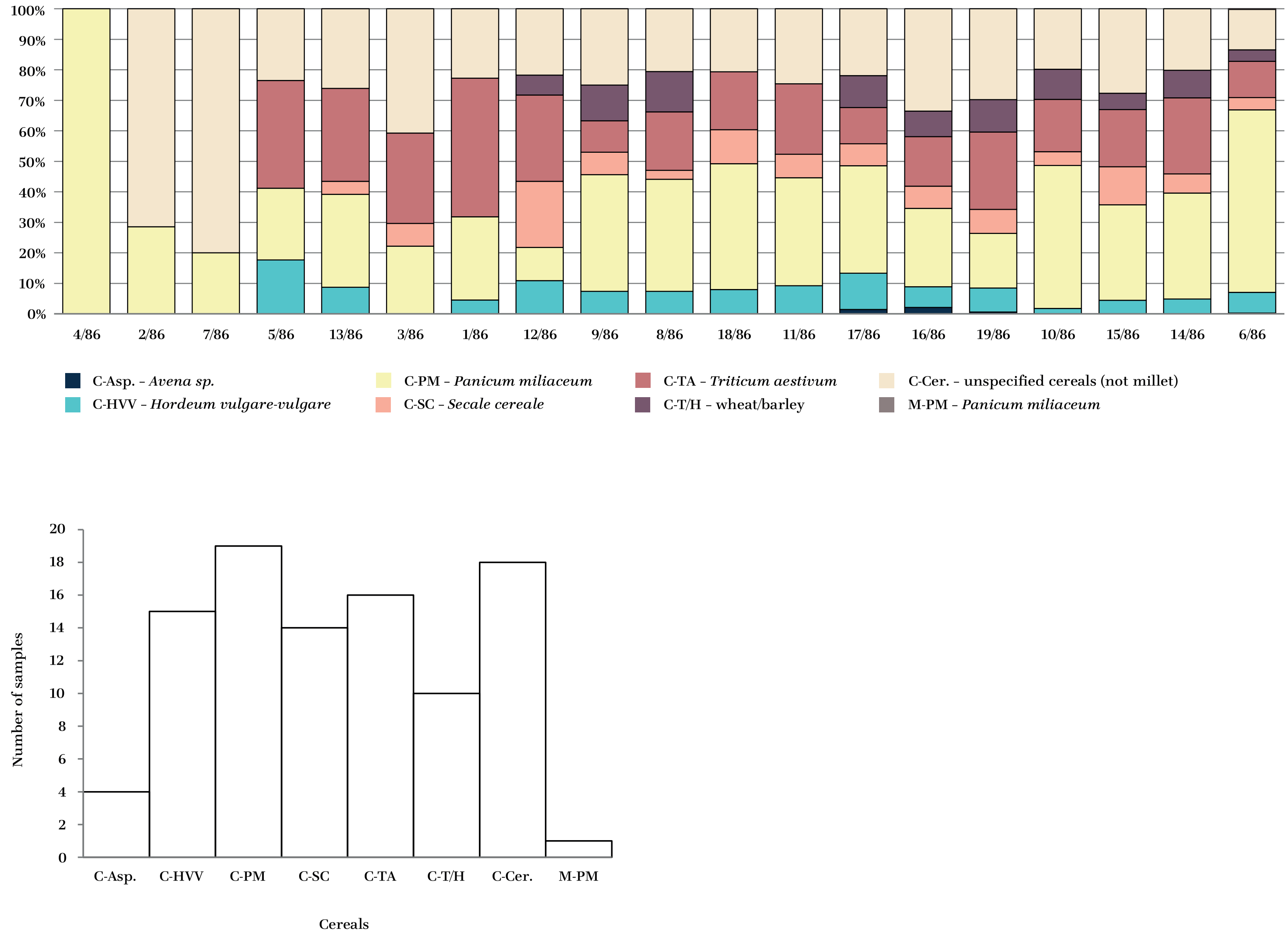


FIG. 68 | Mikulčice – Area 86. Percentage of occurrence (top) and the frequency (below) of finds of cereals in the samples with n = 1731. Captions: C – charred, M – mineralised.

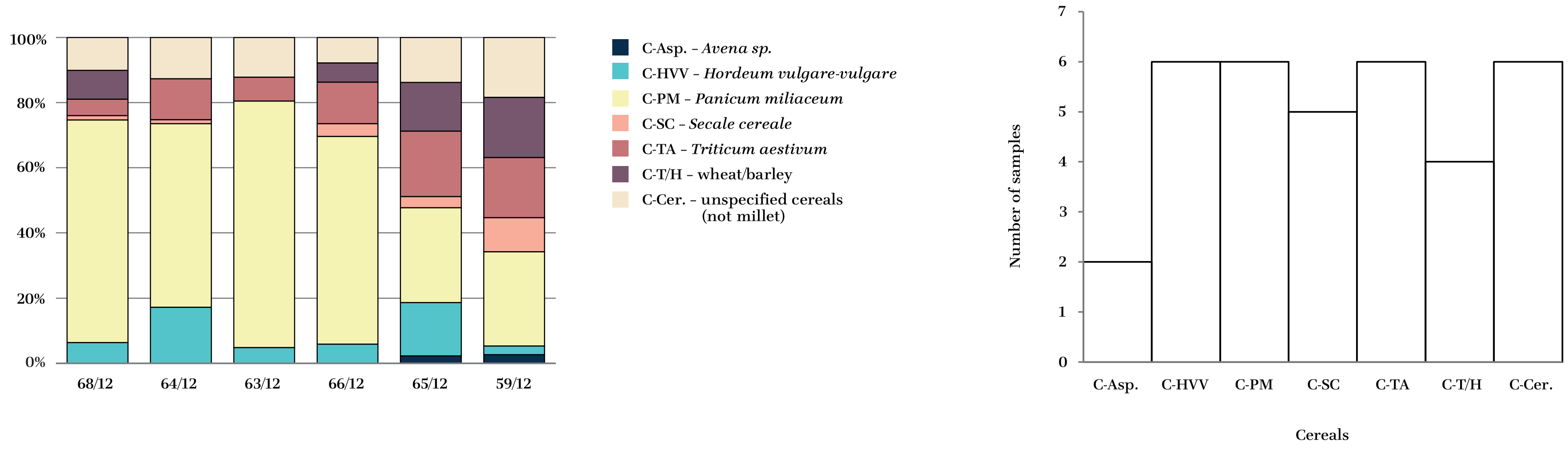


FIG. 69 | Mikulčice – Area 88. Percentage of occurrence (left) and the frequency (right) of finds of cereals in the samples with n = 615. Captions: C – charred.

FIG. 70 | Mikulčice – Area 89. Percentage of occurrence (left) and the frequency (right) of finds of cereals in the samples with n = 299. Captions: C – charred.

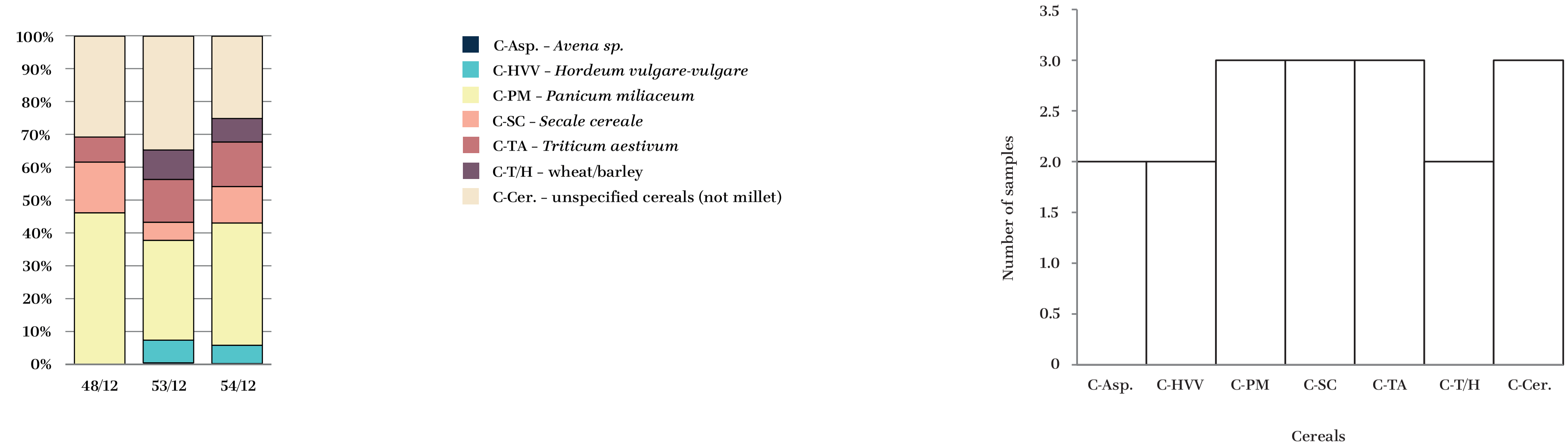


FIG. 71 | Mikulčice – Area 90. Percentage of occurrence (left) and the frequency (right) of finds of cereals in the samples with n = 920. Captions: C – charred.

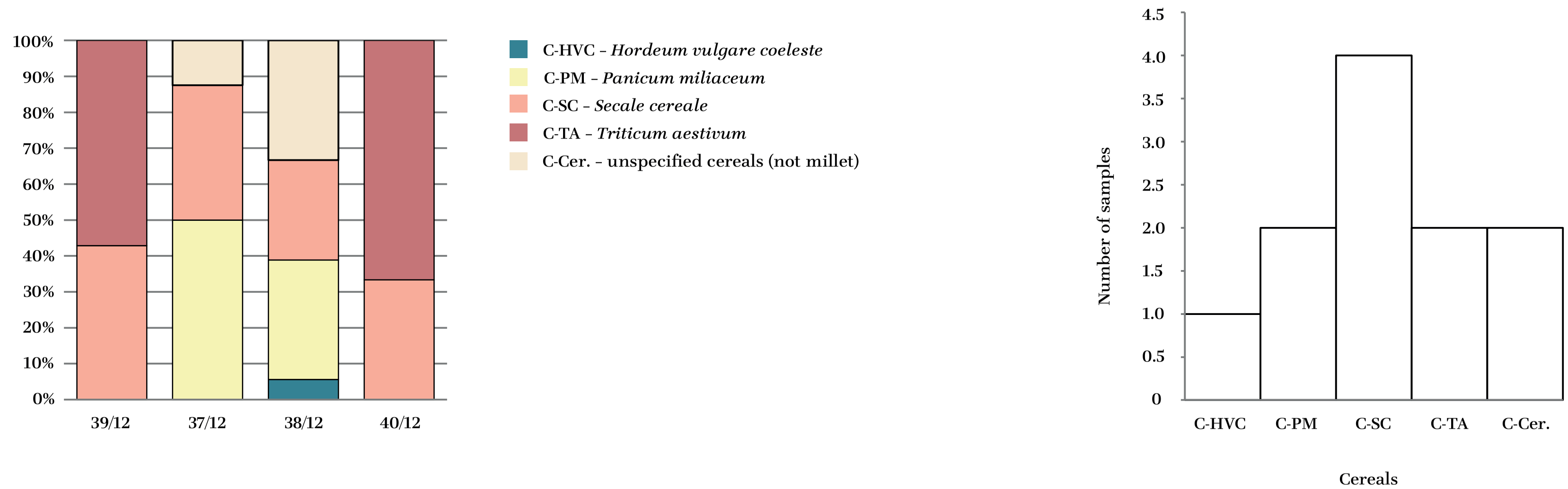


FIG. 72 | Mikulčice – Area 91. Percentage of occurrence (left) and the frequency (right) of finds of cereals in the samples with n = 36. Captions: C – charred.

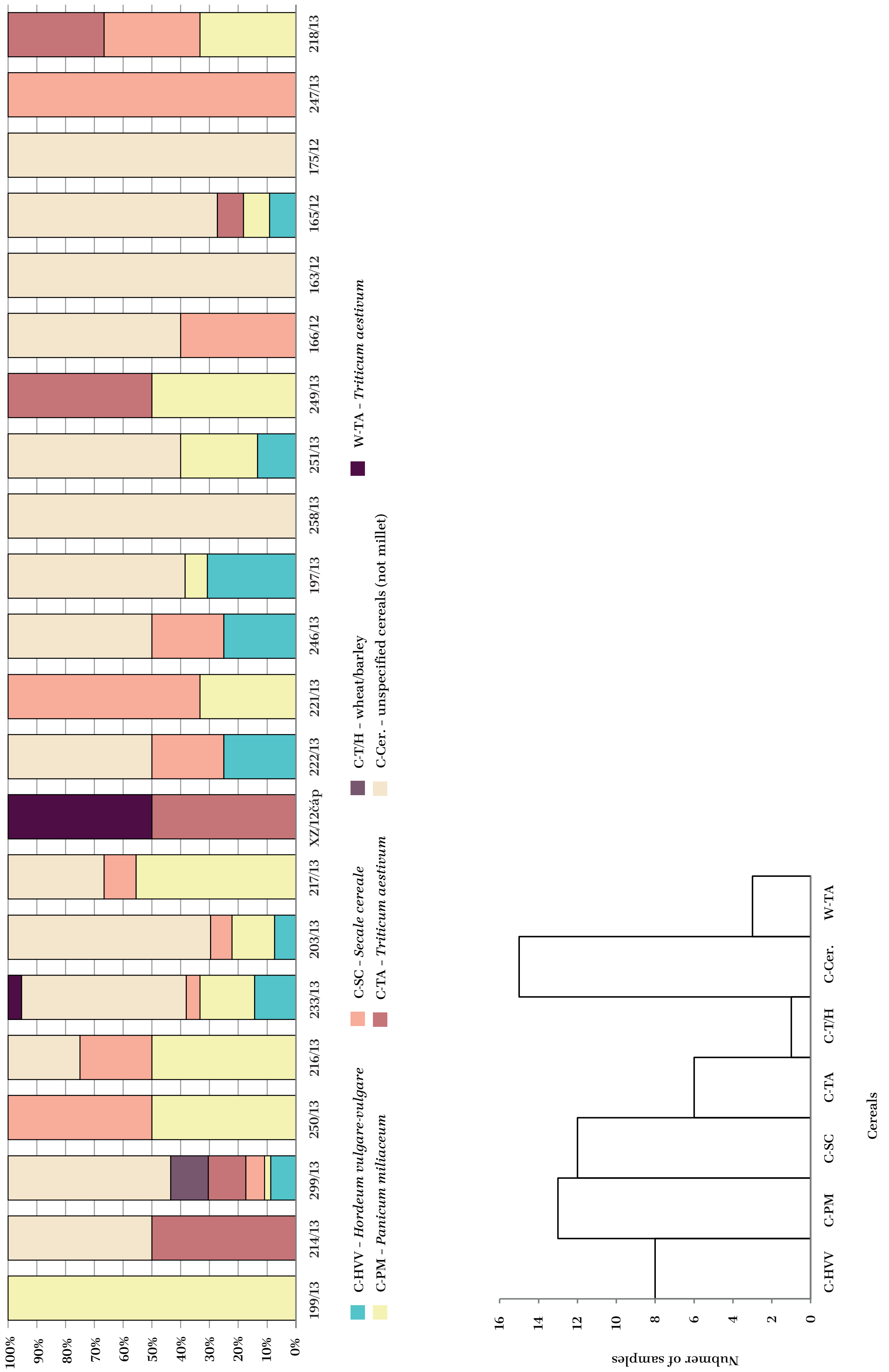


FIG. 73 | Mikulčice – Area 93. Percentage of occurrence (top) and the frequency (below) of finds of cereals in the samples with n = 181. Captions: C – charred, W – waterlogged.

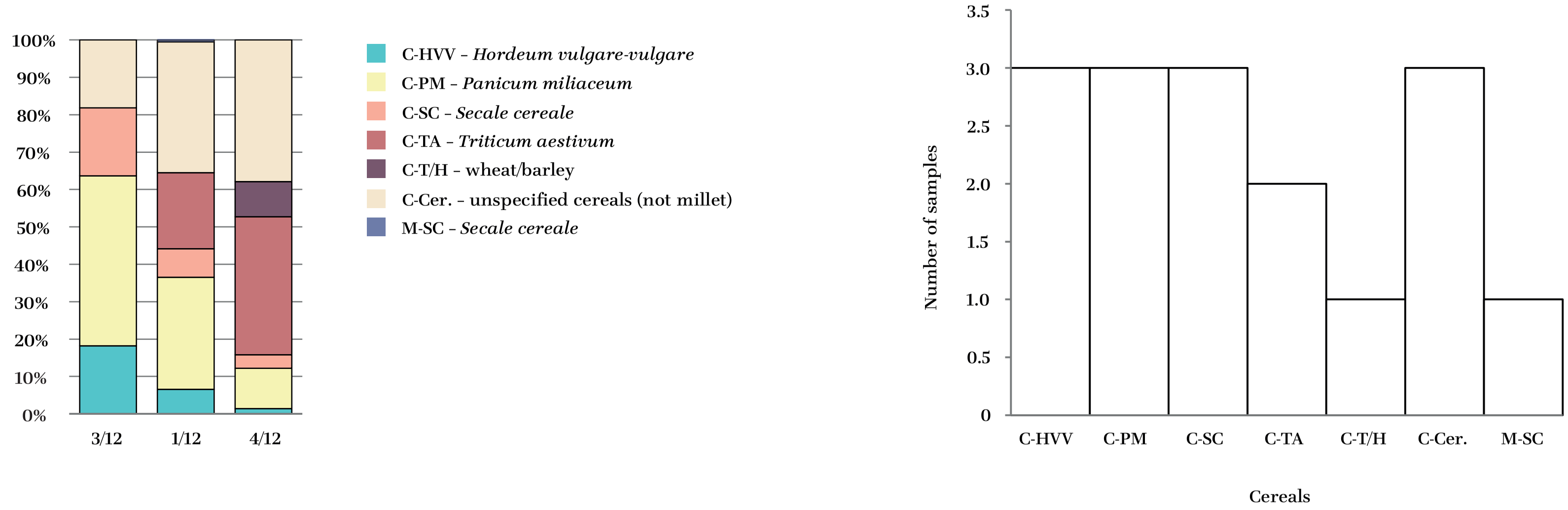


FIG. 74 | Mikulčice - Area 95. Percentage of occurrence (left) and the frequency (right) of finds of cereals in the samples with n = 709. Captions: C - charred, M - mineralised.

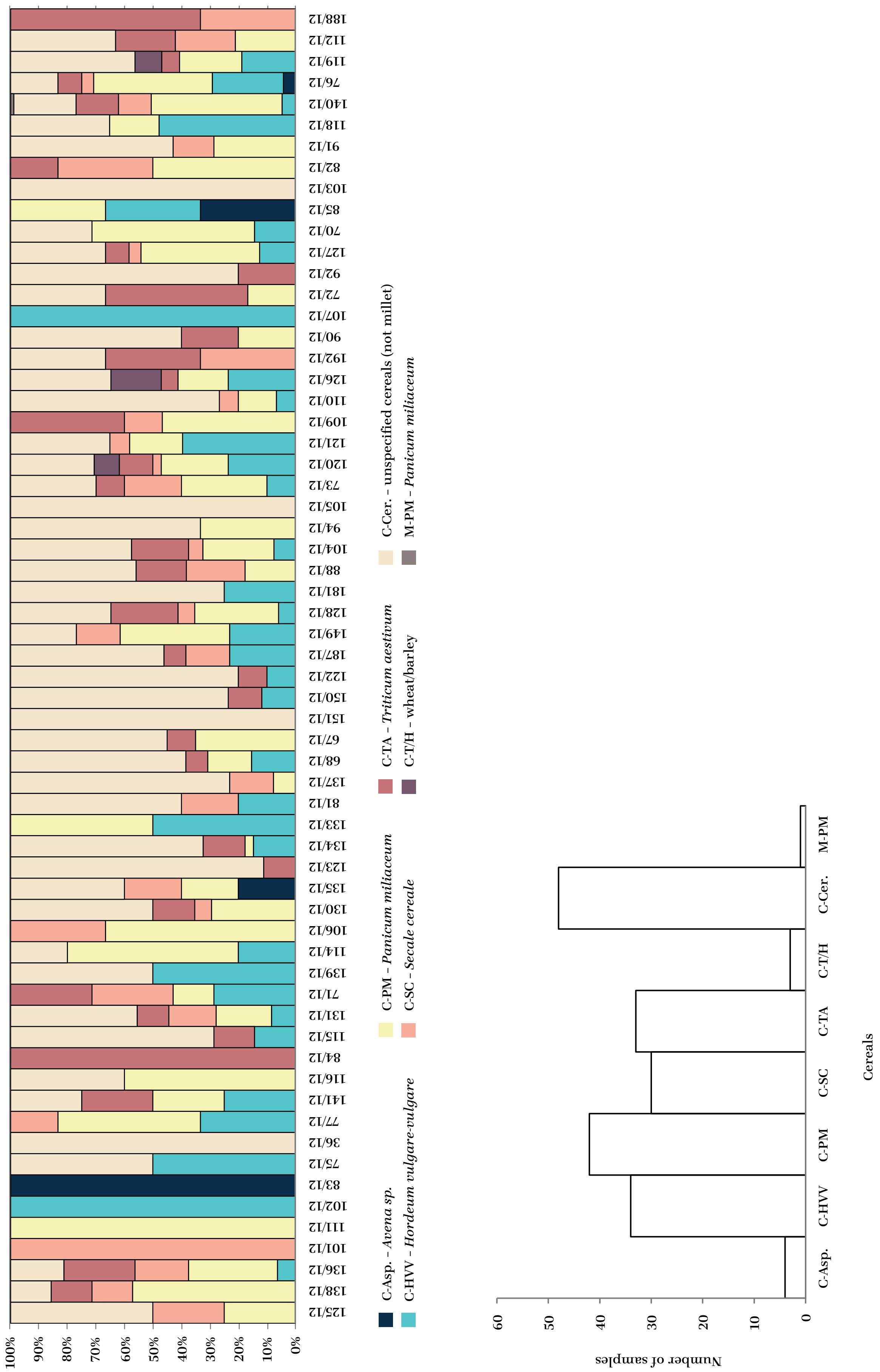


FIG. 75 | Mikulčice – Area 96. Percentage of occurrence (top) and the frequency (below) of finds of cereals in the samples with n = 804. Captions: C – charred, M – mineralised.

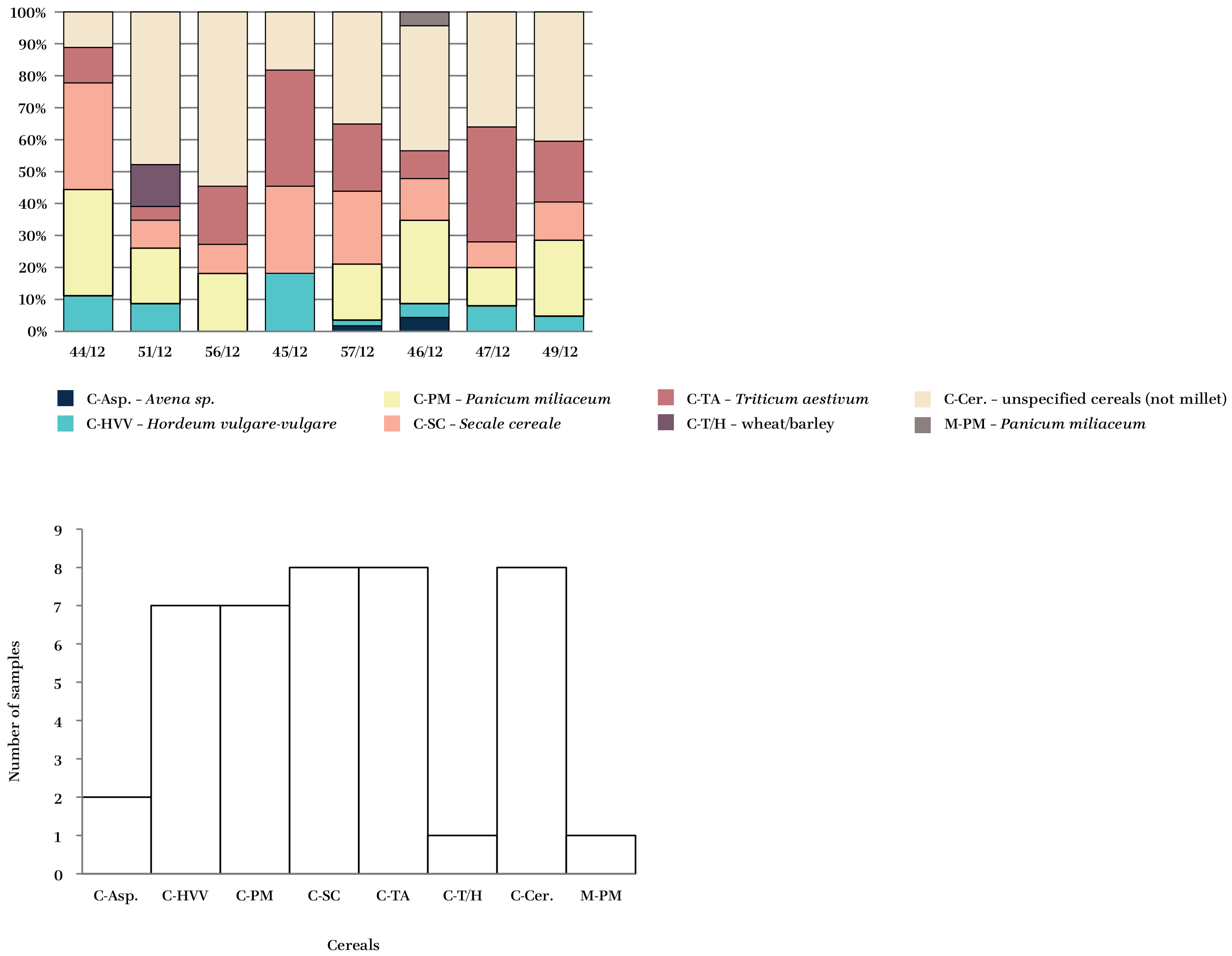


FIG. 76 | Mikulčice – Area 97. Percentage of occurrence (top) and the frequency (below) of finds of cereals in the samples with n = 212. Captions: C – charred, M – mineralised.

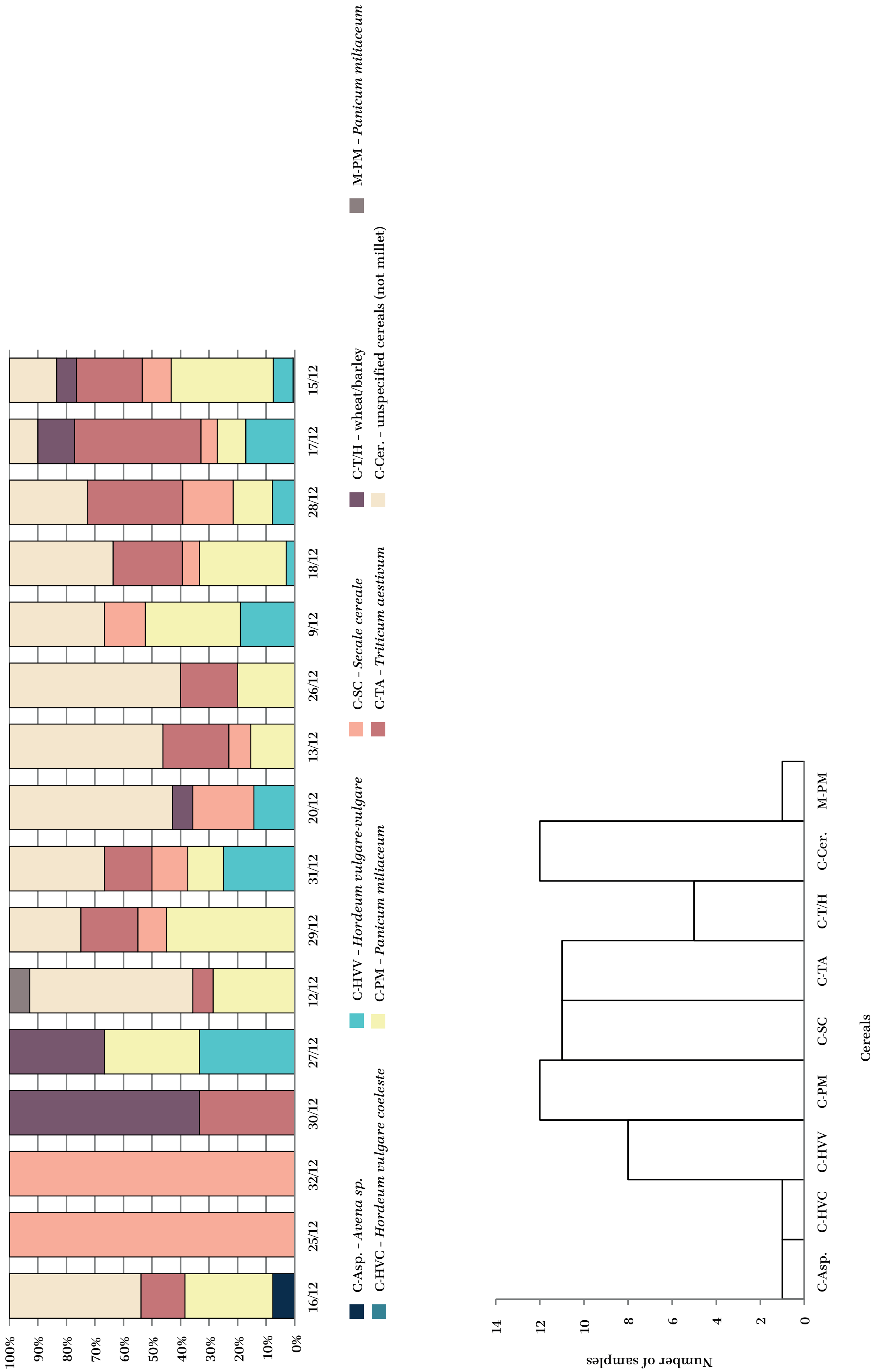
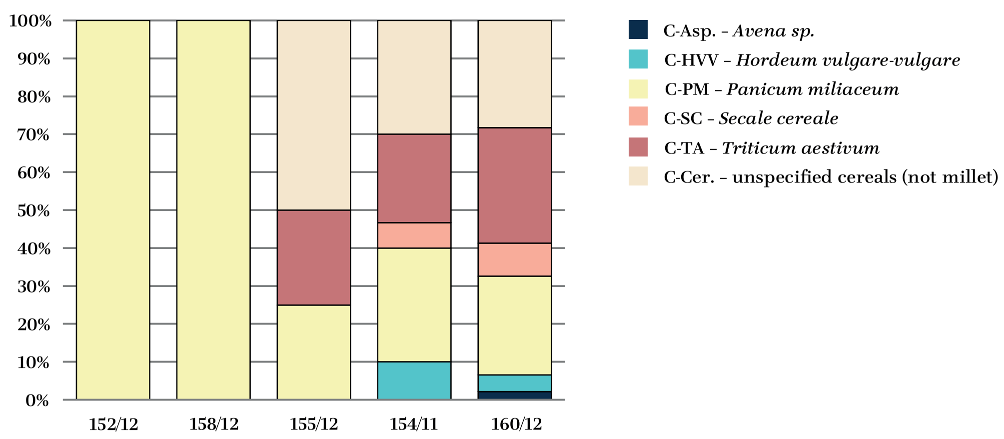


FIG. 77 | Mikulčice – Area 98. Percentage of occurrence (top) and the frequency (below) of finds of cereals in the samples with n = 479. Captions: C – charred, M – mineralised.



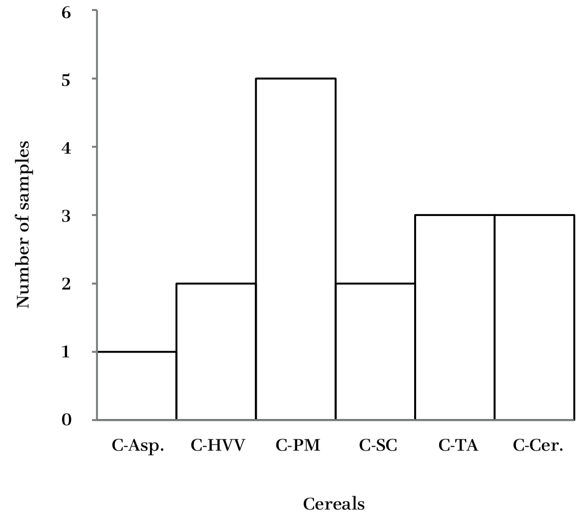


FIG. 78 | Mikulčice – Area 100. Percentage of occurrence (left) and the frequency (right) of finds of cereals in the samples with n = 82. Captions: C – charred.

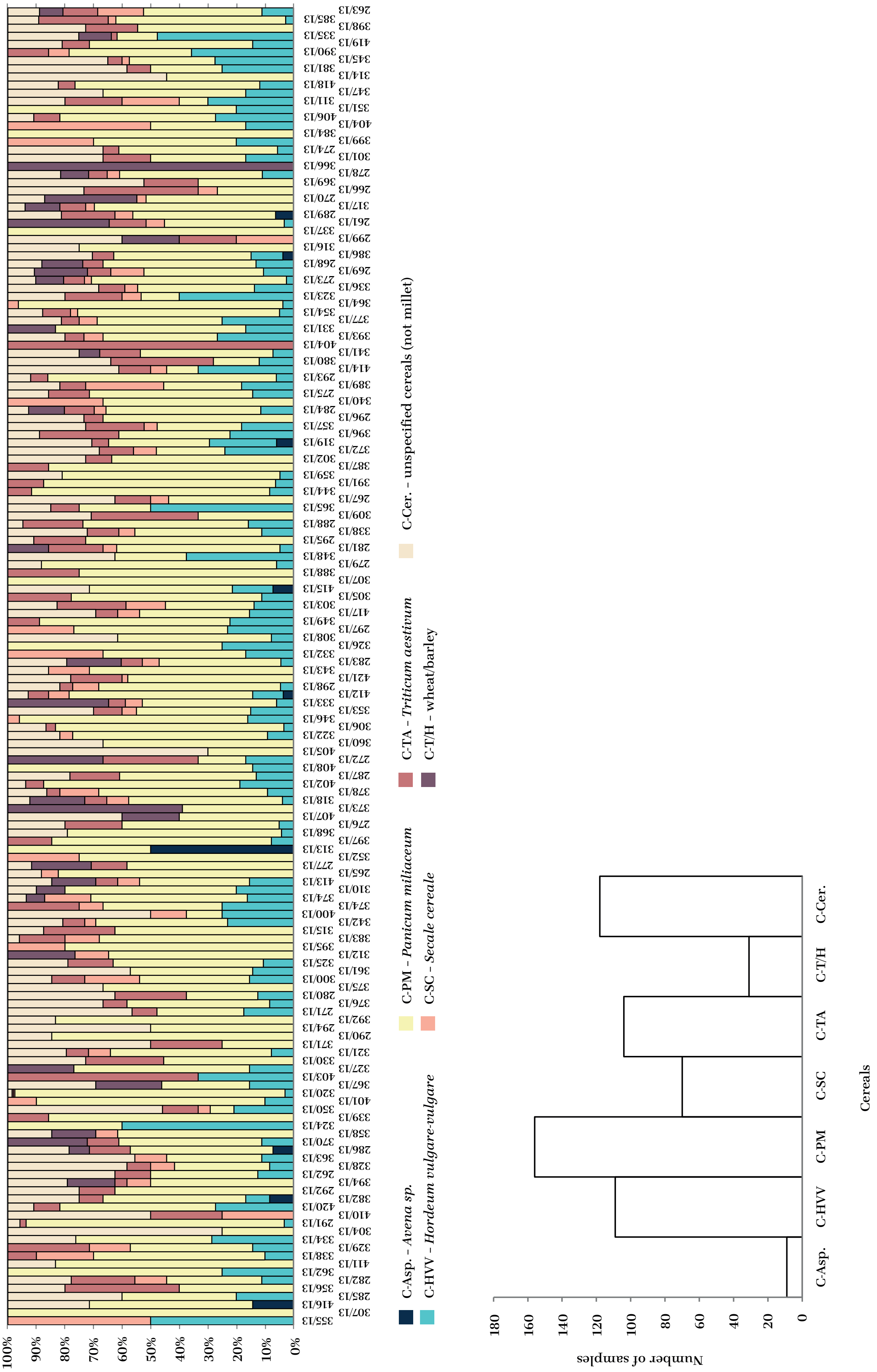


FIG. 79 | Mikulčice – Area 103. Percentage of occurrence (top) and the frequency (below) of finds of cereals in the samples with n = 3392. Captions: C – charred.

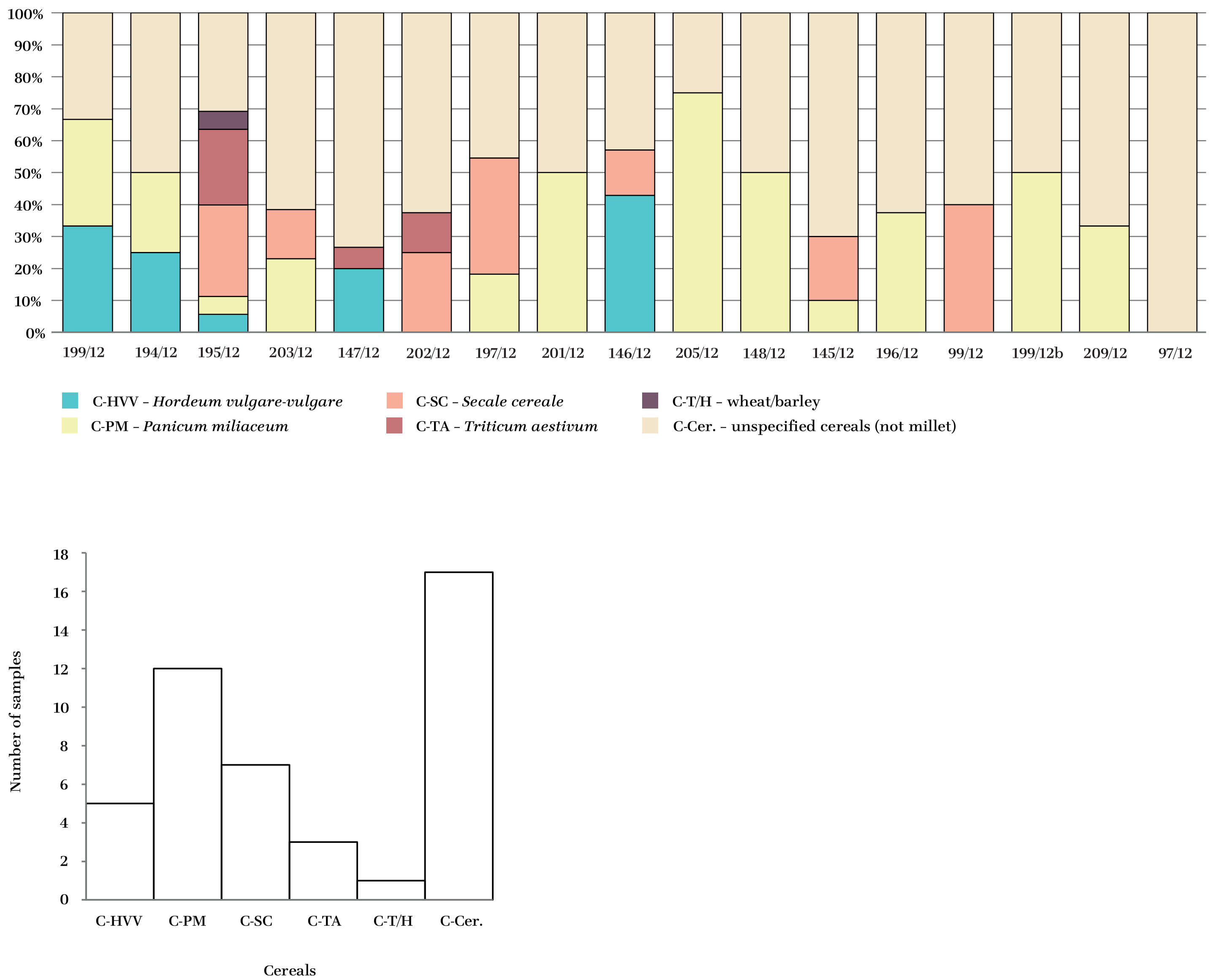


FIG. 80 | Mikulčice – Area M17 "Trapíkov". Percentage of occurrence (top) and the frequency (below) of finds of cereals in the samples with n = 368. Captions: C – charred.

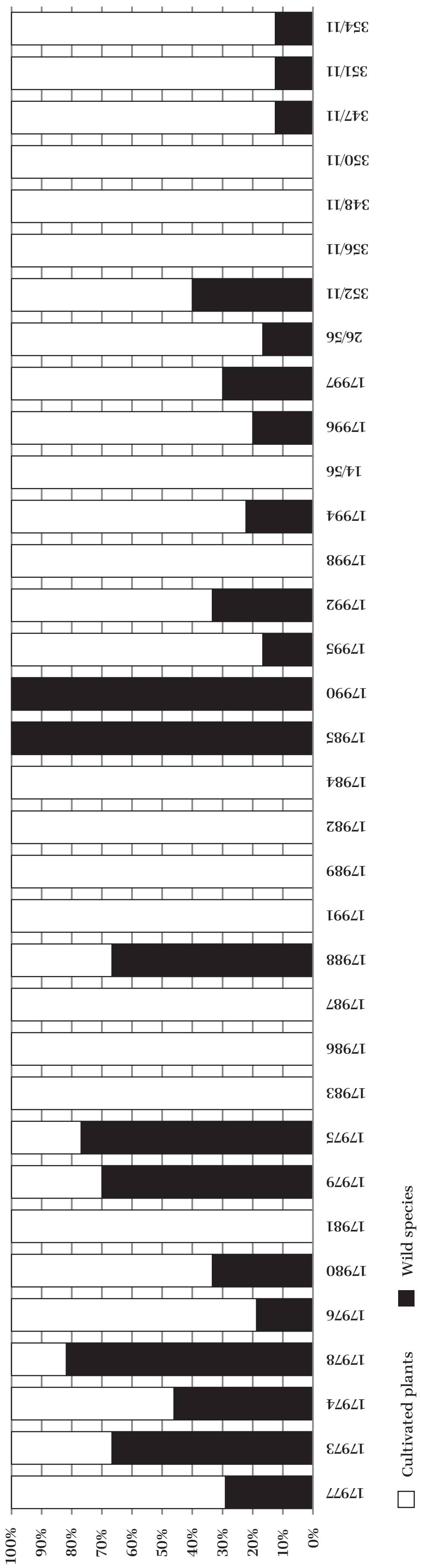


FIG. 81 | Kopčany – Church of St Margaret of Antioch. Percentage of cultivated crops and wild species in the samples with n = 236.

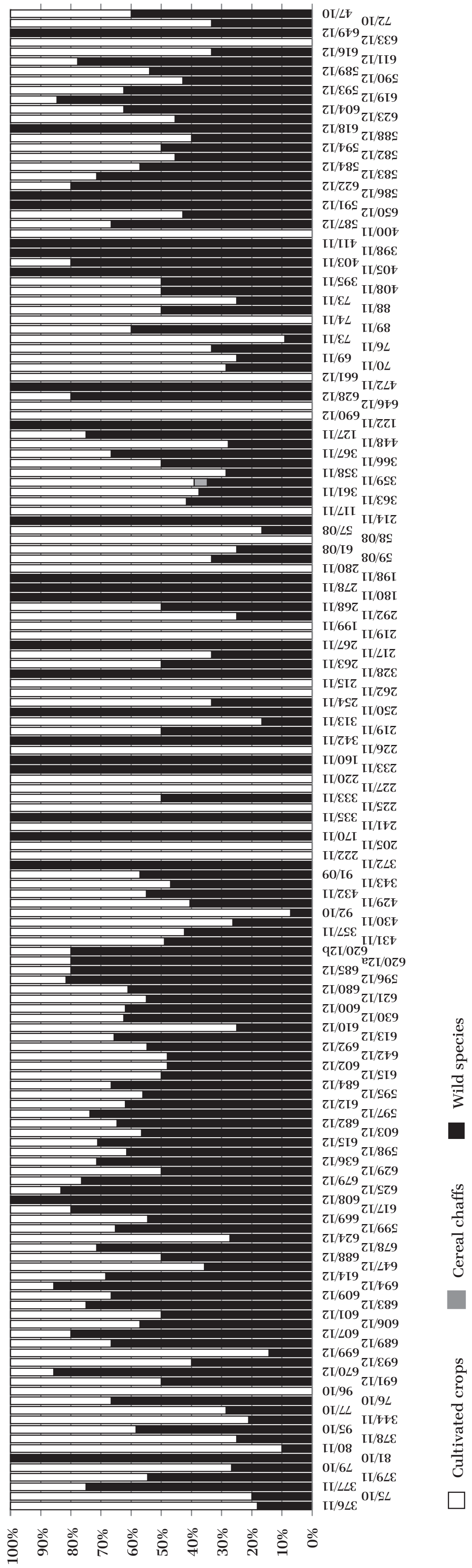


FIG. 82 | Kopčany-Kačenáreň. Percentage of cultivated crops and wild species in the samples with n = 2356.

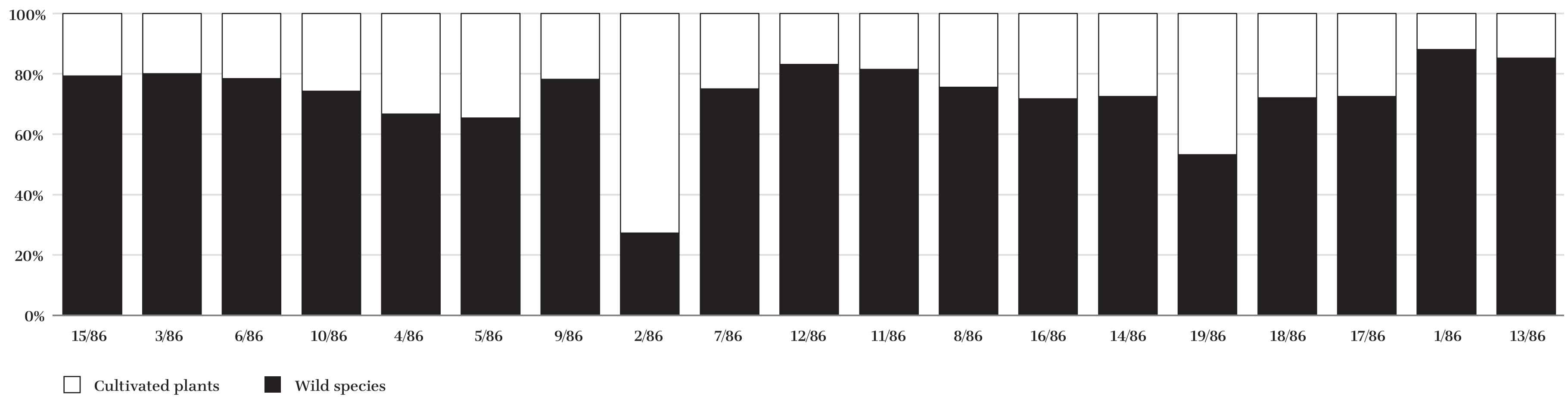


FIG. 83 | Mikulčice – Area 86. Percentage of cultivated crops and wild species in the samples with n = 2478.

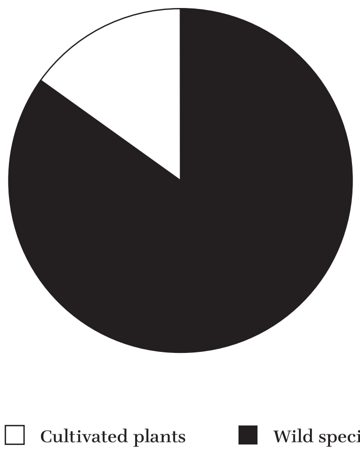


FIG. 84 | Mikulčice – Area 85. Percentage of cultivated crops and wild species in the samples with n = 192.

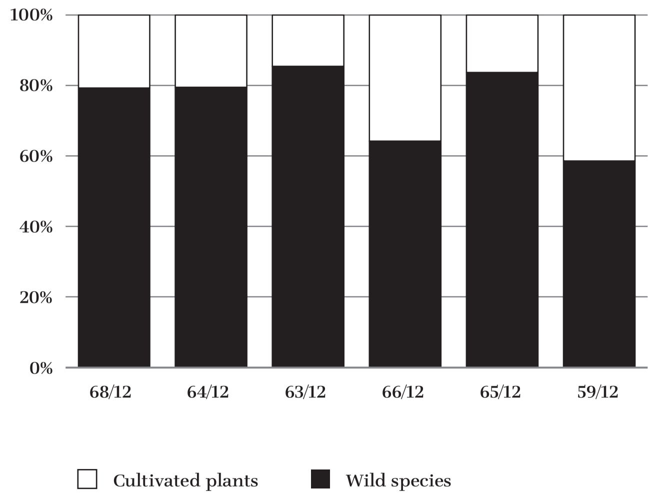


FIG. 85 | Mikulčice – Area 88. Percentage of cultivated crops and wild species in the samples with n = 821.

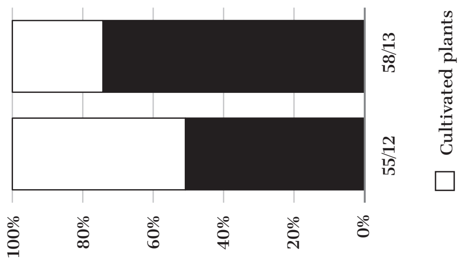


FIG. 86 | Mikulčice – Area 89. Percentage of cultivated crops and wild species in the samples with n = 471.

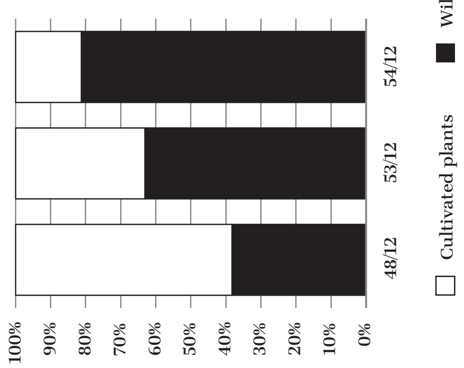


FIG. 87 | Mikulčice – Area 90. Percentage of cultivated crops and wild species in the samples with n = 1336.

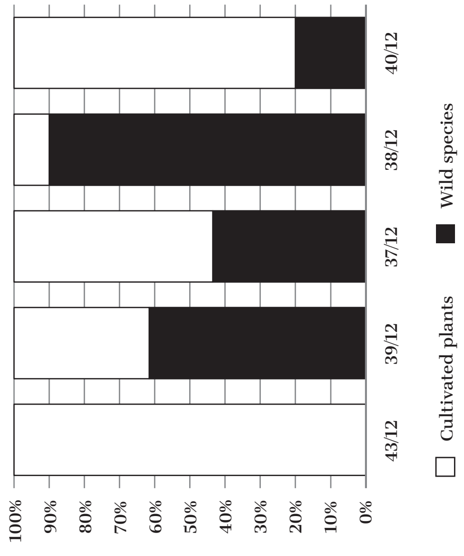


FIG. 88 | Mikulčice – Area 91. Percentage of cultivated crops and wild species in the samples with n = 72.

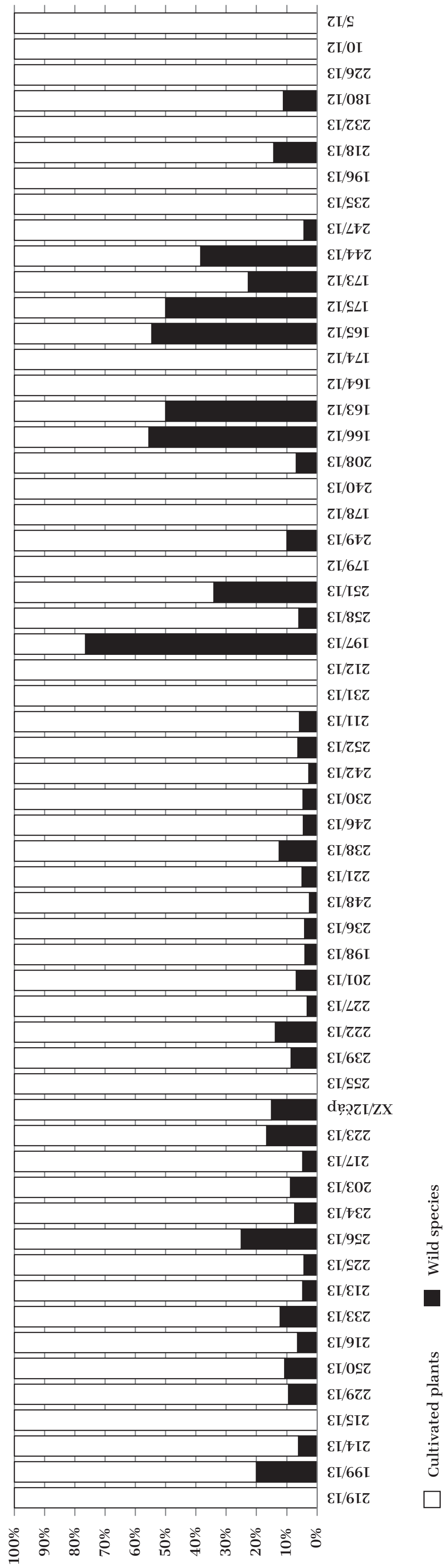


FIG. 89 | Mikulčice – Area 93. Percentage of cultivated crops and wild species in the samples with n = 8506.

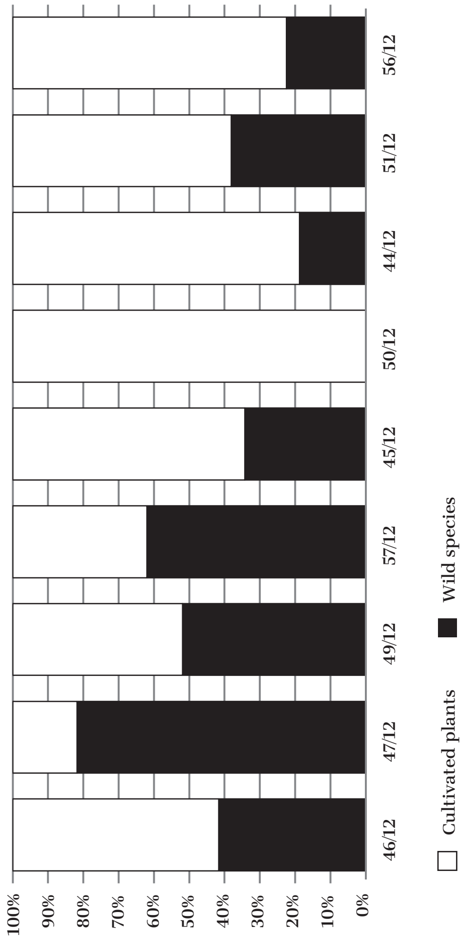


FIG. 91 | Mikulčice – Area 97. Percentage of cultivated crops and wild species in the samples with n = 535.

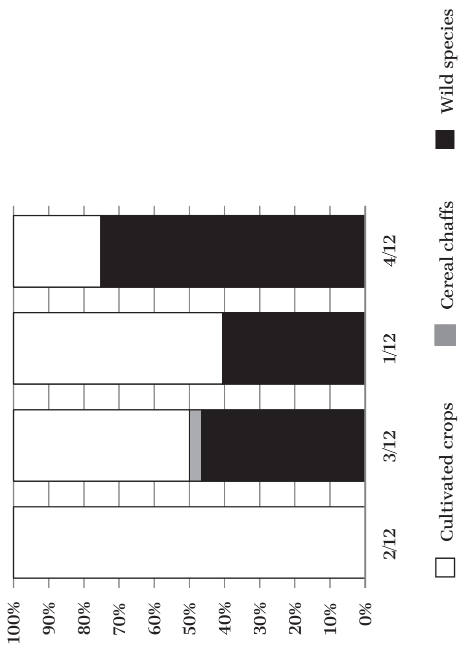


FIG. 90 | Mikulčice – Area 95. Percentage of cultivated crops and wild species in the samples with n = 1287.

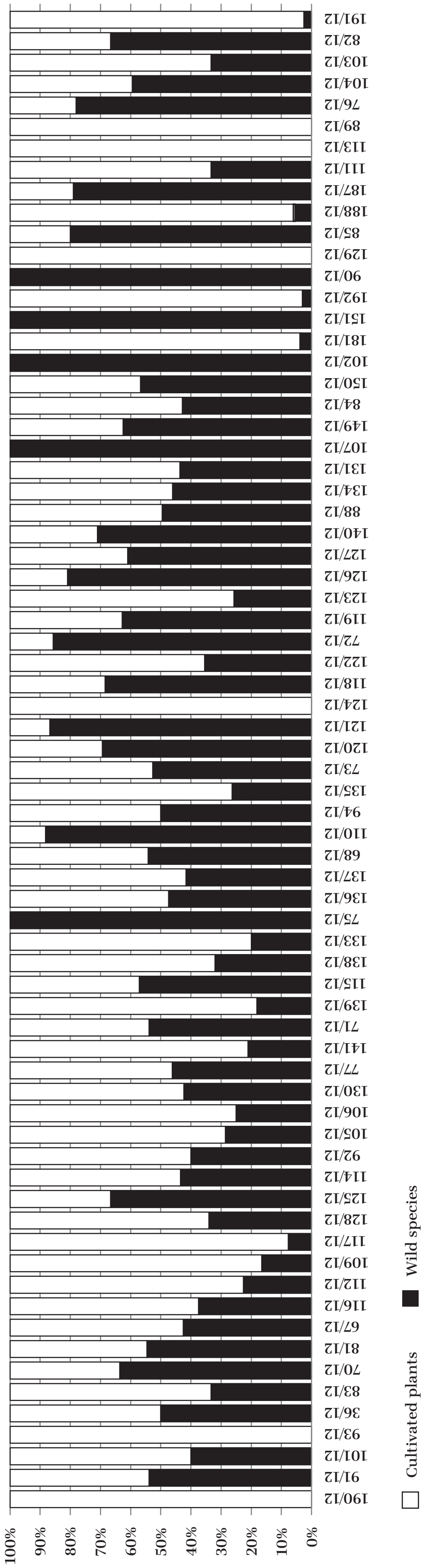


FIG. 92 | Mikulčice – Area 96. Percentage of cultivated crops and wild species in the samples with n = 2295.

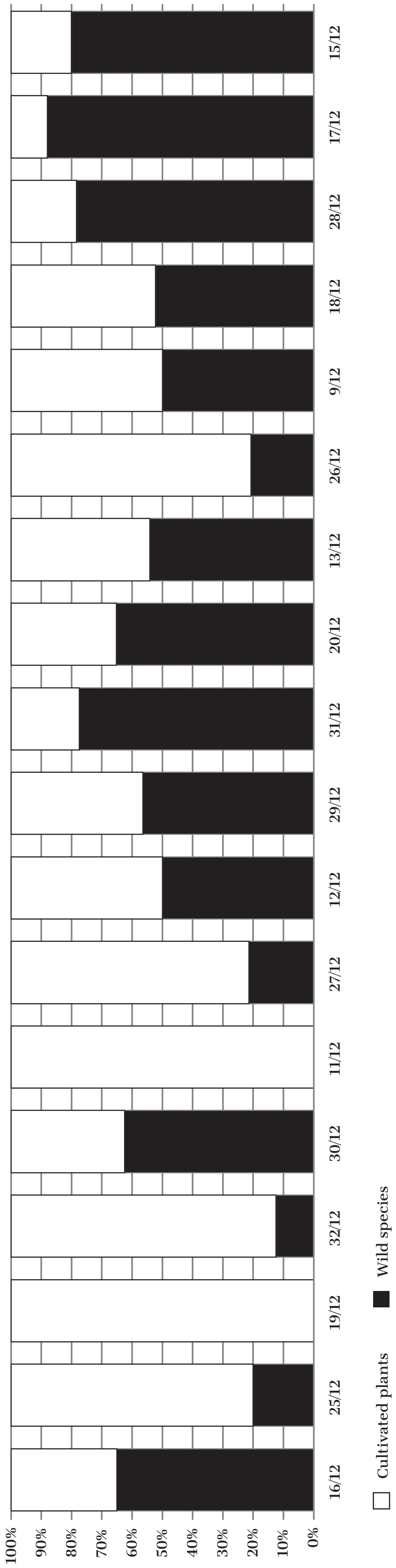


FIG. 93 | Mikulčice – Area 98. Percentage of cultivated crops and wild species in the samples with n = 754.

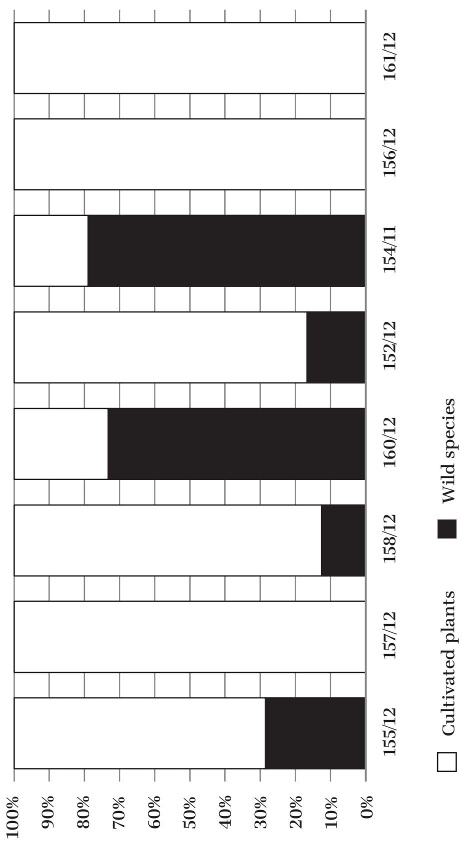


FIG. 94 | Mikulčice – Area 100. Percentage of cultivated crops and wild species in the samples with n = 145.

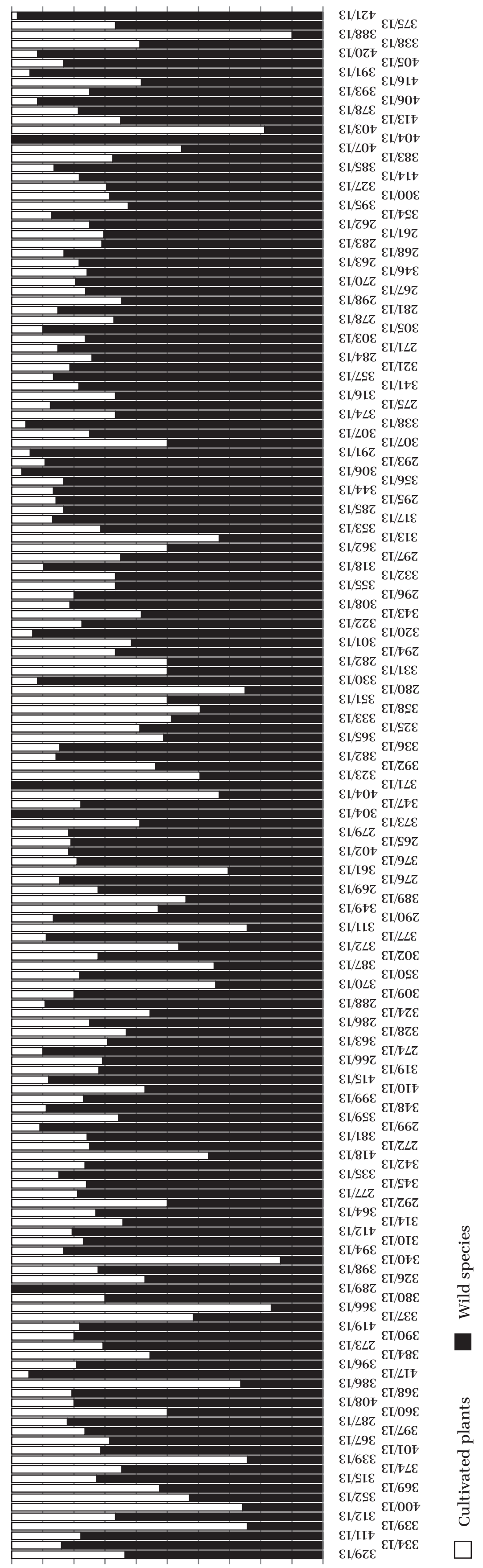


FIG. 95 | Mikulčice – Area 103. Percentage of cultivated crops and wild species in the samples with n = 5053.

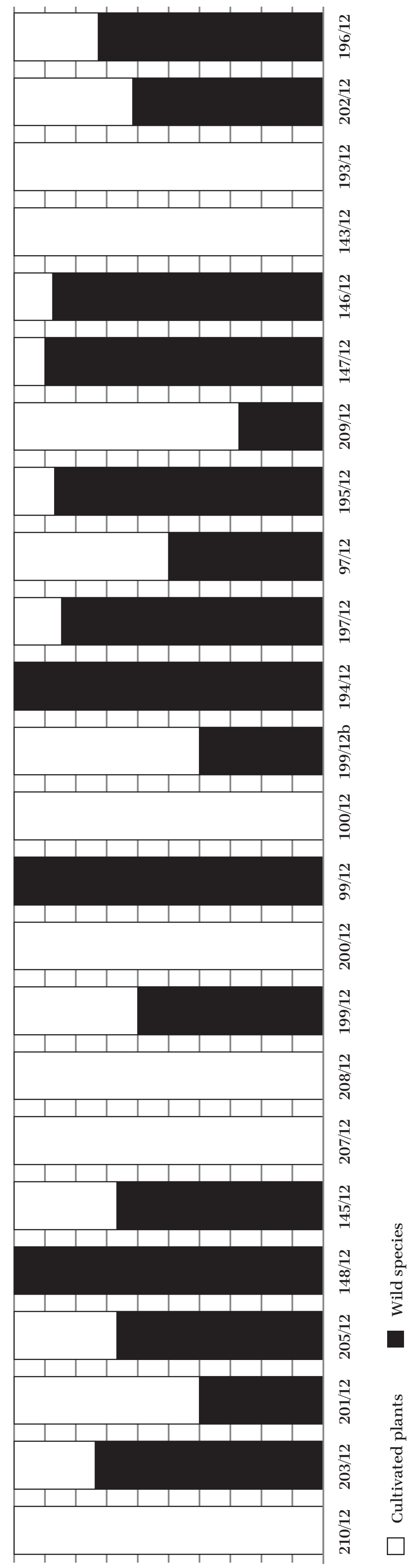


FIG. 96 | Mikulčice – Area MI7. Percentage of cultivated crops and wild species in the samples with n = 481.

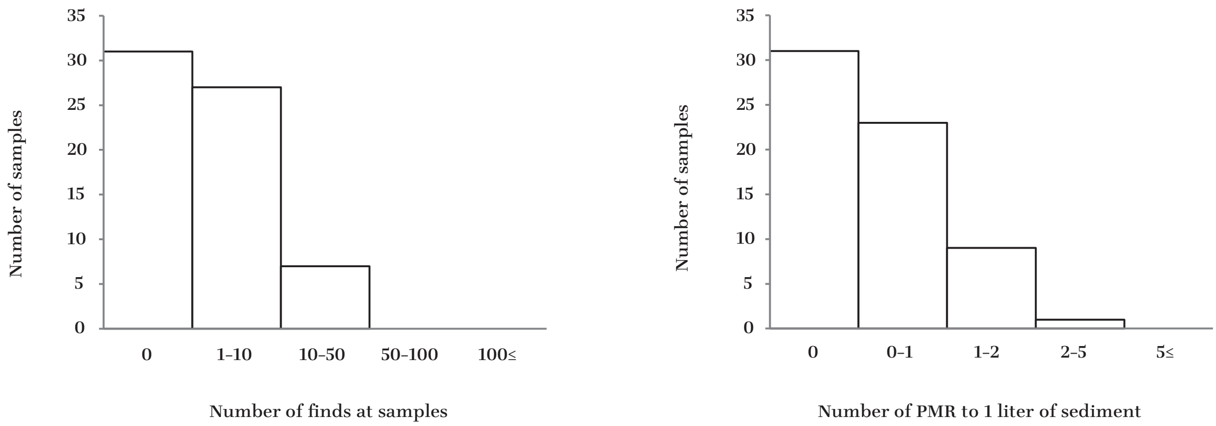


FIG. 97 | Kopčany – Church of St Margaret of Antioch. Histogram of the frequency of finds (left), n = 65 and average density of seeds per litre of sediment (right), n = 64.

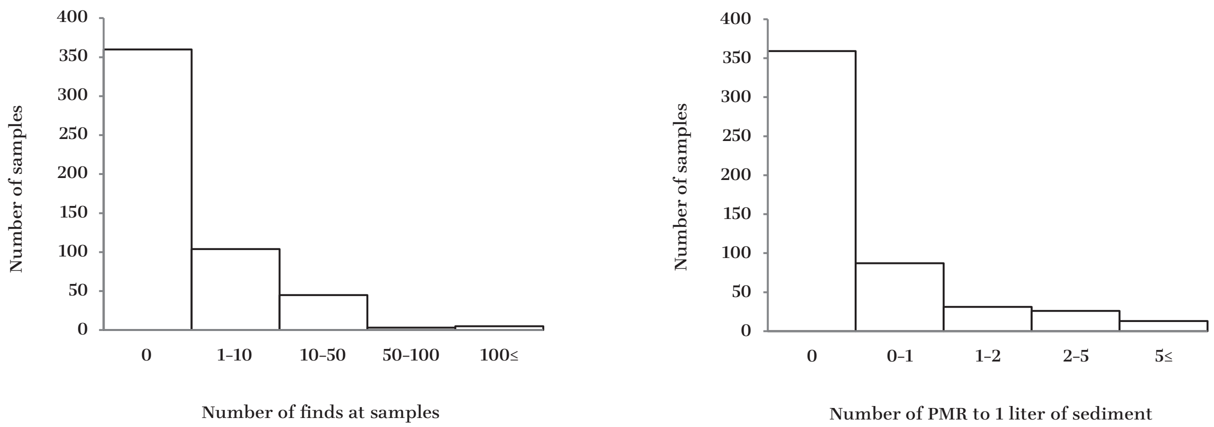


FIG. 98 | Kopčany-Kačenáreň. Histogram of the frequency of finds (left), n = 517 and average density of seeds per litre of sediment (right), n = 516.

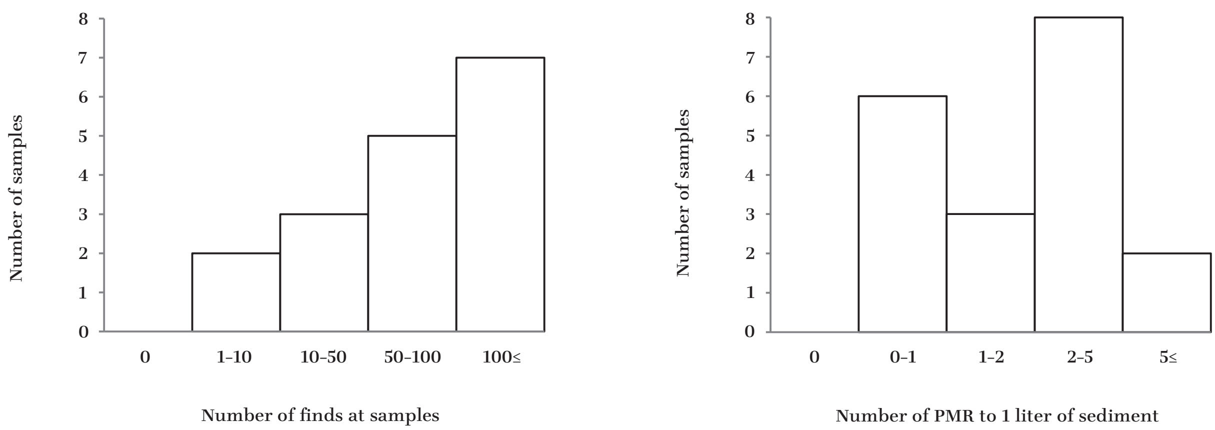


FIG. 99 | Mikulčice – Area 86. Histogram of the frequency of finds (left), n=17 and average density of seeds per litre of sediment (right), n = 19.

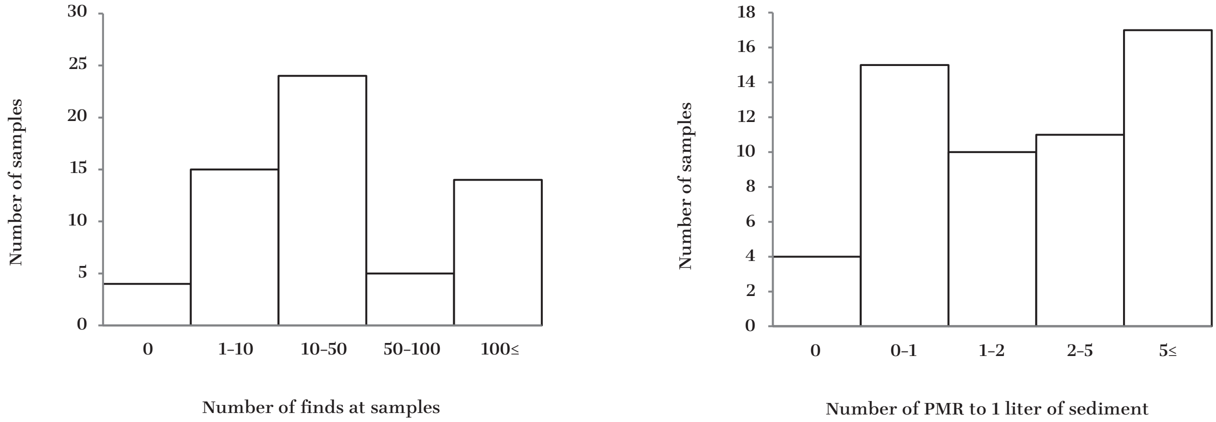


FIG. 100 | Mikulčice – Area 93. Histogram of the frequency of finds (left), n = 62 and average density of seeds per litre of sediment (right), n = 57.

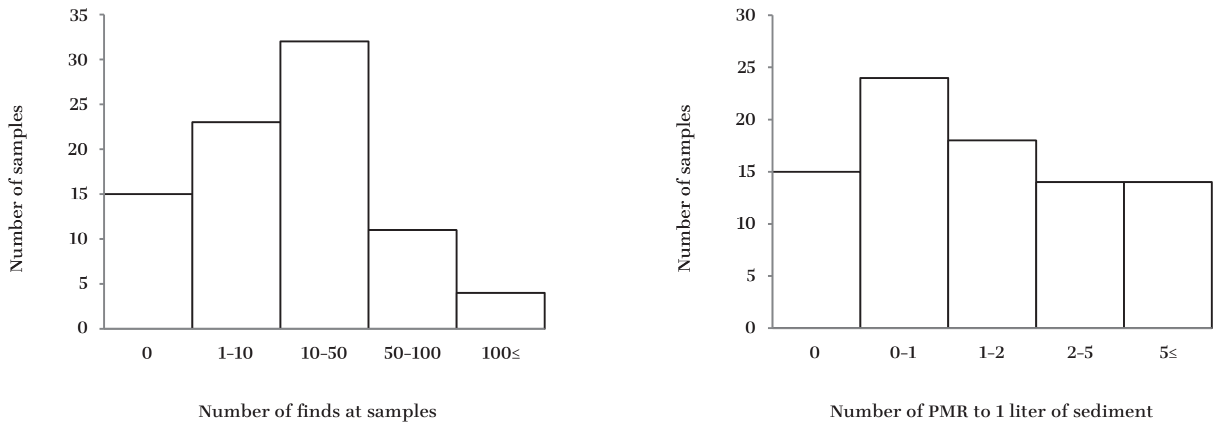


FIG. 101 | Mikulčice – Area 96. Histogram of the frequency of finds (left), n = 85 and average density of seeds per litre of sediment (right), n = 85.

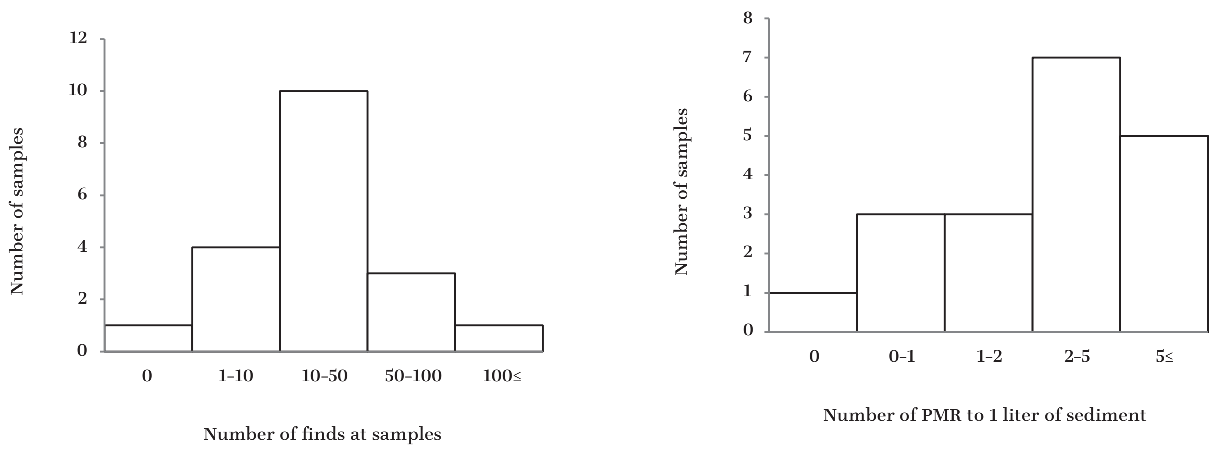


FIG. 102 | Mikulčice – Area 98. Histogram of the frequency of finds (left), n = 19 and average density of seeds per litre of sediment (right), n = 19.

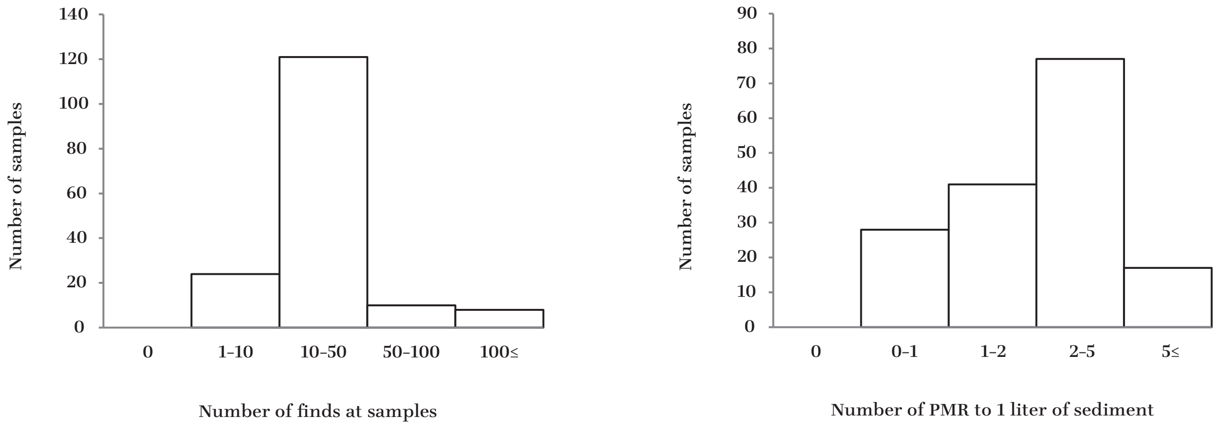


FIG. 103 | Mikulčice – Area 103. Histogram of the frequency of finds (left), n = 163 and average density of seeds per litre of sediment (right), n = 163.

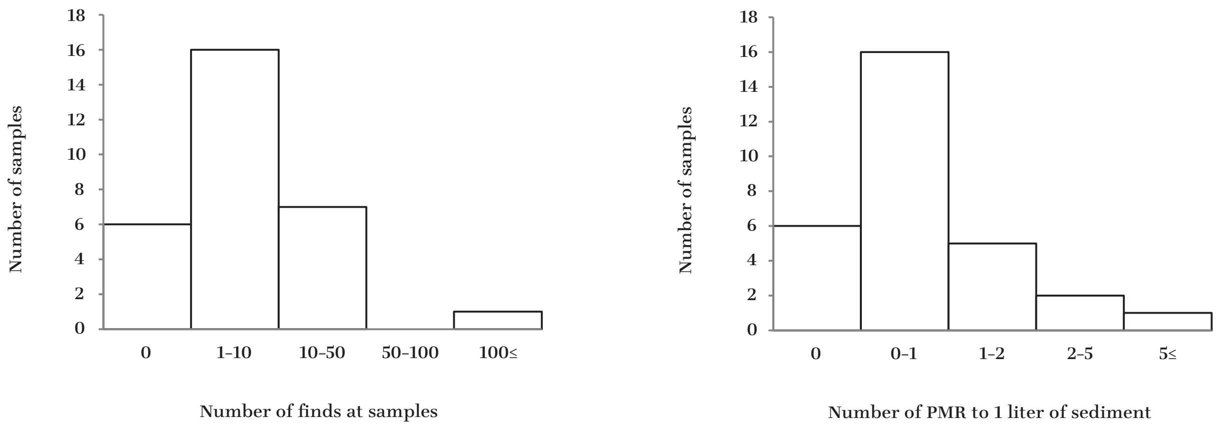


FIG. 104 | Mikulčice – Area M17. Histogram of the frequency of finds (left), n = 30 and average density of seeds per litre of sediment (right), n = 30.

TAB. 29 | Mikulčice-Kopčany. List of identified taxons from excavated areas, charred. Captions: Σ – suma, f – frequency.

Ordinal number	1		2		3		6		4		5		7		8		9	
Site	K		K		M		M		M		M		M		M		M	
Excavated area	KSM		KAČ		AR 91		AR 93		AR 100		AR M17		AR 85		AR 96		AR 88	
Context number	12		13		5		3		7		6		1		14		3	
Sample number	34		155		5		27		7		24		1		67		6	
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f
Cereal grains																		
Avena sp.	4	3	43	12	.	.	.	.	1	1	.	.	.	.	4	4	7	2
Hordeum vulgare-coeleste	3	2	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Hordeum vulgare-vulgare	6	2	45	27	.	.	18	8	5	2	23	5	8	1	104	34	73	6
Hordeum vulgare	4	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum miliaceum	21	12	369	81	10	2	29	13	24	5	35	12	18	1	204	41	288	6
Secale cereale	3	3	201	53	12	4	17	12	6	2	89	7	6	1	66	29	19	5
Triticum aestivum	1	1	66	32	6	2	11	6	22	3	65	3	10	1	96	33	92	6
Triticum/Hordeum	5	3	60	25	.	.	6	1	.	.	15	1	16	1	9	3	60	4
Cerealia indet	18	10	295	69	7	2	98	15	24	3	141	17	102	1	316	47	76	6
Chaff																		
Rachis Triticum aestivum	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Rachis	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Legumes																		
Lens culinaris	4	4	54	31	.	.	4	4	1	1	1	1	2	1	29	17	7	4
Pisum sativum	.	.	6	6	1	1	.	.	1	1	1	1	.	.	21	9	5	5
Vicia ervilia	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vicia faba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viciaceae	6	4	7	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leg. Sat.	3	3	14	8	.	.	2	2	4	1	6	2	.	.	2	2	2	1
Fruits/nuts																		
Malus domestica	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Persica vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Prunus cf. domestica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pyrus communis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Vitis vinifera	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vegetables																		
Petroselinum crispus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oil/fiber plants																		
Cannabis sativa	.	.	33	6	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Papaver somniferum	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Wild plants																		
Agrimonia sp.	.	.	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agrostemma githago	1	1	14	8	.	.	2	2	.	.	1	1	.	.	2	1	3	3
Ajuga reptans	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Alchemilla vulgaris/ arvensis	.	.	1	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Alnus sp.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
cf. Alnus	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Altea cf. officinalis	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Altea cf. palida	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arctium minus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arctium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arnoseris minima	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia campestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia vulgaris	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asperula arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2
Asteraceae	.	.	3	3	.	.	1	1	.	.	.	.	.	.	.	.	.	.
Atriplex sp.	1	1	5	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Ordinal number	10		11		12		13		14		15		16		
Site	M		M		M		M		M		M		M		
Excavated area	AR 86		AR 103		AR 95		AR 90		AR 97		AR 98		AR 89		
Context number	13		33		2		2		4		6		1		
Sample number	19		162		4		3		9		18		2		
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ Total
Cereal grains															
Avena sp.	9	4	9	9	.	.	3	2	2	2	1	1	2	1	85
Hordeum vulgare-coeleste	.	.	.	.	.	.	.	.	.	.	1	1	.	.	5
Hordeum vulgare-vulgare	123	15	392	109	22	3	56	2	11	7	43	8	10	2	939
Hordeum vulgare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
Panicum miliaceum	648	19	1802	156	118	3	315	3	40	7	122	12	58	2	4101
Secale cereale	118	14	154	70	35	3	79	3	33	8	48	11	40	2	926
Triticum aestivum	312	16	301	104	225	2	122	3	41	8	117	11	28	2	1515
Triticum/Hordeum	121	10	188	31	47	1	73	2	3	1	30	5	17	2	650
Cerealia indet	399	18	546	118	261	3	272	3	81	8	116	12	144	2	2896
Chaff															
Rachis Triticum aestivum	.	.	.	.	1	1	.	.	.	.	.	.	.	.	3
Rachis	.	.	.	.	1	1	.	.	.	.	.	.	.	.	2
Legumes															
Lens culinaris	41	13	64	43	14	2	19	2	7	4	15	7	17	2	279
Pisum sativum	2	2	17	15	1	1	6	2	3	2	4	3	6	1	74
Vicia ervilia	.	.	.	.	1	1	.	.	.	.	.	.	.	.	2
Vicia faba	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
Viciaceae	.	.	.	.	7	1	.	.	.	.	.	.	.	.	20
Leg. Sat.	1	1	5	3	.	.	.	.	.	.	.	.	.	.	39
Fruits / nuts															
Malus domestica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Persica vulgaris	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2
Prunus cf. domestica	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
Pyrus communis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Vitis vinifera	7	3	2	2	2	1	1	1	.	.	.	.	.	.	15
Vegetables															
Petroselinum crispus	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1
Oil / fiber plants															
Cannabis sativa	.	.	3	3	3	1	.	.	.	.	.	.	.	.	40
Papaver somniferum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Wild plants															
Agrimonia sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Agrostemma githago	23	7	9	6	7	2	28	2	1	1	6	3	1	1	98
Ajuga reptans	.	.	.	.	2	1	.	.	1	1	.	.	.	.	5
Alchemilla vulgaris/arvensis	.	.	.	.	1	1	.	.	.	.	.	.	.	.	3
Alnus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
cf. Alnus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Altea cf. officinalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Altea cf. palida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Arctium minus	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1
Arctium sp.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1
Arnoseris minima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Artemisia campestris	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1
Artemisia vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Asperula arvensis	1	1	3	1	.	.	.	.	.	.	.	.	.	.	7
Asteraceae	1	1	.	.	.	.	1	1	.	.	.	.	.	.	6
Atriplex sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6

TAB. 29 | Continuation 1

Ordinal number	1		2		3		6		4		5		7		8		9	
Site	K		K		M		M		M		M		M		M		M	
Excavated area	KSM		KAČ		AR 91		AR 93		AR 100		AR M17		AR 85		AR 96		AR 88	
Context number	12		13		5		3		7		6		1		14		3	
Sample number	34		155		5		27		7		24		1		67		6	
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f
Atropa bella-donna	1	1	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Avena/Bromus	3	3	11	3	.	.	6	3	.	.	4	4	.	.	2	2	.	.
Barbarea vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brassica nigra	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brassica rapa	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Brassica/Sinapis	.	.	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brassicaceae	.	.	3	3	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Bromus arvensis	2	2	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bromus secalinus	3	3	3	3	.	.	.	.	.	.	.	.	.	.	.	.	2	2
cf. Bromus tectorum/ sterilis	.	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.
Bud	.	.	1	1	.	.	.	.	.	.	.	.	1	1	3	3	1	1
Bupleurum rotundifolium	3	3	18	15	.	.	1	1	.	.	1	1	.	.	4	4	4	3
Capsella bursa-pastoris/ Lep. rud.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
cf. Cardamine sp.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardaria draba	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex dioica	.	.	11	8	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Carex divulsa	.	.	1	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Carex gracilis	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.
Carex/Setaria glauca	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex sp.	1	1	1	1	.	.	.	.	2	2	.	.	.	.	.	.	.	.
Carpinus betulus	.	.	2	2	.	.	.	.	.	.	3	3	.	.	6	4	1	1
Centaurea cyanus	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Centaurea/Carduus/ Cirsium	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Cerastium sp.	.	.	1	1	.	.	.	.	.	.	1	1	.	.	2	1	.	.
Cerasus avium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Cerasus/Prunus	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cornus mas	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cornus sanguinea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
cf. Corylus avellana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
cf. Crataegus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Digitaria/Setaria	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diplotaxis muralis	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Echinochloa crus-galli	.	.	29	17	.	.	3	3	.	.	2	2	.	.	5	4	1	1
Erodium sp.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fabaceae	1	1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Fallopia convolvulus	2	2	43	19	1	1	.	.	3	2	2	1	1	1	22	13	18	4
Fallopia dumetorum	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fragaria cf. moschata	.	.	5	4	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Fragaria vesca	.	.	.	.	.	.	.	.	.	.	3	3	.	.	1	1	.	.
Galeopsis angustifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galeopsis cf. ladanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium aparine	2	1	3	3	.	.	4	2	2	1	1	1	.	.	2	2	11	3
Galium mollugo	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium palustre	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Galium spurium	24	15	27	19	2	2	3	3	4	2	7	1	.	.	25	17	24	6
Galium/Asperula	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium sp.	13	8	6	6	.	.	1	1	1	1	1	1	.	.	4	4	1	1

Ordinal number	10		11		12		13		14		15		16		
Site	M		M		M		M		M		M		M		
Excavated area	AR 86		AR 103		AR 95		AR 90		AR 97		AR 98		AR 89		
Context number	13		33		2		2		4		6		1		
Sample number	19		162		4		3		9		18		2		
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ Total
Atropa bella-donna	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Avena/Bromus	3	2	2	2	1	1	.	.	1	1	.	.	1	1	34
Barbarea vulgaris	.	.	1	1	.	.	.	.	1	1	.	.	.	.	2
Brassica nigra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Brassica rapa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Brassica/Sinapis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Brassicaceae	.	.	.	.	1	1	.	.	4	1	.	.	1	1	10
Bromus arvensis	.	.	.	.	.	.	1	1	1	1	.	.	.	.	6
Bromus secalinus	.	.	7	7	.	.	3	1	2	2	4	2	1	1	25
cf. Bromus tectorum/ sterilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Bud	.	.	5	4	.	.	.	.	.	.	.	.	4	2	15
Bupleurum rotundifolium	14	9	5	4	3	1	4	1	1	1	9	4	11	2	78
Capsella bursa-pastoris/ Lep. rud.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	2
cf. Cardamine sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Cardaria draba	.	.	.	.	1	1	.	.	.	.	.	.	.	.	2
Carex dioica	4	4	1	1	1	1	29	2	.	.	1	1	.	.	48
Carex divulsa	.	.	.	.	1	1	.	.	.	.	.	.	.	.	3
Carex gracilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Carex/Setaria glauca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Carex sp.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	5
Carpinus betulus	14	4	12	9	34	3	1	1	.	.	2	1	.	.	75
Centaurea cyanus	1	1	.	.	.	.	.	.	.	.	.	.	.	.	3
Centaurea/Carduus/ Cirsium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Cerastium sp.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	5
Cerasus avium	.	.	6	1	.	.	1	1	.	.	.	.	.	.	8
Cerasus/Prunus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Cornus mas	2	2	.	.	.	.	3	1	.	.	.	.	.	.	5
Cornus sanguinea	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
cf. Corylus avellana	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1
cf. Crataegus sp.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
Digitaria/Setaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Diplotaxis muralis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Echinochloa crus-galli	7	3	2	2	4	1	23	2	2	1	2	2	.	.	80
Erodium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Fabaceae	.	.	.	.	.	.	6	1	.	.	1	1	.	.	9
Fallopia convolvulus	55	9	66	45	2	1	10	2	10	5	6	3	3	2	244
Fallopia dumetorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Fragaria cf. moschata	.	.	.	.	1	1	.	.	.	.	.	.	.	.	7
Fragaria vesca	4	3	.	.	1	1	7	1	.	.	.	.	.	.	16
Galeopsis angustifolia	1	1	.	.	.	.	2	2	.	.	.	.	.	.	3
Galeopsis cf. ladanum	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1
Galium aparine	12	4	66	32	19	3	4	1	8	3	8	3	8	2	150
Galium mollugo	1	1	2	2	.	.	.	.	.	.	.	.	.	.	6
Galium palustre	8	5	9	8	.	.	1	1	.	.	.	.	8	1	27
Galium spurium	79	13	142	59	35	3	21	2	8	4	25	9	26	2	452
Galium/Asperula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Galium sp.	11	6	30	22	17	1	1	1	10	4	3	3	.	.	99

TAB. 29 | Continuation 2

Ordinal number	1		2		3		6		4		5		7		8		9	
Site	K		K		M		M		M		M		M		M		M	
Excavated area	KSM		KAČ		AR 91		AR 93		AR 100		AR M17		AR 85		AR 96		AR 88	
Context number	12		13		5		3		7		6		1		14		3	
Sample number	34		155		5		27		7		24		1		67		6	
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f
Gall *(Mikiola fagi)*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Geranium cf. pratense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Glechoma hederacea	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gypsophila muralis	1	1	1	1	.	.	.	.	.	.	.	.	.	.	2	2	.	.
Hieracium sp.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Humulus lupulus	1	1	.	.	.	.	.	.	1	1	1	1	.	.	1	1	.	.
Hyoscyamus niger	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chelidonium majus	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodium album agg.	20	13	79	39	10	2	.	.	12	5	9	4	.	.	50	14	38	6
Chenopodium hybridum	3	3	14	12	1	1	.	.	.	.	2	1	.	.	10	6	10	4
Inula oculus-christi	2	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Inula salicina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
cf. Juniperus communis	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lamiaceae	.	.	3	3	.	.	.	.	.	.	3	1	.	.	.	.	.	.
Lepidium campestre	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepidium ruderale	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepidium/Barbarea	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Linum sp.	1	1	1	1	.	.	1	1	.	.	.	.	.	.	1	1	.	.
Lotus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Malva moschata	1	1	3	1	3	1	.	.	.	.	.	.	.	.	.	.	.	.
Malva sylvestris/pusilla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Malva sp.	1	1	2	2	.	.	.	.	.	.	.	.	.	.	1	1	1	1
Medicago falcata	.	.	2	1	.	.	.	.	.	.	.	.	.	.	2	2	.	.
Medicago lupulina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	1	1
Medicago prostrata/sativa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Medicago cf. sativa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Medicago sp.	1	1	15	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Medicago/Trifolium/ Melilotus	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melilotus albus	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melilotus officinalis/alba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Melilotus/Medicago	2	1	31	15	.	.	.	.	.	.	1	1	1	1	1	1	.	.
Melilotus sp.	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	4	1
Mentha cf. arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mentha/Salvia	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Neslia paniculata	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Origanum vulgare/ Satureja vulgare	1	1	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxalis europaea	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Papaver cf. argemone	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Papaver rhoeas	.	.	5	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phleum pratense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Physalis alkekengi	.	.	2	2	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Phyteuma spicatum/ orbiculare	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plantago lanceolata	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa palustris	1	1	42	19	.	.	.	.	.	.	2	2	.	.	.	.	.	.
Poa typ 2	.	.	5	4	.	.	.	.	.	.	.	.	.	.	.	.	2	1
Poaceae	13	10	40	15	.	.	.	.	5	2	1	1	.	.	2	2	.	.
Polycnemum arvense	.	.	4	4	1	1	.	.	.	.	.	.	.	.	1	1	.	.

Ordinal number	10		11		12		13		14		15		16		
Site	M		M		M		M		M		M		M		
Excavated area	AR 86		AR 103		AR 95		AR 90		AR 97		AR 98		AR 89		
Context number	13		33		2		2		4		6		1		
Sample number	19		162		4		3		9		18		2		
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ Total
Gall *(Mikiola fagi)*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Geranium cf. pratense	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
Glechoma hederacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Gypsophila muralis	.	.	4	3	.	.	4	2	.	.	.	.	.	.	12
Hieracium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Humulus lupulus	3	1	2	1	.	.	2	2	.	.	.	.	1	1	12
Hyoscyamus niger	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Chelidonium majus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Chenopodium album agg.	52	16	197	80	8	3	50	3	9	4	32	9	9	2	575
Chenopodium hybridum	33	10	54	43	3	2	4	2	3	3	38	10	.	.	175
Inula oculus-christi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Inula salicina	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1
cf. Juniperus communis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Lamiaceae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Lepidium campestre	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2
Lepidium ruderale	.	.	3	2	.	.	.	.	.	.	.	.	.	.	4
Lepidium/Barbarea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Linum sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Lotus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Malva moschata	3	2	5	3	.	.	.	.	.	.	1	1	.	.	16
Malva sylvestris/pusilla	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
Malva sp.	2	2	7	6	.	.	.	.	.	.	2	2	.	.	16
Medicago falcata	2	2	.	.	.	.	.	.	.	.	.	.	.	.	6
Medicago lupulina	8	3	2	2	4	2	5	1	.	.	.	.	.	.	22
Medicago prostrata/sativa	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1
Medicago cf. sativa	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1
Medicago sp.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	17
Medicago/Trifolium/ Melilotus	.	.	1	1	.	.	1	1	.	.	.	.	.	.	5
Melilotus albus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Melilotus officinalis/alba	.	.	.	.	2	2	3	1	.	.	.	.	.	.	6
Melilotus/Medicago	5	1	2	2	1	1	2	1	.	.	.	.	1	1	47
Melilotus sp.	2	2	.	.	1	1	.	.	.	.	.	.	.	.	10
Mentha cf. arvensis	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1
Mentha/Salvia	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2
Neslia paniculata	2	1	2	2	.	.	.	.	.	.	.	.	.	.	6
Origanum vulgare/ Satureja vulgare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Oxalis europaea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Papaver cf. argemone	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Papaver rhoeas	.	.	.	.	.	.	1	1	.	.	.	.	.	.	6
Phleum pratense	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1
Physalis alkekengi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Phyteuma spicatum/orbiculare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Plantago lanceolata	.	.	.	.	.	.	.	.	2	1	.	.	.	.	3
Poa palustris	.	.	4	4	.	.	.	.	.	.	.	.	1	1	50
Poa typ 2	.	.	1	1	.	.	2	1	.	.	1	1	.	.	11
Poaceae	.	.	.	.	.	.	.	.	2	2	.	.	1	1	64
Polycnemum arvense	.	.	.	.	.	.	.	.	1	1	.	.	.	.	7

TAB. 29 | Continuation 3

Ordinal number	1		2		3		6		4		5		7		8		9	
Site	K		K		M		M		M		M		M		M		M	
Excavated area	KSM		KAČ		AR 91		AR 93		AR 100		AR M17		AR 85		AR 96		AR 88	
Context number	12		13		5		3		7		6		1		14		3	
Sample number	34		155		5		27		7		24		1		67		6	
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f
Polygonum aviculare	1	1	26	21	.	.	.	.	.	.	.	.	.	.	2	1	.	.
Polygonum hydropiper	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Polygonum lapathifolium	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygonaceae	.	.	.	.	.	.	.	.	2	1	2	2	.	.	.	.	1	1
Portulaca oleracea	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla argentea	1	1	10	7	.	.	.	.	.	.	1	1	.	.	.	.	1	1
Potentilla erecta	.	.	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla pulchella	.	.	5	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla recta	.	.	7	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla reptans	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Potentilla supina	.	.	2	2	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Potentilla sp.	1	1	6	3	1	1	.	.	.	.	.	.	.	.	3	2	.	.
Potentilla/Fragaria	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Prunella vulgaris	2	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prunus spinosa	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prunus/Cerasus	.	.	4	4	.	.	.	.	.	.	.	.	.	.	2	2	3	1
Prunus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
cf. Prunus sp.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Ranunculus acris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Ranunculus cf. bulbosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus repens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Ranunculus sp.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	2	2	.	.
Reseda lutea	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rosaceae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.
Rubus idaeus	.	.	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex acetosa	.	.	1	1	.	.	.	.	.	.	.	.	.	.	3	3	3	1
Rumex acetosella	3	2	15	11	1	1	.	.	3	2	.	.	.	.	10	6	.	.
Rumex aquaticus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Rumex conglomeratus	.	.	3	3	.	.	.	.	.	.	1	1	.	.	.	.	5	2
Rumex crispus/ obtusifolius	.	.	5	4	.	.	.	.	.	.	.	.	.	.	5	3	.	.
Rumex maritimus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex cf. palustris	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Rumex sp.	.	.	3	3	.	.	.	.	.	.	2	2	.	.	.	.	2	2
Salsola kali	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sambucus nigra	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sambucus ebulus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	10	2
Saponaria officinalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Satureja vulgaris	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Satureja/Calamintha	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.
Scirpus maritimus	.	.	26	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scirpus sylvaticus	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Scirpus/Carex	3	2	4	3	.	.	.	.	.	.	1	1	.	.	13	3	1	1
Scleranthus sp.	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Setaria glauca	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	1	.	.
Setaria cf. italica	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Setaria viridis/verticillata	3	3	19	14	1	1	1	1	1	1	.	.	.	.	3	3	.	.
Setaria/Panicum	2	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Setaria sp.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Ordinal number	10		11		12		13		14		15		16		
Site	M		M		M		M		M		M		M		
Excavated area	AR 86		AR 103		AR 95		AR 90		AR 97		AR 98		AR 89		
Context number	13		33		2		2		4		6		1		
Sample number	19		162		4		3		9		18		2		
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ Total
Polygonum aviculare	4	4	3	3	1	1	1	1	2	1	2	2	.	.	42
Polygonum hydropiper	.	.	7	4	1	1	.	.	.	.	.	.	.	.	10
Polygonum lapathifolium	5	4	1	1	.	.	3	1	.	.	.	.	.	.	10
Polygonaceae	1	1	3	3	.	.	2	2	1	1	.	.	.	.	12
Portulaca oleracea	.	.	.	.	.	.	1	1	.	.	.	.	.	.	2
Potentilla argentea	1	1	.	.	.	.	.	.	.	.	.	.	.	.	14
Potentilla erecta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Potentilla pulchella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
Potentilla recta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Potentilla reptans	.	.	1	1	.	.	4	1	.	.	.	.	.	.	7
Potentilla supina	.	.	2	1	1	1	3	1	.	.	.	.	.	.	9
Potentilla sp.	.	.	1	1	1	1	2	1	.	.	.	.	.	.	15
Potentilla/Fragaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Prunella vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Prunus spinosa	.	.	1	1	.	.	.	.	.	.	.	.	.	.	3
Prunus/Cerasus	13	5	4	4	2	2	.	.	.	.	.	.	.	.	28
Prunus sp.	.	.	4	3	.	.	.	.	.	.	1	1	.	.	5
cf. Prunus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Ranunculus acris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Ranunculus cf. bulbosum	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
Ranunculus repens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Ranunculus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
Reseda lutea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Rosaceae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Rubus idaeus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Rumex acetosa	25	9	18	15	.	.	4	1	.	.	2	1	.	.	56
Rumex acetosella	8	4	5	4	4	2	1	1	.	.	3	3	1	1	54
Rumex aquaticus	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2
Rumex conglomeratus	5	3	10	9	2	2	3	1	.	.	.	.	2	2	31
Rumex crispus/ obtusifolius	12	3	.	.	.	.	2	1	4	3	1	1	2	1	31
Rumex maritimus	8	1	2	1	.	.	.	.	.	.	.	.	.	.	10
Rumex cf. palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Rumex sp.	1	1	6	6	.	.	.	.	.	.	.	.	2	1	16
Salsola kali	.	.	.	.	.	.	.	.	.	.	1	1	.	.	2
Sambucus nigra	.	.	15	3	.	.	.	.	.	.	.	.	.	.	17
Sambucus ebulus	.	.	72	15	.	.	1	1	5	3	1	1	.	.	90
Saponaria officinalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Satureja vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Satureja/Calamintha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Scirpus maritimus	.	.	.	.	.	.	8	1	.	.	1	1	.	.	35
Scirpus sylvaticus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Scirpus/Carex	4	2	.	.	.	.	.	.	.	.	.	.	.	.	26
Scleranthus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Setaria glauca	.	.	1	1	1	1	.	.	.	.	.	.	.	.	4
Setaria cf. italica	.	.	1	1	.	.	.	.	.	.	.	.	.	.	3
Setaria viridis/verticillata	13	4	4	4	1	1	7	2	3	2	1	1	.	.	57
Setaria/Panicum	.	.	1	1	.	.	1	1	.	.	1	1	.	.	6
Setaria sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1

TAB. 29 | Continuation 4

Ordinal number	1		2		3		6		4		5		7		8		9	
Site	K		K		M		M		M		M		M		M		M	
Excavated area	KSM		KAČ		AR 91		AR 93		AR 100		AR M17		AR 85		AR 96		AR 88	
Context number	12		13		5		3		7		6		1		14		3	
Sample number	34		155		5		27		7		24		1		67		6	
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f
Sideritis montana	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Silene noctiflora	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Silene nutans	1	1	.	.	.	.	.	.	3	2	.	.	.	.	.	.	.	.
Silene vulgaris	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.
cf. Sinapis arvensis	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sinapis sp.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sisymbrium cf. altissima	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum dulcamara	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Solanum nigrum	.	.	10	5	.	.	.	.	.	.	.	.	1	1	1	1	.	.
Solanum sp.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sorbus aucuparia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stachys arvensis	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2	2	1	1
Stachys recta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stachys/Ballota	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stachys/Galeopsis	.	.	4	2	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Stellaria graminea/ palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	.	.
Stellaria media	.	.	11	9	.	.	.	.	.	.	1	1	.	.	1	1	.	.
cf. Taxus baccata	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Teucrium scorodonia	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Teucrium sp.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thalictrum sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thlaspi arvense	.	.	3	3	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Thlaspi/Capsella/Lepidium	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
cf. Tilia cordata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium hybridum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium repens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium sp.	.	.	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trigonela sp.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Typha sp.	.	.	42	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vaccinium myrtillus	.	.	6	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Veronica hederifolia	1	1	25	21	.	.	.	.	.	.	3	2	1	1	1	1	.	.
Vicia hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1
Vicia cf. sylvatica	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.
Vicia hirsuta/sylvatica	.	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.
Vicia tetrasperma	1	1	42	17	.	.	.	.	.	.	.	.	.	.	3	2	1	1
Vicia tetrasperma/hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vicia/Barassica	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vicia/Lathyrus	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vicia sp.	2	1	30	21	.	.	.	.	.	.	2	2	1	1	11	5	3	2
Viola arvensis	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Viola biflora	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Violacea	.	.	1	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Vitis sylvestris	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Quercus sp.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	5	3
Xanthium strumarium	1	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indeterminate seeds	17	10	237	58	6	3	4	1	16	5	42	14	17	1	495	46	17	3
Seeds suma	232		2311		72		214		144		488		185		1589		814	
Soil volume	345		1284		41		246		64		853		44		806		203	

Ordinal number	10		11		12		13		14		15		16		
Site	M		M		M		M		M		M		M		
Excavated area	AR 86		AR 103		AR 95		AR 90		AR 97		AR 98		AR 89		
Context number	13		33		2		2		4		6		1		
Sample number	19		162		4		3		9		18		2		
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ Total
Sideritis montana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Silene noctiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Silene nutans	.	.	3	2	.	.	.	.	.	.	.	.	.	.	7
Silene vulgaris	2	2	6	5	.	.	1	1	.	.	2	1	.	.	13
cf. Sinapis arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Sinapis sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Sisymbrium cf. altissima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Solanum dulcamara	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2
Solanum nigrum	6	3	3	3	.	.	2	2	.	.	.	.	.	.	23
Solanum sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Sorbus aucuparia	.	.	.	.	5	1	.	.	.	.	.	.	.	.	5
Stachys arvensis	1	1	1	1	1	1	1	1	.	.	.	.	.	.	8
Stachys recta	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
Stachys/Ballota	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
Stachys/Galeopsis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
Stellaria graminea/palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Stellaria media	.	.	4	3	.	.	.	.	.	.	.	.	.	.	17
cf. Taxus baccata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Teucrium scorodonia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Teucrium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Thalictrum sp.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1
Thlaspi arvense	.	.	1	1	.	.	.	.	.	.	.	.	.	.	5
Thlaspi/Capsella/Lepidium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
cf. Tilia cordata	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
Trifolium hybridum	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
Trifolium repens	.	.	.	.	1	1	7	1	.	.	.	.	.	.	8
Trifolium sp.	.	.	1	1	.	.	.	.	1	1	.	.	1	1	7
Trigonela sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Typha sp.	1	1	20	9	.	.	.	.	.	.	.	.	.	.	63
Vaccinium myrtillus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Veronica hederifolia	.	.	19	14	.	.	.	.	1	1	3	1	.	.	54
Vicia hirsuta	11	2	2	2	.	.	.	.	.	.	.	.	.	.	15
Vicia cf. sylvatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Vicia hirsuta/sylvatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Vicia tetrasperma	18	10	11	10	6	1	7	2	2	1	2	2	.	.	93
Vicia tetrasperma/hirsuta	.	.	.	.	.	.	24	1	2	1	1	1	6	1	33
Vicia/Barassica	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2
Vicia/Lathyrus	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2
Vicia sp.	40	11	18	10	.	.	1	1	8	3	6	4	3	2	125
Viola arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Viola biflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Violacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Vitis sylvestris	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2
Quercus sp.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	8
Xanthium strumarium	1	1	.	.	.	.	.	.	.	.	.	.	.	.	4
Indeterminate seeds	90	11	38	30	255	4	33	3	119	5	19	9	49	2	1454
Seeds suma	2416		4439		1173		1286		436		686		469		16954
Soil volume	1083		1750		105		76		161		158		139		7355

TAB. 30 | Mikulčice-Kopčany. List of identified taxons from excavated areas, mineralised. Captions: Σ – suma, f – frequency.

Ordinal number	1		2		3		4		5		6		7		8		9	
Site	K		K		M		M		M		M		M		M		M	
Excavated area	KSM		KAČ		AR 85		AR 86		AR 88		AR 89		AR 90		AR 95		AR 96	
Context number	3		2		1		9		2		1		1		2		12	
Sample number	3		13		1		12		3		2		2		2		38	
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f
Cereal grains																		
Panicum miliaceum	.	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	1	1
Secale cereale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Legumes																		
Lens culinaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	.	.
Lathyrus sativus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fruits / nuts																		
Vitis vinifera	.	.	.	.	1	1	.	.	.	.	.	.	.	.	4	1	5	2
Vegetables																		
Cucumis sativus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Petroselinum crispus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Oil / fiber plants																		
Cannabis sativa	.	.	2	2	.	.	2	1	.	.	.	.	1	1	2	1	.	.
Linum cf. usitatissimum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2
Wild plants																		
Agropyron canina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Agrostemma githago	.	.	.	.	.	.	.	.	.	.	.	.	1	1	6	1	1	1
Ajuga reptans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	6
Anchusa officinalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Asteraceae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Avena / Bromus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brassica nigra / campestri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Bupleurum rotundifolium	.	.	4	3	.	.	6	5	.	.	.	.	1	1	3	2	15	10
Cannabaceae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Capsella bursa-pastoris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardaria draba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex dioica	.	.	.	.	.	.	1	1	.	.	.	.	3	1	5	2	2	2
Carex divulsa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Carex sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.
Carduus crispus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cerasus / Prunus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium / Carduus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Cornus sanguinea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fallopia convolvulus	.	.	18	8	4	1	17	5	.	.	1	1	2	1	11	2	7	3
Fallopia dumetorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galeopsis angustifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Galium aparine	.	.	.	.	.	.	1	1	.	.	.	.	1	1	6	2	.	.
Galium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Genista pilosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Geranium cf. pratense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Glaucium flavum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Humulus lupulus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Chenopodium album agg.	.	.	.	.	.	.	1	1	.	.	.	.	15	1	3	1	1	1
Lamium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepidium ruderale	.	.	1	1	.	.	3	1	.	.	.	.	2	1	.	.	.	.
Lithospermum arvense	.	.	.	.	.	.	1	1	.	.	.	.	1	1	1	1	1	1
Lycopus europaeus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Malva sp.	.	.	.	.	.	.	1	1	.	.	.	.	1	1	6	2	.	.
Malus sylvestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.

Ordinal number	10		11		12		
Site	M		M		M		
Excavated area	AR 97		AR 98		AR 103		
Context number	3		5		24		
Sample number	5		9		88		
	Σ	f	Σ	f	Σ	f	Σ Total
Cereal grains							
Panicum miliaceum	1	1	1	1	.	.	10
Secale cereale	.	.	.	.	.	.	2
Legumes							
Lens culinaris	.	.	.	.	1	1	7
Lathyrus sativus	.	.	2	1	2	2	7
Fruits / nuts							
Vitis vinifera	3	3	2	2	16	12	52
Vegetables							
Cucumis sativus	.	.	.	.	1	1	2
Petroselinum crispus	.	.	.	.	.	.	2
Oil / fiber plants							
Cannabis sativa	1	1	2	2	2	2	22
Linum cf. usitatissimum	.	.	.	.	.	.	4
Wild plants							
Agropyron canina	.	.	.	.	.	.	2
Agrostemma githago	1	1	2	2	.	.	17
Ajuga reptans	.	.	.	.	.	.	15
Anchusa officinalis	.	.	.	.	.	.	2
Asteraceae	.	.	.	.	1	1	4
Avena / Bromus	1	1	.	.	.	.	2
Brassica nigra / campestri	.	.	1	1	.	.	4
Bupleurum rotundifolium	2	2	3	2	2	2	63
Cannabaceae	1	1	.	.	.	.	2
Capsella bursa-pastoris	1	1	.	.	.	.	2
Cardaria draba	1	1	.	.	.	.	2
Carex dioica	6	3	1	1	.	.	28
Carex divulsa	.	.	.	.	.	.	2
Carex sp.	1	1	.	.	.	.	5
Carduus crispus	.	.	.	.	1	1	2
Cerasus / Prunus	.	.	.	.	1	1	2
Cirsium / Carduus	.	.	.	.	.	.	2
Cornus sanguinea	.	.	.	.	12	9	21
Fallopia convolvulus	27	4	8	4	15	13	152
Fallopia dumetorum	1	1	1	1	.	.	4
Galeopsis angustifolia	2	1	.	.	.	.	5
Galium aparine	1	1	.	.	1	1	16
Galium sp.	.	.	3	2	.	.	5
Genista pilosa	.	.	.	.	.	.	2
Geranium cf. pratense	.	.	.	.	1	1	2
Glaucium flavum	.	.	1	1	.	.	2
Humulus lupulus	.	.	2	1	1	1	7
Chenopodium album agg.	6	2	10	3	1	1	47
Lamium sp.	2	2	.	.	1	1	6
Lepidium ruderale	.	.	.	.	.	.	9
Lithospermum arvense	.	.	.	.	.	.	8
Lycopus europaeus	.	.	1	1	.	.	2
Malva sp.	2	2	.	.	.	.	16
Malus sylvestris	.	.	.	.	.	.	2

TAB. 30 | Continuation 1

Ordinal number	1		2		3		4		5		6		7		8		9	
Site	K		K		M		M		M		M		M		M		M	
Excavated area	KSM		KAČ		AR 85		AR 86		AR 88		AR 89		AR 90		AR 95		AR 96	
Context number	3		2		1		9		2		1		1		2		12	
Sample number	3		13		1		12		3		2		2		2		38	
	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f	Σ	f
Malus/Pyrus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Melilotus altissimus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melilotus/Medicago	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Poaceae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Polygonum aviculare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum lapathifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1
Pyrus/Malus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Ranunculus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubus idaeus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex acetosella	.	.	.	.	.	.	1	1	.	.	.	.	.	.	2	2	.	.
Rumex conglomeratus	.	.	1	1	.	.	4	3	.	.	.	.	.	.	1	1	1	1
Rumex crispus/ obtusifolius	.	.	1	1	1	1	.	.	.	.	.	.	1	1	.	.	.	.
Sambucus nigra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2
Sambucus ebulus	4	3	1	1	.	.	11	5	7	3	1	1	13	2	.	.	93	17
Scirpus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	1	.	.
Setaria glauca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1
Setaria viridis/ verticillata	.	.	8	8	.	.	8	6	.	.	.	.	7	1	19	2	6	5
Sinapis sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	1	.	.
Solanum dulcamara	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Solanum nigrum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.
Solanum sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Stachys arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Stachys/Origanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thlaspi arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	1
Vicia tetrasperma	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Vicia sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.
Viola arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Violacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	2
Indeterminate seeds	.	.	2	2	.	.	6	2	.	.	.	.	1	1	2	2	9	7
Seeds suma	4		40		7		64		7		2		50		114		168	
Soil volume	19		132		44		869		99		139		65		53		503	

Ordinal number	10		11		12		
Site	M		M		M		
Excavated area	AR 97		AR 98		AR 103		
Context number	3		5		24		
Sample number	5		9		88		
	Σ	f	Σ	f	Σ	f	Σ Total
Malus/Pyrus	1	1	1	1	.	.	6
Melilotus altissimus	.	.	.	.	1	1	2
Melilotus/Medicago	.	.	.	.	.	.	4
Poaceae	.	.	.	.	.	.	2
Polygonum aviculare	.	.	3	3	.	.	6
Polygonum lapathifolium	.	.	2	1	1	1	9
Pyrus/Malus	.	.	.	.	.	.	2
Ranunculus sp.	2	2	.	.	.	.	4
Rubus idaeus	.	.	.	.	1	1	2
Rumex acetosella	.	.	.	.	.	.	6
Rumex conglomeratus	1	1	.	.	.	.	15
Rumex crispus/ obtusifolius	1	1	.	.	.	.	8
Sambucus nigra	.	.	.	.	21	15	40
Sambucus ebulus	7	3	3	3	307	53	538
Scirpus sp.	1	1	.	.	.	.	16
Setaria glauca	.	.	.	.	.	.	3
Setaria viridis/ verticillata	16	3	8	4	26	17	144
Sinapis sp.	.	.	.	.	.	.	5
Solanum dulcamara	.	.	.	.	.	.	2
Solanum nigrum	.	.	.	.	.	.	3
Solanum sp.	.	.	.	.	.	.	2
Stachys arvensis	1	1	.	.	.	.	4
Stachys/Origanum	1	1	.	.	.	.	2
Thlaspi arvense	2	2	.	.	1	1	11
Vicia tetrasperma	.	.	.	.	.	.	2
Vicia sp.	.	.	.	.	.	.	3
Viola arvensis	.	.	.	.	.	.	2
Violacea	.	.	1	1	.	.	8
Indeterminate seeds	6	2	10	4	4	4	64
Seeds suma	99		68		421		1044
Soil volume	82		70		996		3069

TAB. 31 | Mikulčice-Kopčany. List of identified taxons from excavated areas, waterlogged. Captions: Σ – suma, f – frequency.

Ordinal number	1		2		3		
Site	M		M		M		
Excavated area	AR 93		AR 96		AR 103		
Context number	3		4		2		
Sample number	59		6		2		
	Σ	f	Σ	f	Σ	f	Σ Total
Cereal grains							
Triticum aestivum	2	2	.	.	.	.	4
Fruits / nuts							
Juglans regia	1	1	.	.	.	.	2
Malus domestica	.	.	.	.	1	1	0
Persica vulgaris	2	2	.	.	.	.	4
Prunus domestica cf. insititia	1	1	.	.	.	.	2
Vitis vinifera	116	13	2	2	1	1	133
Vegetables							
Cucumis sativus	6	4	.	.	.	.	10
Daucus carota	4	4	.	.	1	1	8
Petroselinum crispus	1	1	2	2	.	.	6
Oil / fiber plants							
Cannabis sativa	327	27	3	2	1	1	359
Wild plants							
Acer campestre	2	2	.	.	.	.	4
Aethusa cynapium	3	3	1	1	.	.	8
Agrimonia eupatoria	6	6	.	.	.	.	12
Agrostemma githago	4	3	3	1	1	1	11
Ajuga reptans	73	28	1	1	2	1	103
Alisma plantago-aquatica	15	8	4	2	1	1	29
cf. Alnus	141	16	10	2	.	.	169
Apiaceae	1	1	.	.	.	.	2
Arctium minus	40	7	1	1	.	.	49
Arenaria serpyllifolia	4	2	.	.	.	.	6
Asteraceae	.	.	1	1	1	1	2
Atriplex sp.	3	2	.	.	.	.	5
Atropa bella-donna	2	2	.	.	.	.	4
Berula erecta	4	1	.	.	.	.	5
Betula pendula	66	24	.	.	.	.	90
Brassica rapa	.	.	.	.	1	1	0
Bud	1975	34	77	3	26	1	2089
Bupleurum rotundifolium	13	6	3	1	1	1	23
Carex dioica	2	2	.	.	.	.	4
Carex divulsa	82	10	.	.	.	.	92
Carex gracilis	3	3	.	.	.	.	6
Carex spicata	1	1	.	.	.	.	2
Carex / Scirpus	29	6	23	3	9	1	61
Carpinus betulus	2217	30	2	1	11	1	2250
Carduus crispus	.	.	1	1	.	.	2
Carduus / Cirsium	1	1	5	1	1	1	8
Caucalis platycarpos	2	2	.	.	.	.	4
Cerasus avium	5	3	1	1	.	.	10
Ceratophyllum demersum	8	4	.	.	.	.	12
Cornus mas	12	6	1	1	.	.	20
cf. Corylus avellana	5	2	.	.	.	.	7
Crataegus sp.	102	14	2	2	.	.	120
Fallopia convolvulus	108	18	29	4	2	1	159
Fallopia dumetorum	1	1	.	.	.	.	2

Ordinal number	1		2		3		
Site	M		M		M		
Excavated area	AR 93		AR 96		AR 103		
Context number	3		4		2		
Sample number	59		6		2		
	Σ	f	Σ	f	Σ	f	Σ Total
Fragaria cf. moschata	3	2	.	.	.	.	5
Fragaria vesca	13	4	4	2	.	.	23
Fumaria officinalis	2	2	1	1	.	.	6
Galeopsis cf. ladanum	6	2	.	.	.	.	8
Galeopsis tetrahit	1	1	.	.	.	.	2
Galeopsis sp.	2	2	.	.	.	.	4
Galium sp.	1	1	.	.	.	.	2
Glaucium flavum	8	5	2	2	.	.	17
Humulus lupulus	18	5	.	.	.	.	23
Hyoscyamus niger	38	12	1	1	2	1	52
Chelidonium majus	1	1	.	.	.	.	2
Chenopodium album agg.	539	37	92	3	15	2	671
Chenopodium hybridum	99	18	18	3	1	1	138
Iris pseudacorus	19	9	.	.	.	.	28
Lamium amplexicaule	3	2	.	.	.	.	5
Lamium maculatum	3	1	.	.	.	.	4
Lamiaceae	26	2	.	.	.	.	28
Lamium sp.	13	5	.	.	1	1	18
Leaf	23	3	.	.	.	.	26
Linaria vulgaris	27	1	.	.	.	.	28
Lycopus europaeus	6	3	.	.	.	.	9
Malva sp.	2	2	.	.	.	.	4
Marrubium vulgare	9	5	.	.	.	.	14
Mentha cf. arvensis	2	1	.	.	.	.	3
Neslia paniculata	11	6	24	3	.	.	44
Oenanthe aquatica	1	1	.	.	.	.	2
Physalis alkekengi	14	4	4	3	.	.	25
Polygonum aviculare	72	12	2	1	4	2	87
Polygonum lapathifolium	13	3	.	.	2	2	16
Polygonum persicaria	14	6	.	.	.	.	20
Polygonum rurivagum	3	2	.	.	.	.	5
Polygonum sp.	19	4	2	1	.	.	26
Potentilla argentea	23	2	2	2	1	1	29
Potentilla collina	1	1	.	.	.	.	2
Potentilla erecta	3	2	.	.	.	.	5
Potentilla recta	3	2	1	1	.	.	7
Potentilla reptans	29	3	7	2	2	1	41
Potentilla supina	17	9	2	2	1	1	30
Potentilla sp.	34	3	2	2	.	.	41
Potamogeton crispus	.	.	.	.	1	1	0
Potamogeton natans	152	16	3	2	1	1	173
Potamogeton pusillus	41	7	.	.	.	.	48
Potamogeton sp.	.	.	1	1	3	2	2
Prunus spinosa	19	5	.	.	.	.	24
Prunus padus	.	.	1	1	.	.	2
Prunus/Cerasus	35	4	7	4	.	.	50
Prunus sp.	7	3	1	1	.	.	12
Ranunculus acris	42	15	4	2	.	.	63
Ranunculus cf. bulbosum	10	4	4	1	1	1	19
Ranunculus lanuginosus	15	6	.	.	.	.	21

TAB. 31 | Continuation 1

Ordinal number	1		2		3		
Site	M		M		M		
Excavated area	AR 93		AR 96		AR 103		
Context number	3		4		2		
Sample number	59		6		2		
	Σ	f	Σ	f	Σ	f	Σ Total
Ranunculus polyanthemos	1	1	.	.	.	.	2
Ranunculus repens	87	4	8	3	2	2	102
Ranunculus sp.	9	4	9	1	.	.	23
Reseda lutea	7	6	.	.	2	2	13
Robinia pseudoacacia	2	2	.	.	.	.	4
Rubus caesius	12	6	2	2	.	.	22
Rubus fruticosus	6	6	.	.	1	1	12
Rubus idaeus	1	1	.	.	.	.	2
Rubus sp.	5	3	.	.	.	.	8
Rumex acetosella	9	6	.	.	1	1	15
Rumex aquaticus	6	2	2	1	2	1	11
Rumex conglomeratus	26	5	.	.	1	1	31
Rumex maritimus	19	3	.	.	.	.	22
Rumex cf. palustris	.	.	2	1	.	.	3
Rumex sp.	4	3	.	.	.	.	7
Salvia/Mentha	4	1	.	.	.	.	5
Sambucus nigra	8	7	.	.	.	.	15
Sambucus ebulus	145	27	7	4	37	1	183
Saponaria officinalis	.	.	.	.	1	1	0
Scirpus maritimus	132	14	3	2	.	.	151
Scirpus sp.	21	2	.	.	1	1	23
Setaria viridis/verticillata	293	11	57	4	10	2	365
Silene nutans	4	1	1	1	.	.	7
Solanum nigrum	18	6	1	1	.	.	26
Sonchus arvensis	.	.	3	1	.	.	4
Stachys arvensis	16	5	2	1	.	.	24
Stachys palustris	7	3	.	.	.	.	10
Stellaria graminea	3	3	.	.	.	.	6
Stellaria holostea	.	.	1	1	.	.	2
Stellaria media	4	2	2	2	3	1	10
Thalictrum flavum	48	10	.	.	.	.	58
Thalictrum minus	18	6	.	.	.	.	24
Thlaspi arvense	12	3	.	.	.	.	15
Typha sp.	3	1	14	2	.	.	20
Verbena officinalis	11	3	1	1	.	.	16
Vicia hirsuta	.	.	1	1	.	.	2
Vicia sp.	1	1	.	.	.	.	2
Viola arvensis	7	4	.	.	.	.	11
Viola cf. reichenbachiana	4	2	.	.	.	.	6
Viola sp.	1	1	.	.	.	.	2
Urtica dioica	21	7	6	3	1	1	37
Quercus sp.	170	22	4	1	3	1	197
Xanthium strumarium	30	5	.	.	.	.	35
Indeterminate seeds	286	41	44	3	.	.	374
Seeds suma	8293		527		160		8820
Soil volume	583		45		21		627

TAB. 32 | Cereal grain measurements - basic measurements and the indexes of thickness and lengths. Abč – archaeobotanical sample number.

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
1	*Hordeum vulgare-vulgare*	KAČ	O1	3.6	2.1	1.2	595/12	171.43	57.14
2	*Hordeum vulgare-vulgare*	KAČ	O1	4.7	2.4	2.2	595/12	195.83	91.67
3	*Hordeum vulgare-vulgare*	KAČ	O1	4.4	2.2	1.9	595/12	200.00	86.36
4	*Secale cereale*	KAČ	O1	5.0	2.1	2.3	595/12	238.10	109.52
5	*Secale cereale*	KAČ	O1	4.1	1.7	2.1	595/12	241.18	123.53
6	*Secale cereale*	KAČ	O1	3.7	1.5	1.4	6.15/12	246.67	93.33
7	*Secale cereale*	KAČ	O1	4.5	2.0	2.1	6.15/12	225.00	105.00
8	*Secale cereale*	KAČ	O1	5.2	2.3	2.1	6.15/12	226.09	91.30
9	*Secale cereale*	KAČ	O1	3.9	1.7	1.5	692/12	229.41	88.24
10	*Triticum aestivum*	KAČ	O1	2.6	2.2	1.7	595/12	118.18	77.27
11	*Triticum aestivum*	KAČ	O1	4.7	2.6	2.2	595/12	180.77	84.62
12	*Triticum aestivum*	KAČ	O1	4.3	2.6	2.3	615/12	165.38	88.46
13	*Panicum miliaceum*	KAČ	O1	1.8	1.5	1.4	595/12	120.00	93.33
14	*Panicum miliaceum*	KAČ	O1	1.8	1.4	1.4	595/12	128.57	100.00
15	*Panicum miliaceum*	KAČ	O1	1.4	1.6	1.2	595/12	87.50	75.00
16	*Panicum miliaceum*	KAČ	O1	1.8	1.4	1.4	595/12	128.57	100.00
17	*Panicum miliaceum*	KAČ	O1	1.6	1.8	1.2	595/12	88.89	66.67
18	*Panicum miliaceum*	KAČ	O1	1.5	1.9	1.5	595/12	78.95	78.95
19	*Panicum miliaceum*	KAČ	O1	1.6	1.4	1.3	595/12	114.29	92.86
20	*Panicum miliaceum*	KAČ	O1	1.8	1.4	1.3	595/12	128.57	92.86
21	*Panicum miliaceum*	KAČ	O1	1.7	1.7	1.4	595/12	100.00	82.35
22	*Panicum miliaceum*	KAČ	O1	1.7	1.5	1.3	595/12	113.33	86.67
23	*Panicum miliaceum*	KAČ	O1	1.4	1.7	1.5	595/12	82.35	88.24
24	*Panicum miliaceum*	KAČ	O1	1.4	1.1	1.1	595/12	127.27	100.00
25	*Panicum miliaceum*	KAČ	O1	1.3	1.1	0.8	595/12	118.18	72.73
26	*Panicum miliaceum*	KAČ	O1	1.5	1.5	1.1	595/12	100.00	73.33
27	*Panicum miliaceum*	KAČ	O1	1.8	1.3	0.9	595/12	138.46	69.23
28	*Panicum miliaceum*	KAČ	O1	1.7	1.6	1.5	615/12	106.25	93.75
29	*Panicum miliaceum*	KAČ	O1	1.6	1.5	1.3	615/12	106.67	86.67
30	*Panicum miliaceum*	KAČ	O1	1.5	1.4	1.4	615/12	107.14	100.00
31	*Panicum miliaceum*	KAČ	O1	1.9	1.5	1.5	615/12	126.67	100.00
32	*Panicum miliaceum*	KAČ	O1	1.7	1.5	1.2	615/12	113.33	80.00
33	*Panicum miliaceum*	KAČ	O1	1.6	1.3	1.0	615/12	123.08	76.92
34	*Panicum miliaceum*	KAČ	O1	1.5	1.6	1.1	615/12	93.75	68.75
35	*Panicum miliaceum*	KAČ	O1	1.5	1.7	1.3	692/12	88.24	76.47
36	*Panicum miliaceum*	KAČ	O1	1.6	1.3	1.4	692/12	123.08	107.69
37	*Panicum miliaceum*	KAČ	O1	1.9	1.6	1.5	692/12	118.75	93.75
38	*Panicum miliaceum*	KAČ	O1	1.5	1.8	1.4	692/12	83.33	77.78
39	*Panicum miliaceum*	KAČ	O1	1.6	1.5	1.4	642/12	106.67	93.33
40	*Panicum miliaceum*	KAČ	O1	1.7	1.5	1.5	642/12	113.33	100.00
41	*Panicum miliaceum*	KAČ	O1	1.7	1.5	1.3	642/12	113.33	86.67
42	*Panicum miliaceum*	KAČ	O1	1.6	1.6	1.2	642/12	100.00	75.00
43	*Secale cereale*	KAČ	O2	3.8	2.0	1.5	429/11	190.00	75.00
44	*Secale cereale*	KAČ	O2	4.4	1.9	1.8	429/11	231.58	94.74
45	*Secale cereale*	KAČ	O2	4.5	1.8	1.8	429/11	250.00	100.00
46	*Secale cereale*	KAČ	O2	4.6	1.5	1.7	429/11	306.67	113.33
47	*Secale cereale*	KAČ	O2	5.2	1.7	1.8	429/11	305.88	105.88
48	*Secale cereale*	KAČ	O2	4.2	1.9	1.8	429/11	221.05	94.74
49	*Secale cereale*	KAČ	O2	4.8	1.7	1.6	429/11	282.35	94.12
50	*Secale cereale*	KAČ	O2	4.0	1.6	1.5	429/11	250.00	93.75
51	*Secale cereale*	KAČ	O2	3.2	1.2	1.3	429/11	266.67	108.33
52	*Secale cereale*	KAČ	O2	3.8	1.4	1.3	429/11	271.43	92.86
53	*Secale cereale*	KAČ	O2	5.4	1.8	2.1	357/11	300.00	116.67

TAB. 32 | Continuation 1

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
54	*Secale cereale*	KAČ	O2	5.5	2.1	1.8	357/11	261.90	85.71
55	*Panicum miliaceum*	KAČ	O2	1.9	1.5	1.4	429/11	126.67	93.33
56	*Panicum miliaceum*	KAČ	O2	1.6	(?)	1.5	357/11	.	.
57	*Triticum aestivum*	KAČ	O2	4.8	2.7	1.8	429/11	177.78	66.67
58	*Triticum aestivum*	KAČ	O2	3.3	2.3	2.0	429/11	143.48	86.96
59	*Triticum aestivum*	KAČ	O2	4.5	2.9	2.2	357/11	155.17	75.86
60	*Triticum aestivum*	KAČ	O2	4.3	2.5	2.1	357/11	172.00	84.00
61	*Hordeum vulgare-vulgare*	KAČ	O2	5.6	2.7	2.0	357/11	207.41	74.07
62	*Triticum aestivum*	KAČ	H2	4.1	3.0	1.9	372/11	136.67	63.33
63	*Triticum aestivum*	KAČ	H3	4.1	2.8	2.3	233/11	146.43	82.14
64	*Hordeum vulgare-vulgare*	KAČ	H3	5.5	2.5	2.2	160/11	220.00	88.00
65	*Hordeum vulgare-vulgare*	KAČ	H4	5.4	2.9	2.3	180/11	186.21	79.31
66	*Panicum miliaceum*	KAČ	H4	1.8	1.5	1.1	328/11	120.00	73.33
67	*Panicum miliaceum*	KAČ	H4	1.8	1.4	1.2	250/11	128.57	85.71
68	*Secale cereale*	KAČ	H4	5.0	1.6	1.8	214/11	312.50	112.50
69	*Triticum aestivum*	KAČ	H4	4.5	2.5	2.2	313/11	180.00	88.00
70	*Triticum aestivum*	KAČ	H4	3.6	2.1	1.6	268/11	171.43	76.19
71	*Hordeum vulgare-vulgare*	KAČ	H5	4.0	2.3	1.7	359/11	173.91	73.91
72	*Panicum miliaceum*	KAČ	H5	2.0	1.6	1.5	363/11	125.00	93.75
73	*Secale cereale*	KAČ	H5	4.0	1.6	1.6	358/11	250.00	100.00
74	*Secale cereale*	KAČ	H5	3.6	1.4	1.4	359/11	257.14	100.00
75	*Secale cereale*	KAČ	H5	3.2	1.5	1.5	359/11	213.33	100.00
76	*Triticum aestivum*	KAČ	H5	4.7	2.4	2.2	367/11	195.83	91.67
77	*Secale cereale*	KAČ	H6	5.4	1.8	1.7	122/11	300.00	94.44
78	*Panicum miliaceum*	KAČ	H6	2.2	1.4	1.2	127/11	157.14	85.71
79	*Panicum miliaceum*	KAČ	H7	1.2	1.5	1.3	628/12	80.00	86.67
80	*Secale cereale*	KAČ	H7	4.5	1.9	2.0	472/11	236.84	105.26
81	*Triticum aestivum*	KAČ	H8	3.8	2.4	2.5	88/11	158.33	104.17
82	*Panicum miliaceum*	KAČ	H8	1.2	1.4	1.2	89/11	85.71	85.71
83	*Panicum miliaceum*	KAČ	H8	1.1	0.9	0.9	89/11	122.22	100.00
84	*Secale cereale*	KAČ	H8	4.0	2.2	2.0	76/11	181.82	90.91
85	*Secale cereale*	KAČ	H8	4.9	2.4	1.6	70/11	204.17	66.67
86	*Panicum miliaceum*	KAČ	H9	1.5	1.6	1.3	405/11	93.75	81.25
87	*Panicum miliaceum*	KAČ	between O1/H10	1.5	1.6	1.0	620/12a	93.75	62.50
88	*Panicum miliaceum*	KAČ	between O1/H10	1.8	1.7	1.4	620/12a	105.88	82.35
89	*Panicum miliaceum*	KAČ	between O1/H10	1.5	1.5	1.2	620/12a	100.00	80.00
90	*Hordeum vulgare-vulgare*	KAČ	H10	4.5	1.7	1.8	586/12	264.71	105.88
91	*Hordeum vulgare-vulgare*	KAČ	H10	4.0	2.0	1.5	622/12	200.00	75.00
92	*Secale cereale*	KAČ	H10	3.5	1.6	1.5	589/12	218.75	93.75
93	*Triticum aestivum*	KAČ	H10	3.8	3.4	2.4	584/12	111.76	70.59
94	*Panicum miliaceum*	KAČ	H10	1.8	1.6	1.4	611/12	112.50	87.50
95	*Panicum miliaceum*	KAČ	H10	1.8	1.4	1.2	611/12	128.57	85.71
96	*Panicum miliaceum*	KAČ	H10	1.5	1.3	1.2	611/12	115.38	92.31
97	*Panicum miliaceum*	KAČ	H10	2.1	1.5	1.4	619/12	140.00	93.33
98	*Panicum miliaceum*	KAČ	H10	1.6	1.6	1.2	619/12	100.00	75.00
99	*Panicum miliaceum*	KAČ	H10	2.0	1.6	1.7	619/12	125.00	106.25
100	*Panicum miliaceum*	KAČ	H10	1.6	1.5	1.2	619/12	106.67	80.00
101	*Panicum miliaceum*	KAČ	H10	1.6	1.6	1.4	619/12	100.00	87.50
102	*Panicum miliaceum*	KAČ	H10	1.9	1.5	1.4	619/12	126.67	93.33
103	*Panicum miliaceum*	KAČ	H10	1.5	1.4	1.4	619/12	107.14	100.00
104	*Hordeum vulgare-vulgare*	AR 85	85/11	5.4	2.6	2.0	1/85	207.69	76.92
105	*Hordeum vulgare-vulgare*	AR 85	85/11	6.4	3.4	2.5	1/85	188.24	73.53

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
106	*Hordeum vulgare-vulgare*	AR 85	85/11	6.2	2.9	2.0	1/85	213.79	68.97
107	*Hordeum vulgare-vulgare*	AR 85	85/11	5.6	3.5	2.0	1/85	160.00	57.14
108	*Hordeum vulgare-vulgare*	AR 85	85/11	4.2	2.5	1.7	1/85	168.00	68.00
109	*Hordeum vulgare-vulgare*	AR 85	85/11	4.9	2.8	2.5	1/85	175.00	89.29
110	*Triticum aestivum*	AR 85	85/11	4.1	2.3	1.8	1/85	178.26	78.26
111	*Triticum aestivum*	AR 85	85/11	4.0	3.1	2.2	1/85	129.03	70.97
112	*Triticum aestivum*	AR 85	85/11	4.5	3.4	3.2	1/85	132.35	94.12
113	*Triticum aestivum*	AR 85	85/11	5.1	3.6	2.3	1/85	141.67	63.89
114	*Triticum aestivum*	AR 85	85/11	4.2	2.8	2.1	1/85	150.00	75.00
115	*Triticum aestivum*	AR 85	85/11	4.2	3.4	2.6	1/85	123.53	76.47
116	*Triticum aestivum*	AR 85	85/11	4.5	2.7	1.8	1/85	166.67	66.67
117	*Triticum aestivum*	AR 85	85/11	3.7	2.3	2.1	1/85	160.87	91.30
118	*Secale cereale*	AR 85	85/11	5.3	2.0	1.8	1/85	265.00	90.00
119	*Secale cereale*	AR 85	85/11	5.4	1.8	1.7	1/85	300.00	94.44
120	*Panicum miliaceum*	AR 85	85/11	1.7	1.5	1.5	1/85	113.33	100.00
121	*Panicum miliaceum*	AR 85	85/11	1.8	1.6	1.5	1/85	112.50	93.75
122	*Panicum miliaceum*	AR 85	85/11	1.9	1.7	1.4	1/85	111.76	82.35
123	*Panicum miliaceum*	AR 85	85/11	1.9	1.8	1.5	1/85	105.56	83.33
124	*Panicum miliaceum*	AR 85	85/11	1.7	1.2	1.1	1/85	141.67	91.67
125	*Panicum miliaceum*	AR 85	85/11	1.5	1.5	1.4	1/85	100.00	93.33
126	*Panicum miliaceum*	AR 85	85/11	1.8	1.4	1.5	1/85	128.57	107.14
127	*Panicum miliaceum*	AR 85	85/11	1.4	1.5	1.2	1/85	93.33	80.00
128	*Panicum miliaceum*	AR 85	85/11	1.4	1.2	1.1	1/85	116.67	91.67
129	*Panicum miliaceum*	AR 85	85/11	1.4	1.3	1.2	1/85	107.69	92.31
130	*Triticum aestivum*	AR 89	K9	5.0	2.9	2.5	55/12	172.41	86.21
131	*Triticum aestivum*	AR 89	K9	4.1	2.8	2.6	55/12	146.43	92.86
132	*Triticum aestivum*	AR 89	K9	3.9	2.8	2.0	55/12	139.29	71.43
133	*Triticum aestivum*	AR 89	K9	3.4	2.1	1.9	55/12	161.90	90.48
134	*Secale cereale*	AR 89	K9	5.6	2.4	2.1	55/12	233.33	87.50
135	*Hordeum vulgare-vulgare*	AR 89	K9	4.4	2.2	1.3	55/12	200.00	59.09
136	*Panicum miliaceum*	AR 89	K9	1.7	1.5	1.6	55/12	113.33	106.67
137	*Panicum miliaceum*	AR 89	K9	1.8	1.7	1.6	55/12	105.88	94.12
138	*Panicum miliaceum*	AR 89	K9	1.6	1.5	1.6	55/12	106.67	106.67
139	*Hordeum vulgare-vulgare*	AR 95	K4	5.1	2.9	2.4	4/12	175.86	82.76
140	*Hordeum vulgare-vulgare*	AR 95	K4	4.2	2.4	1.8	4/12	175.00	75.00
141	*Secale cereale*	AR 95	K4	4.9	1.9	1.7	4/12	257.89	89.47
142	*Secale cereale*	AR 95	K4	6.5	2.6	2.7	4/12	250.00	103.85
143	*Secale cereale*	AR 95	K4	4.8	2.4	2.4	4/12	200.00	100.00
144	*Panicum miliaceum*	AR 95	K4	2.1	1.8	1.6	4/12	116.67	88.89
145	*Panicum miliaceum*	AR 95	K4	1.8	1.8	1.5	4/12	100.00	83.33
146	*Panicum miliaceum*	AR 95	K4	1.9	1.7	1.6	4/12	111.76	94.12
147	*Panicum miliaceum*	AR 95	K4	2.0	1.8	1.7	4/12	111.11	94.44
148	*Panicum miliaceum*	AR 95	K4	2.3	1.6	1.4	4/12	143.75	87.50
149	*Panicum miliaceum*	AR 95	K4	1.9	2.0	1.3	4/12	95.00	65.00
150	*Triticum aestivum*	AR 95	K4	4.3	3.2	2.4	4/12	134.38	75.00
151	*Triticum aestivum*	AR 95	K4	5.0	3.9	2.5	4/12	128.21	64.10
152	*Triticum aestivum*	AR 95	K4	4.1	2.7	1.8	4/12	151.85	66.67
153	*Triticum aestivum*	AR 95	K4	4.6	3.5	2.5	4/12	131.43	71.43
154	*Triticum aestivum*	AR 95	K4	4.2	3.5	2.8	4/12	120.00	80.00
155	*Triticum aestivum*	AR 95	K4	5.2	3.6	2.7	4/12	144.44	75.00
156	*Triticum aestivum*	AR 95	K4	5.0	3.1	2.3	4/12	161.29	74.19
157	*Triticum aestivum*	AR 95	K4	4.3	2.9	2.3	4/12	148.28	79.31
158	*Triticum aestivum*	AR 95	K4	5.1	2.8	2.3	4/12	182.14	82.14
159	*Triticum aestivum*	AR 95	K4	4.5	3.5	2.3	4/12	128.57	65.71

TAB. 32 | Continuation 2

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
160	*Triticum aestivum*	AR 95	K4	3.7	2.0	1.9	4/12	185.00	95.00
161	*Triticum aestivum*	AR 95	K4	4.4	3.7	2.3	4/12	118.92	62.16
162	*Triticum aestivum*	AR 95	K4	3.9	3.0	2.2	4/12	130.00	73.33
163	*Triticum aestivum*	AR 95	K4	4.3	3.1	2.3	4/12	138.71	74.19
164	*Triticum aestivum*	AR 95	K4	4.5	3	2.1	4/12	150.00	70.00
165	*Triticum aestivum*	AR 95	K4	4.2	2.7	1.8	4/12	155.56	66.67
166	*Triticum aestivum*	AR 95	K4	3.4	3.2	2.1	4/12	106.25	65.63
167	*Triticum aestivum*	AR 95	K4	5.5	3.3	2.1	4/12	166.67	63.64
168	*Triticum aestivum*	AR 95	K4	5.1	3.6	2.7	4/12	141.67	75.00
169	*Triticum aestivum*	AR 95	K4	4.5	3.9	2.5	4/12	115.38	64.10
170	*Triticum aestivum*	AR 95	K4	4.2	3.5	2.5	4/12	120.00	71.43
171	*Triticum aestivum*	AR 95	K4	4.5	3.3	2.3	4/12	136.36	69.70
172	*Triticum aestivum*	AR 95	K4	4.5	3.3	2.5	4/12	136.36	75.76
173	*Triticum aestivum*	AR 95	K4	4.6	2.8	1.7	4/12	164.29	60.71
174	*Triticum aestivum*	AR 95	K4	4.7	3.0	2.3	4/12	156.67	76.67
175	*Triticum aestivum*	AR 95	K4	3.6	2.7	2.2	4/12	133.33	81.48
176	*Hordeum vulgare-vulgare*	AR 95	K5	5.2	2.7	1.6	1/12	192.59	59.26
177	*Hordeum vulgare-vulgare*	AR 95	K5	6.5	2.8	2.5	1/12	232.14	89.29
178	*Hordeum vulgare-vulgare*	AR 95	K5	5.1	2.2	1.6	1/12	231.82	72.73
179	*Hordeum vulgare-vulgare*	AR 95	K5	3.6	2.5	1.9	1/12	144.00	76.00
180	*Secale cereale*	AR 95	K5	5.9	2.3	2.2	1/12	256.52	95.65
181	*Secale cereale*	AR 95	K5	5.4	2.2	1.6	1/12	245.45	72.73
182	*Secale cereale*	AR 95	K5	4.6	2.5	1.9	1/12	184.00	76.00
183	*Secale cereale*	AR 95	K5	5.7	2.0	2.0	1/12	285.00	100.00
184	*Secale cereale*	AR 95	K5	4.8	2.6	2.3	1/12	184.62	88.46
185	*Secale cereale*	AR 95	K5	5.1	2.0	1.9	1/12	255.00	95.00
186	*Triticum aestivum*	AR 95	K5	4.9	3.1	2.6	1/12	158.06	83.87
187	*Triticum aestivum*	AR 95	K5	4.1	3.1	2.3	1/12	132.26	74.19
188	*Triticum aestivum*	AR 95	K5	4.8	2.7	2.6	1/12	177.78	96.30
189	*Triticum aestivum*	AR 95	K5	4.2	3.7	2.8	1/12	113.51	75.68
190	*Triticum aestivum*	AR 95	K5	4.5	3.1	2.1	1/12	145.16	67.74
191	*Triticum aestivum*	AR 95	K5	4.0	2.3	1.8	1/12	173.91	78.26
192	*Triticum aestivum*	AR 95	K5	4.4	3.4	2.6	1/12	129.41	76.47
193	*Triticum aestivum*	AR 95	K5	3.6	2.8	2.3	1/12	128.57	82.14
194	*Triticum aestivum*	AR 95	K5	3.9	3.0	2.4	1/12	130.00	80.00
195	*Triticum aestivum*	AR 95	K5	3.9	2.5	2.0	1/12	156.00	80.00
196	*Panicum miliaceum*	AR 95	K5	1.8	1.8	1.5	1/12	100.00	83.33
197	*Panicum miliaceum*	AR 95	K5	1.7	1.5	1.3	1/12	113.33	86.67
198	*Panicum miliaceum*	AR 95	K5	2.3	1.8	1.5	1/12	127.78	83.33
199	*Panicum miliaceum*	AR 95	K5	1.5	1.9	1.6	1/12	78.95	84.21
200	*Panicum miliaceum*	AR 95	K5	2.0	1.5	1.2	1/12	133.33	80.00
201	*Panicum miliaceum*	AR 95	K5	1.6	1.6	1.5	1/12	100.00	93.75
202	*Hordeum vulgare-vulgare*	AR 97	K5	4.5	3.4	2.5	46/12	132.35	73.53
203	*Secale cereale*	AR 97	K5	4.9	2.4	2.0	46/12	204.17	83.33
204	*Secale cereale*	AR 97	K5	3.8	1.5	1.5	46/12	253.33	100.00
205	*Triticum aestivum*	AR 97	K5	3.5	2.2	2.2	46/12	159.09	100.00
206	*Triticum aestivum*	AR 97	K5	3.3	2.5	2.3	46/12	132.00	92.00
207	*Panicum miliaceum*	AR 97	K5	2.0	1.6	1.5	46/12	125.00	93.75
208	*Panicum miliaceum*	AR 97	K5	1.8	1.7	1.3	46/12	105.88	76.47
209	*Panicum miliaceum*	AR 97	K5	2.0	1.9	1.6	46/12	105.26	84.21
210	*Panicum miliaceum*	AR 97	K5	1.8	1.7	1.4	46/12	105.88	82.35
211	*Hordeum vulgare-vulgare*	AR 97	K 12	4.7	2.6	1.6	45/12	180.77	61.54
212	*Secale cereale*	AR 97	K 12	5.0	2.4	1.9	45/12	208.33	79.17
213	*Secale cereale*	AR 97	K 12	5.1	1.8	1.9	45/12	283.33	105.56

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
214	*Triticum aestivum*	AR 97	K 12	3.3	2.5	2.0	45/12	132.00	80.00
215	*Triticum aestivum*	AR 97	K 12	3.0	1.9	1.9	45/12	157.89	100.00
216	*Hordeum vulgare-vulgare*	AR 97	K 8	6.1	3.0	2.5	47/12	203.33	83.33
217	*Hordeum vulgare-vulgare*	AR 97	K 8	3.6	2.1	1.5	47/12	171.43	71.43
218	*Secale cereale*	AR 97	K 8	5.5	2.4	1.8	47/12	229.17	75.00
219	*Secale cereale*	AR 97	K 8	5.8	2.5	2.2	47/12	232.00	88.00
220	*Triticum aestivum*	AR 97	K 8	5.1	3.5	3.0	47/12	145.71	85.71
221	*Triticum aestivum*	AR 97	K 8	4.0	3.0	2.3	47/12	133.33	76.67
222	*Triticum aestivum*	AR 97	K 8	4.8	3.2	2.9	47/12	150.00	90.63
223	*Triticum aestivum*	AR 97	K 8	4.3	3.4	2.5	57/12	126.47	73.53
224	*Triticum aestivum*	AR 97	K 8	3.6	2.5	2.5	57/12	144.00	100.00
225	*Triticum aestivum*	AR 97	K 8	3.6	2.5	2.5	57/12	144.00	100.00
226	*Panicum miliaceum*	AR 97	K 8	1.5	2.0	1.2	57/12	75.00	60.00
227	*Panicum miliaceum*	AR 97	K 8	1.5	1.6	1.1	57/12	93.75	68.75
228	*Panicum miliaceum*	AR 97	K 8	2.3	1.7	1.4	57/12	135.29	82.35
229	*Panicum miliaceum*	AR 97	K 8	1.4	1.5	1.4	57/12	93.33	93.33
230	*Panicum miliaceum*	AR 97	K 8	1.5	1.5	1.3	57/12	100.00	86.67
231	*Hordeum vulgare-vulgare*	AR 97	K 22	4.8	2.3	1.7	51/12	208.70	73.91
232	*Hordeum vulgare-vulgare*	AR 97	K 22	5.2	2.4	2.3	44/12	216.67	95.83
233	*Triticum aestivum*	AR 97	K 22	4.4	3.3	2.9	51/12	133.33	87.88
234	*Triticum aestivum*	AR 97	K 22	4.3	3.2	2.0	56/12	134.38	62.50
235	*Secale cereale*	AR 97	K 22	4.6	2.0	2.1	51/12	230.00	105.00
236	*Secale cereale*	AR 97	K 22	4.8	2.3	1.9	44/12	208.70	82.61
237	*Panicum miliaceum*	AR 97	K 22	1.5	2.1	1.4	44/12	71.43	66.67
238	*Panicum miliaceum*	AR 97	K 22	1.5	1.4	1.2	56/12	107.14	85.71
239	*Panicum miliaceum*	AR 97	K 22	1.7	1.5	1.3	56/12	113.33	86.67
240	*Panicum miliaceum*	AR 97	K 22	2.3	1.8	1.4	51/12	127.78	77.78
241	*Hordeum vulgare-vulgare*	AR 88	K 131	6.0	3.3	2.5	64/12	181.82	75.76
242	*Hordeum vulgare-vulgare*	AR 88	K 131	5.1	3.3	2.8	64/12	154.55	84.85
243	*Hordeum vulgare-vulgare*	AR 88	K 131	4.6	2.4	1.9	64/12	191.67	79.17
244	*Triticum aestivum*	AR 88	K 131	5.3	3.4	2.8	64/12	155.88	82.35
245	*Triticum aestivum*	AR 88	K 131	4.8	2.8	2.2	64/12	171.43	78.57
246	*Triticum aestivum*	AR 88	K 131	4.9	3.0	2.7	64/12	163.33	90.00
247	*Triticum aestivum*	AR 88	K 131	3.9	3.1	2.2	64/12	125.81	70.97
248	*Triticum aestivum*	AR 88	K 131	4.5	2.3	2.1	64/12	195.65	91.30
249	*Panicum miliaceum*	AR 88	K 131	1.7	1.5	1.3	64/12	113.33	86.67
250	*Panicum miliaceum*	AR 88	K 131	1.6	1.6	1.3	64/12	100.00	81.25
251	*Panicum miliaceum*	AR 88	K 131	2.0	1.6	1.6	64/12	125.00	100.00
252	*Panicum miliaceum*	AR 88	K 131	1.8	1.7	1.6	64/12	105.88	94.12
253	*Panicum miliaceum*	AR 88	K 131	1.8	1.3	1.4	64/12	138.46	107.69
254	*Panicum miliaceum*	AR 88	K 131	2.1	1.7	1.5	64/12	123.53	88.24
255	*Panicum miliaceum*	AR 88	K 131	2.2	1.5	1.5	64/12	146.67	100.00
256	*Panicum miliaceum*	AR 88	K 131	1.8	1.4	1.3	64/12	128.57	92.86
257	*Panicum miliaceum*	AR 88	K 131	1.8	1.5	1.2	64/12	120.00	80.00
258	*Panicum miliaceum*	AR 88	K 131	1.5	1.3	1.0	64/12	115.38	76.92
259	*Hordeum vulgare-vulgare*	AR 88	K 127–129	6.1	3.0	2.7	65/12	203.33	90.00
260	*Hordeum vulgare-vulgare*	AR 88	K 127–129	5.7	3.5	2.8	65/12	162.86	80.00
261	*Hordeum vulgare-vulgare*	AR 88	K 127–129	7.1	2.3	2.0	65/12	308.70	86.96
262	*Hordeum vulgare-vulgare*	AR 88	K 127–129	4.8	2.9	1.8	65/12	165.52	62.07
263	*Hordeum vulgare-vulgare*	AR 88	K 127–129	5.5	3.1	2.2	65/12	177.42	70.97
264	*Hordeum vulgare-vulgare*	AR 88	K 127–129	4.8	2.6	2.1	65/12	184.62	80.77
265	*Secale cereale*	AR 88	K 127–129	5.2	1.9	1.9	65/12	273.68	100.00
266	*Secale cereale*	AR 88	K 127–129	4.2	2.0	1.9	65/12	210.00	95.00
267	*Secale cereale*	AR 88	K 127–129	5.2	2.0	1.7	65/12	260.00	85.00

TAB. 32 | Continuation 3

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
268	*Triticum aestivum*	AR 88	K 127–129	4.5	2.9	2.3	65/12	155.17	79.31
269	*Triticum aestivum*	AR 88	K 127–129	5.0	3.3	2.2	65/12	151.52	66.67
270	*Triticum aestivum*	AR 88	K 127–129	4.8	3.4	2.3	65/12	141.18	67.65
271	*Triticum aestivum*	AR 88	K 127–129	4.5	3.0	2.4	65/12	150.00	80.00
272	*Triticum aestivum*	AR 88	K 127–129	5.5	3.4	2.8	65/12	161.76	82.35
273	*Triticum aestivum*	AR 88	K 127–129	4.5	2.4	2.0	65/12	187.50	83.33
274	*Triticum aestivum*	AR 88	K 127–129	4.6	3.1	2.3	65/12	148.39	74.19
275	*Triticum aestivum*	AR 88	K 127–129	4.9	3.2	2.3	65/12	153.13	71.88
276	*Triticum aestivum*	AR 88	K 127–129	4.1	3.3	2.7	65/12	124.24	81.82
277	*Triticum aestivum*	AR 88	K 127–129	4.9	2.6	2.4	65/12	188.46	92.31
278	*Panicum miliaceum*	AR 88	K 127–129	1.7	1.7	1.4	65/12	100.00	82.35
279	*Panicum miliaceum*	AR 88	K 127–129	1.6	1.7	1.4	65/12	94.12	82.35
280	*Panicum miliaceum*	AR 88	K 127–129	1.5	1.7	1.4	65/12	88.24	82.35
281	*Panicum miliaceum*	AR 88	K 127–129	1.7	1.5	1.3	65/12	113.33	86.67
282	*Panicum miliaceum*	AR 88	K 127–129	1.9	1.5	1.3	65/12	126.67	86.67
283	*Panicum miliaceum*	AR 88	K 127–129	1.6	1.6	1.2	65/12	100.00	75.00
284	*Panicum miliaceum*	AR 88	K 127–129	1.7	1.8	1.4	65/12	94.44	77.78
285	*Panicum miliaceum*	AR 88	K 127–129	1.9	1.5	1.5	65/12	126.67	100.00
286	*Panicum miliaceum*	AR 88	K 127–129	1.6	1.8	1.2	65/12	88.89	66.67
287	*Panicum miliaceum*	AR 88	K 127–129	1.6	1.8	1.4	65/12	88.89	77.78
288	*Hordeum vulgare-vulgare*	AR 88	K 133	6.0	2.9	2.1	68/12	206.90	72.41
289	*Hordeum vulgare-vulgare*	AR 88	K 133	5.0	2.8	2.1	66/12	178.57	75.00
290	*Hordeum vulgare-vulgare*	AR 88	K 133	5.1	3.3	2.6	66/12	154.55	78.79
291	*Secale cereale*	AR 88	K 133	5.3	2.1	1.8	68/12	252.38	85.71
292	*Secale cereale*	AR 88	K 133	4.5	2.0	2.1	66/12	225.00	105.00
293	*Secale cereale*	AR 88	K 133	4.5	1.6	1.5	66/12	281.25	93.75
294	*Triticum aestivum*	AR 88	K 133	4.9	3.2	2.4	66/12	153.13	75.00
295	*Triticum aestivum*	AR 88	K 133	4.1	2.4	2.4	66/12	170.83	100.00
296	*Triticum aestivum*	AR 88	K 133	4.0	3.1	2.3	66/12	129.03	74.19
297	*Triticum aestivum*	AR 88	K 133	4.2	3.3	2.1	66/12	127.27	63.64
298	*Triticum aestivum*	AR 88	K 133	3.6	2.5	2.3	66/12	144.00	92.00
299	*Triticum aestivum*	AR 88	K 133	4.1	3.0	2.8	68/12	136.67	93.33
300	*Panicum miliaceum*	AR 88	K 133	1.7	1.7	1.6	68/12	100.00	94.12
301	*Panicum miliaceum*	AR 88	K 133	1.8	1.7	1.6	68/12	105.88	94.12
302	*Panicum miliaceum*	AR 88	K 133	1.5	1.7	1.4	68/12	88.24	82.35
303	*Panicum miliaceum*	AR 88	K 133	2.2	2.0	1.6	68/12	110.00	80.00
304	*Panicum miliaceum*	AR 88	K 133	1.7	1.7	1.5	68/12	100.00	88.24
305	*Panicum miliaceum*	AR 88	K 133	1.8	1.7	1.7	66/12	105.88	100.00
306	*Panicum miliaceum*	AR 88	K 133	1.7	1.8	1.4	66/12	94.44	77.78
307	*Panicum miliaceum*	AR 88	K 133	2.4	1.7	1.4	66/12	141.18	82.35
308	*Panicum miliaceum*	AR 88	K 133	1.7	1.6	1.4	66/12	106.25	87.50
309	*Panicum miliaceum*	AR 88	K 133	1.9	1.4	0.9	66/12	135.71	64.29
310	*Secale cereale*	AR 91	K 9	4.5	2.2	2.1	40/12	204.55	95.45
311	*Triticum aestivum*	AR 91	K 9	4.1	2.8	2.3	40/12	146.43	82.14
312	*Panicum miliaceum*	AR 91	K 24	2.5	1.9	1.9	38/12	131.58	100.00
313	*Panicum miliaceum*	AR 91	K 24	2.1	1.8	1.8	38/12	116.67	100.00
314	*Panicum miliaceum*	AR 91	K 24	1.6	1.4	1.0	38/12	114.29	71.43
315	*Panicum miliaceum*	AR 91	K 24	1.8	1.5	1.4	38/12	120.00	93.33
316	*Secale cereale*	AR 91	K 8	5.1	1.8	2.2	37/12	283.33	122.22
317	*Panicum miliaceum*	AR 91	K 8	1.7	1.5	1.0	37/12	113.33	66.67
318	*Secale cereale*	AR 91	K 30	4.7	2.4	2.0	39/12	195.83	83.33
319	*Secale cereale*	AR 91	K 30	5.0	1.9	1.8	39/12	263.16	94.74
320	*Triticum aestivum*	AR 91	K 30	4.7	2.9	2.1	39/12	162.07	72.41
321	*Triticum aestivum*	AR 91	K 30	3.3	2.3	1.6	39/12	143.48	69.57

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
322	*Triticum aestivum*	AR 91	K 30	3.7	2.5	2.3	39/12	148.00	92.00
323	*Triticum aestivum*	AR 91	K 30	4.4	2.0	1.9	39/12	220.00	95.00
324	*Panicum miliaceum*	AR 100	K 2	1.5	1.6	1.0	155/12	93.75	62.50
325	*Triticum aestivum*	AR 100	K 2	4.5	3.3	2.4	155/12	136.36	72.73
326	*Panicum miliaceum*	AR 100	K 8	1.5	1.5	1.4	152/12	100.00	93.33
327	*Hordeum vulgare-vulgare*	AR 100	K 9	6.2	2.3	2.2	154/12	269.57	95.65
328	*Hordeum vulgare-vulgare*	AR 100	K 9	5.7	2.9	2.3	154/12	196.55	79.31
329	*Panicum miliaceum*	AR 100	K 9	1.8	1.4	1.0	154/12	128.57	71.43
330	*Panicum miliaceum*	AR 100	K 9	1.8	1.6	1.3	154/12	112.50	81.25
331	*Panicum miliaceum*	AR 100	K 9	1.7	1.3	1.2	154/12	130.77	92.31
332	*Secale cereale*	AR 100	K 9	5.4	2.0	1.3	154/12	270.00	65.00
333	*Triticum aestivum*	AR 100	K 9	5.5	3.3	2.3	154/12	166.67	69.70
334	*Triticum aestivum*	AR 100	K 9	3.9	3.2	2.2	154/12	121.88	68.75
335	*Triticum aestivum*	AR 100	K 9	3.9	2.6	2.0	154/12	150.00	76.92
336	*Hordeum vulgare-vulgare*	AR 100	K 6	4.3	2.2	2.0	160/12	195.45	90.91
337	*Panicum miliaceum*	AR 100	K 6	1.9	1.5	1.5	160/12	126.67	100.00
338	*Panicum miliaceum*	AR 100	K 6	1.6	1.5	1.4	160/12	106.67	93.33
339	*Panicum miliaceum*	AR 100	K 6	1.7	1.5	1.4	160/12	113.33	93.33
340	*Secale cereale*	AR 100	K 6	5.1	2.4	2.0	160/12	212.50	83.33
341	*Secale cereale*	AR 100	K 6	3.9	1.8	1.7	160/12	216.67	94.44
342	*Secale cereale*	AR 100	K 6	3.9	1.7	1.6	160/12	229.41	94.12
343	*Triticum aestivum*	AR 100	K 6	5.4	3.7	2.5	160/12	145.95	67.57
344	*Triticum aestivum*	AR 100	K 6	4.5	3.0	2.2	160/12	150.00	73.33
345	*Triticum aestivum*	AR 100	K 6	4.1	2.7	2.4	160/12	151.85	88.89
346	*Triticum aestivum*	AR 100	K 6	4.1	3.3	2.9	160/12	124.24	87.88
347	*Triticum aestivum*	AR 100	K 6	4.2	2.8	1.9	160/12	150.00	67.86
348	*Triticum aestivum*	AR 100	K 6	3.3	2.6	1.9	160/12	126.92	73.08
349	*Triticum aestivum*	AR 100	K 6	4.1	2.3	1.7	160/12	178.26	73.91
350	*Hordeum vulgare-vulgare*	AR 86	O 318	5.2	3.1	2.5	15/86	167.74	80.65
351	*Secale cereale*	AR 86	O 318	5.4	2.3	2.1	15/86	234.78	91.30
352	*Secale cereale*	AR 86	O 318	4.8	2.4	1.9	15/86	200.00	79.17
353	*Secale cereale*	AR 86	O 318	5.1	2.3	2.0	15/86	221.74	86.96
354	*Secale cereale*	AR 86	O 318	5.0	2.1	1.8	15/86	238.10	85.71
355	*Panicum miliaceum*	AR 86	O 318	1.6	1.6	1.5	15/86	100.00	93.75
356	*Panicum miliaceum*	AR 86	O 318	1.7	1.8	1.2	15/86	94.44	66.67
357	*Panicum miliaceum*	AR 86	O 318	1.9	1.8	1.5	15/86	105.56	83.33
358	*Panicum miliaceum*	AR 86	O 318	1.8	1.7	1.4	15/86	105.88	82.35
359	*Panicum miliaceum*	AR 86	O 318	1.6	1.5	1.2	15/86	106.67	80.00
360	*Panicum miliaceum*	AR 86	O 318	2.1	1.8	1.7	15/86	116.67	94.44
361	*Triticum aestivum*	AR 86	O 318	4.4	3.4	2.3	15/86	129.41	67.65
362	*Triticum aestivum*	AR 86	O 318	4.0	3.0	2.1	15/86	133.33	70.00
363	*Triticum aestivum*	AR 86	O 318	4.0	3.5	2.3	15/86	114.29	65.71
364	*Triticum aestivum*	AR 86	O 318	3.9	2.7	2.0	15/86	144.44	74.07
365	*Triticum aestivum*	AR 86	O 318	4.2	3.2	2.5	15/86	131.25	78.13
366	*Triticum aestivum*	AR 86	O 318	4.3	3.1	2.6	15/86	138.71	83.87
367	*Triticum aestivum*	AR 86	O 318	4.0	2.6	2.3	15/86	153.85	88.46
368	*Secale cereale*	AR 86	O 352	5.6	2.3	2.5	3/86	243.48	108.70
369	*Secale cereale*	AR 86	O 352	6.9	2.6	2.2	3/86	265.38	84.62
370	*Panicum miliaceum*	AR 86	O 352	2.2	1.7	1.7	3/86	129.41	100.00
371	*Panicum miliaceum*	AR 86	O 352	2.2	2.1	1.6	3/86	104.76	76.19
372	*Panicum miliaceum*	AR 86	O 352	1.6	1.7	1.4	3/86	94.12	82.35
373	*Triticum aestivum*	AR 86	O 352	3.9	2.5	2.0	3/86	156.00	80.00
374	*Triticum aestivum*	AR 86	O 352	4.0	2.9	2.1	3/86	137.93	72.41
375	*Triticum aestivum*	AR 86	O 352	4.1	2.5	2.0	3/86	164.00	80.00

TAB. 32 | Continuation 4

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
376	*Hordeum vulgare-vulgare*	AR 86	O 353	5.2	2.3	1.8	6/86	226.09	78.26
377	*Hordeum vulgare-vulgare*	AR 86	O 353	6.0	2.4	2.1	6/86	250.00	87.50
378	*Hordeum vulgare-vulgare*	AR 86	O 353	5.0	3.3	3.5	6/86	151.52	106.06
379	*Hordeum vulgare-vulgare*	AR 86	O 353	5.0	2.2	1.6	6/86	227.27	72.73
380	*Hordeum vulgare-vulgare*	AR 86	O 353	5.5	3.0	2.3	6/86	183.33	76.67
381	*Hordeum vulgare-vulgare*	AR 86	O 353	6.4	2.3	1.7	6/86	278.26	73.91
382	*Hordeum vulgare-vulgare*	AR 86	O 353	5.0	2.1	1.6	6/86	238.10	76.19
383	*Secale cereale*	AR 86	O 353	5.5	2.2	2.2	6/86	250.00	100.00
384	*Secale cereale*	AR 86	O 353	5.2	2.3	2.0	6/86	226.09	86.96
385	*Secale cereale*	AR 86	O 353	5.2	1.8	1.8	6/86	288.89	100.00
386	*Secale cereale*	AR 86	O 353	5.0	2.2	2.0	6/86	227.27	90.91
387	*Panicum miliaceum*	AR 86	O 353	1.8	1.9	1.3	6/86	94.74	68.42
388	*Panicum miliaceum*	AR 86	O 353	2.2	1.8	1.5	6/86	122.22	83.33
389	*Panicum miliaceum*	AR 86	O 353	1.8	1.8	1.5	6/86	100.00	83.33
390	*Panicum miliaceum*	AR 86	O 353	2.0	1.8	1.5	6/86	111.11	83.33
391	*Panicum miliaceum*	AR 86	O 353	1.8	1.7	1.5	6/86	105.88	88.24
392	*Panicum miliaceum*	AR 86	O 353	1.6	1.5	1.2	6/86	106.67	80.00
393	*Panicum miliaceum*	AR 86	O 353	2.0	1.8	1.5	6/86	111.11	83.33
394	*Panicum miliaceum*	AR 86	O 353	1.7	1.8	1.3	6/86	94.44	72.22
395	*Panicum miliaceum*	AR 86	O 353	1.6	1.6	1.5	6/86	100.00	93.75
396	*Panicum miliaceum*	AR 86	O 353	1.7	1.5	1.3	6/86	113.33	86.67
397	*Panicum miliaceum*	AR 86	O 353	1.8	1.6	1.4	6/86	112.50	87.50
398	*Panicum miliaceum*	AR 86	O 353	1.8	1.8	1.5	6/86	100.00	83.33
399	*Panicum miliaceum*	AR 86	O 353	1.9	1.5	1.0	6/86	126.67	66.67
400	*Panicum miliaceum*	AR 86	O 353	2.0	1.5	1.4	6/86	133.33	93.33
401	*Panicum miliaceum*	AR 86	O 353	1.7	1.6	1.2	6/86	106.25	75.00
402	*Panicum miliaceum*	AR 86	O 353	1.7	1.6	1.2	6/86	106.25	75.00
403	*Panicum miliaceum*	AR 86	O 353	1.8	1.5	1.5	6/86	120.00	100.00
404	*Panicum miliaceum*	AR 86	O 353	2.1	1.4	1.4	6/86	150.00	100.00
405	*Panicum miliaceum*	AR 86	O 353	1.7	1.4	1.1	6/86	121.43	78.57
406	*Panicum miliaceum*	AR 86	O 353	2.0	1.6	1.3	6/86	125.00	81.25
407	*Panicum miliaceum*	AR 86	O 353	1.8	1.5	1.3	6/86	120.00	86.67
408	*Panicum miliaceum*	AR 86	O 353	2.2	1.7	1.5	6/86	129.41	88.24
409	*Panicum miliaceum*	AR 86	O 353	1.7	1.8	1.5	6/86	94.44	83.33
410	*Panicum miliaceum*	AR 86	O 353	1.8	2.0	1.5	6/86	90.00	75.00
411	*Panicum miliaceum*	AR 86	O 353	1.9	1.5	1.4	6/86	126.67	93.33
412	*Panicum miliaceum*	AR 86	O 353	1.7	1.7	1.3	6/86	100.00	76.47
413	*Panicum miliaceum*	AR 86	O 353	2.0	1.6	1.5	6/86	125.00	93.75
414	*Triticum aestivum*	AR 86	O 353	5.1	3.3	1.9	6/86	154.55	57.58
415	*Triticum aestivum*	AR 86	O 353	4.6	3.4	2.8	6/86	135.29	82.35
416	*Triticum aestivum*	AR 86	O 353	4.0	3.1	1.9	6/86	129.03	61.29
417	*Triticum aestivum*	AR 86	O 353	5.1	3.7	3.0	6/86	137.84	81.08
418	*Triticum aestivum*	AR 86	O 353	5.0	3.1	2.3	6/86	161.29	74.19
419	*Triticum aestivum*	AR 86	O 353	4.2	3.3	2.8	6/86	127.27	84.85
420	*Triticum aestivum*	AR 86	O 353	3.9	2.8	2.5	6/86	139.29	89.29
421	*Triticum aestivum*	AR 86	O 353	4.3	3.5	2.5	6/86	122.86	71.43
422	*Triticum aestivum*	AR 86	O 353	4.5	2.9	2.8	6/86	155.17	96.55
423	*Triticum aestivum*	AR 86	O 353	4.3	3.0	2.5	6/86	143.33	83.33
424	*Hordeum vulgare-vulgare*	AR 86	O 378	4.8	3.0	1.6	5/86	160.00	53.33
425	*Hordeum vulgare-vulgare*	AR 86	O 378	4.3	2.8	2.0	5/86	153.57	71.43
426	*Panicum miliaceum*	AR 86	O 378	1.8	1.7	1.1	5/86	105.88	64.71
427	*Panicum miliaceum*	AR 86	O 378	1.7	1.9	1.5	5/86	89.47	78.95
428	*Panicum miliaceum*	AR 86	O 378	1.9	1.8	1.4	5/86	105.56	77.78
429	*Triticum aestivum*	AR 86	O 378	4.3	3.5	2.1	5/86	122.86	60.00

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
430	*Triticum aestivum*	AR 86	O 378	4.2	3.0	2.2	5/86	140.00	73.33
431	*Triticum aestivum*	AR 86	O 378	3.9	3.0	2.5	5/86	130.00	83.33
432	*Panicum miliaceum*	AR 86	K 16	1.6	1.4	1.3	7/86	114.29	92.86
433	*Hordeum vulgare-vulgare*	AR 86	K 21	5.3	2.6	1.5	12/86	203.85	57.69
434	*Secale cereale*	AR 86	K 21	6.3	2.2	1.9	12/86	286.36	86.36
435	*Secale cereale*	AR 86	K 21	5.2	2.3	2.3	12/86	226.09	100.00
436	*Secale cereale*	AR 86	K 21	5.8	2.2	2.1	12/86	263.64	95.45
437	*Secale cereale*	AR 86	K 21	4.2	1.8	1.9	12/86	233.33	105.56
438	*Secale cereale*	AR 86	K 21	4.5	1.6	1.2	12/86	281.25	75.00
439	*Panicum miliaceum*	AR 86	K 21	1.5	1.6	1.6	12/86	93.75	100.00
440	*Panicum miliaceum*	AR 86	K 21	2.2	1.8	1.4	12/86	122.22	77.78
441	*Panicum miliaceum*	AR 86	K 21	1.4	1.7	1.4	12/86	82.35	82.35
442	*Triticum aestivum*	AR 86	K 21	4.2	3.0	2.0	12/86	140.00	66.67
443	*Triticum aestivum*	AR 86	K 21	3.6	2.5	2.0	12/86	144.00	80.00
444	*Triticum aestivum*	AR 86	K 21	4.3	2.7	2.1	12/86	159.26	77.78
445	*Triticum aestivum*	AR 86	K 21	4.5	2.8	2.3	12/86	160.71	82.14
446	*Triticum aestivum*	AR 86	K 21	3.6	3.4	2.6	12/86	105.88	76.47
447	*Triticum aestivum*	AR 86	K 21	4.5	3.0	2.1	12/86	150.00	70.00
448	*Hordeum vulgare-vulgare*	AR 86	K 25	5.9	3.5	2.5	11/86	168.57	71.43
449	*Secale cereale*	AR 86	K 25	4.7	2.1	1.8	11/86	223.81	85.71
450	*Secale cereale*	AR 86	K 25	4.8	2.1	1.7	11/86	228.57	80.95
451	*Panicum miliaceum*	AR 86	K 25	1.8	1.7	1.6	11/86	105.88	94.12
452	*Panicum miliaceum*	AR 86	K 25	1.4	1.7	1.4	11/86	82.35	82.35
453	*Panicum miliaceum*	AR 86	K 25	1.6	1.6	1.4	11/86	100.00	87.50
454	*Panicum miliaceum*	AR 86	K 25	1.7	(?)	1.4	11/86	.	.
455	*Triticum aestivum*	AR 86	K 25	3.9	3.1	2.3	11/86	125.81	74.19
456	*Triticum aestivum*	AR 86	K 25	3.7	2.3	2.7	11/86	160.87	117.39
457	*Triticum aestivum*	AR 86	K 25	4.2	2.5	2.2	11/86	168.00	88.00
458	*Triticum aestivum*	AR 86	K 25	4.8	3.0	2.5	11/86	160.00	83.33
459	*Hordeum vulgare-vulgare*	AR 86	K 41/42	5.9	2.9	3.3	16/86	203.45	113.79
460	*Hordeum vulgare-vulgare*	AR 86	K 41/42	5.6	3.0	1.9	16/86	186.67	63.33
461	*Secale cereale*	AR 86	K 41/42	4.5	2.0	1.8	16/86	225.00	90.00
462	*Secale cereale*	AR 86	K 41/42	5.0	2.1	2.0	16/86	238.10	95.24
463	*Secale cereale*	AR 86	K 41/42	5.2	2.3	1.8	16/86	226.09	78.26
464	*Panicum miliaceum*	AR 86	K 41/42	1.8	2.1	1.2	16/86	85.71	57.14
465	*Panicum miliaceum*	AR 86	K 41/42	1.5	2.0	1.2	16/86	75.00	60.00
466	*Panicum miliaceum*	AR 86	K 41/42	2.1	1.5	1.5	16/86	140.00	100.00
467	*Panicum miliaceum*	AR 86	K 41/42	1.9	1.6	1.6	16/86	118.75	100.00
468	*Panicum miliaceum*	AR 86	K 41/42	1.5	2.0	1.4	16/86	75.00	70.00
469	*Triticum aestivum*	AR 86	K 41/42	4.8	3.3	2.3	16/86	145.45	69.70
470	*Triticum aestivum*	AR 86	K 41/42	4.9	3.3	2.3	16/86	148.48	69.70
471	*Triticum aestivum*	AR 86	K 41/42	4.4	2.8	2.6	16/86	157.14	92.86
472	*Hordeum vulgare-vulgare*	AR 86	K 55	6.0	3.4	2.5	14/86	176.47	73.53
473	*Hordeum vulgare-vulgare*	AR 86	K 55	4.8	2.3	1.8	14/86	208.70	78.26
474	*Panicum miliaceum*	AR 86	K 55	2.2	1.5	1.4	14/86	146.67	93.33
475	*Panicum miliaceum*	AR 86	K 55	1.8	1.7	1.5	14/86	105.88	88.24
476	*Panicum miliaceum*	AR 86	K 55	2.0	1.3	1.3	14/86	153.85	100.00
477	*Panicum miliaceum*	AR 86	K 55	1.6	1.8	1.5	14/86	88.89	83.33
478	*Panicum miliaceum*	AR 86	K 55	1.8	1.8	1.7	14/86	100.00	94.44
479	*Triticum aestivum*	AR 86	K 55	4.0	2.5	2.4	14/86	160.00	96.00
480	*Triticum aestivum*	AR 86	K 55	4.4	2.7	2.4	14/86	162.96	88.89
481	*Triticum aestivum*	AR 86	K 55	4.3	3.0	2.2	14/86	143.33	73.33
482	*Triticum aestivum*	AR 86	K 55	3.8	2.7	2.2	14/86	140.74	81.48
483	*Triticum aestivum*	AR 86	K 55	3.5	2.6	2.0	14/86	134.62	76.92

TAB. 32 | Continuation 5

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
484	*Hordeum vulgare-vulgare*	AR 86	K 77	5.3	3.1	2.4	19/86	170.97	77.42
485	*Hordeum vulgare-vulgare*	AR 86	K 77	5.0	2.8	2.3	19/86	178.57	82.14
486	*Hordeum vulgare-vulgare*	AR 86	K 77	4.5	2.3	1.8	19/86	195.65	78.26
487	*Secale cereale*	AR 86	K 77	3.8	2.1	1.7	19/86	180.95	80.95
488	*Secale cereale*	AR 86	K 77	4.2	2.2	1.5	19/86	190.91	68.18
489	*Secale cereale*	AR 86	K 77	5.3	2.0	1.8	19/86	265.00	90.00
490	*Secale cereale*	AR 86	K 77	7.0	2.5	2.1	19/86	280.00	84.00
491	*Secale cereale*	AR 86	K 77	5.2	2.6	2.1	19/86	200.00	80.77
492	*Panicum miliaceum*	AR 86	K 77	1.7	1.6	1.5	19/86	106.25	93.75
493	*Panicum miliaceum*	AR 86	K 77	1.6	1.7	1.5	19/86	94.12	88.24
494	*Panicum miliaceum*	AR 86	K 77	2.0	1.7	1.4	19/86	117.65	82.35
495	*Panicum miliaceum*	AR 86	K 77	1.6	1.7	1.2	19/86	94.12	70.59
496	*Panicum miliaceum*	AR 86	K 77	1.7	1.6	1.3	19/86	106.25	81.25
497	*Triticum aestivum*	AR 86	K 77	4.5	3.6	2.3	19/86	125.00	63.89
498	*Triticum aestivum*	AR 86	K 77	4.6	3.4	2.5	19/86	135.29	73.53
499	*Triticum aestivum*	AR 86	K 77	4.0	2.7	2.6	19/86	148.15	96.30
500	*Triticum aestivum*	AR 86	K 77	3.6	3.3	2.6	19/86	109.09	78.79
501	*Triticum aestivum*	AR 86	K 77	4.1	2.5	2.2	19/86	164.00	88.00
502	*Triticum aestivum*	AR 86	K 77	4.6	3.2	2.6	19/86	143.75	81.25
503	*Hordeum vulgare-vulgare*	AR 86	K 81	4.9	2.8	2.1	17/86	175.00	75.00
504	*Hordeum vulgare-vulgare*	AR 86	K 81	5.4	2.5	2.1	1/86	216.00	84.00
505	*Hordeum vulgare-vulgare*	AR 86	K 81	5.4	3.2	2.1	18/86	168.75	65.63
506	*Secale cereale*	AR 86	K 81	4.9	2.1	1.7	17/86	233.33	80.95
507	*Secale cereale*	AR 86	K 81	4.7	2.0	2.1	17/86	235.00	105.00
508	*Panicum miliaceum*	AR 86	K 81	1.7	1.5	1.1	17/86	113.33	73.33
509	*Panicum miliaceum*	AR 86	K 81	1.8	1.5	1.4	17/86	120.00	93.33
510	*Panicum miliaceum*	AR 86	K 81	2.2	1.7	1.8	17/86	129.41	105.88
511	*Panicum miliaceum*	AR 86	K 81	1.7	1.5	1.0	17/86	113.33	66.67
512	*Panicum miliaceum*	AR 86	K 81	1.8	1.5	1.6	17/86	120.00	106.67
513	*Triticum aestivum*	AR 86	K 81	4.7	3.0	2.5	17/86	156.67	83.33
514	*Triticum aestivum*	AR 86	K 81	3.6	2.8	2.4	17/86	128.57	85.71
515	*Triticum aestivum*	AR 86	K 81	3.9	2.6	2.5	17/86	150.00	96.15
516	*Triticum aestivum*	AR 86	K 81	4.3	3.4	2.5	1/86	126.47	73.53
517	*Triticum aestivum*	AR 86	K 81	4.2	3.4	2.6	1/86	123.53	76.47
518	*Triticum aestivum*	AR 86	K 81	3.8	2.5	2.0	1/86	152.00	80.00
519	*Panicum miliaceum*	AR M 17	Z1	1.5	1.5	1.3	203/12	100.00	86.67
520	*Panicum miliaceum*	AR M 17	Z1	1.6	1.8	1.2	205/12	88.89	66.67
521	*Panicum miliaceum*	AR M 17	Z1	1.8	1.5	1.5	205/12	120.00	100.00
522	*Panicum miliaceum*	AR M 17	Z1	1.7	1.4	0.9	205/12	121.43	64.29
523	*Secale cereale*	AR M 17	Z1	3.3	1.4	1.2	203/12	235.71	85.71
524	*Hordeum vulgare-vulgare*	AR M 17	Z2	4.5	2.3	2.5	194/12	195.65	108.70
525	*Panicum miliaceum*	AR M 17	Z2	1.8	1.7	1.6	199/12	105.88	94.12
526	*Secale cereale*	AR M 17	Z3	4.2	2.0	2.0	197/12	210.00	100.00
527	*Panicum miliaceum*	AR M 17	Z3	1.7	1.5	1.6	197/12	113.33	106.67
528	*Panicum miliaceum*	AR M 17	Z3	2.3	1.7	1.4	197/12	135.29	82.35
529	*Panicum miliaceum*	AR M 17	Z5	1.9	1.6	1.4	209/12	118.75	87.50
530	*Hordeum vulgare-vulgare*	AR M 17	Z8	5.6	3.1	2.5	147/12	180.65	80.65
531	*Hordeum vulgare-vulgare*	AR M 17	Z8	5.1	3.2	2.1	147/12	159.38	65.63
532	*Hordeum vulgare-vulgare*	AR M 17	Z8	4.0	2.3	1.6	147/12	173.91	69.57
533	*Triticum aestivum*	AR M 17	Z8	3.3	2.5	1.7	147/12	132.00	68.00
534	*Hordeum vulgare-vulgare*	AR M 17	Z4	5.6	2.7	2.3	195/12	207.41	85.19
535	*Hordeum vulgare-vulgare*	AR M 17	Z4	5.4	3.3	2.3	195/12	163.64	69.70
536	*Hordeum vulgare-vulgare*	AR M 17	Z4	4.3	2.8	2.1	195/12	153.57	75.00
537	*Secale cereale*	AR M 17	Z4	5.5	2.2	2.3	195/12	250.00	104.55

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
538	*Secale cereale*	AR M 17	Z4	5.6	2.3	2.2	195/12	243.48	95.65
539	*Secale cereale*	AR M 17	Z4	5.3	2.2	2.1	195/12	240.91	95.45
540	*Secale cereale*	AR M 17	Z4	4.5	1.9	1.8	195/12	236.84	94.74
541	*Secale cereale*	AR M 17	Z4	4.9	1.6	1.6	195/12	306.25	100.00
542	*Triticum aestivum*	AR M 17	Z4	4.2	2.5	2.2	195/12	168.00	88.00
543	*Triticum aestivum*	AR M 17	Z4	4.3	3.3	2.2	195/12	130.30	66.67
544	*Triticum aestivum*	AR M 17	Z4	4.6	3.1	2.3	195/12	148.39	74.19
545	*Triticum aestivum*	AR M 17	Z4	4.5	3.6	2.4	195/12	125.00	66.67
546	*Triticum aestivum*	AR M 17	Z4	3.6	3.3	2.5	195/12	109.09	75.76
547	*Triticum aestivum*	AR M 17	Z4	4.7	3.5	2.6	195/12	134.29	74.29
548	*Triticum aestivum*	AR M 17	Z4	4.2	3.4	2.5	195/12	123.53	73.53
549	*Hordeum vulgare-vulgare*	AR 98	K1	4.2	2.4	2.1	20/12	175.00	87.50
550	*Hordeum vulgare-vulgare*	AR 98	K1	4.1	2.5	2.3	20/12	164.00	92.00
551	*Panicum miliaceum*	AR 98	K1	1.7	1.8	1.0	9/12	94.44	55.56
552	*Panicum miliaceum*	AR 98	K1	1.5	1.5	1.5	9/12	100.00	100.00
553	*Panicum miliaceum*	AR 98	K1	1.9	1.8	1.5	9/12	105.56	83.33
554	*Panicum miliaceum*	AR 98	K1	1.8	1.9	1.7	16/12	94.74	89.47
555	*Secale cereale*	AR 98	K1	5.0	2.5	2.3	20/12	200.00	92.00
556	*Triticum aestivum*	AR 98	K1	4.0	3.0	2.3	16/12	133.33	76.67
557	*Triticum aestivum*	AR 98	K1	3.8	2.9	2.3	26/12	131.03	79.31
558	*Hordeum vulgare-vulgare*	AR 98	K2	5.5	3.0	1.9	17/12	183.33	63.33
559	*Hordeum vulgare-vulgare*	AR 98	K2	5.6	3.4	2.7	17/12	164.71	79.41
560	*Hordeum vulgare-vulgare*	AR 98	K2	5.6	3.0	2.3	17/12	186.67	76.67
561	*Hordeum vulgare-vulgare*	AR 98	K2	6.3	3.3	2.2	17/12	190.91	66.67
562	*Hordeum vulgare-vulgare*	AR 98	K2	5.1	2.7	1.9	17/12	188.89	70.37
563	*Hordeum vulgare-vulgare*	AR 98	K2	5.8	3.2	2.5	17/12	181.25	78.13
564	*Panicum miliaceum*	AR 98	K2	2.0	1.7	1.8	17/12	117.65	105.88
565	*Panicum miliaceum*	AR 98	K2	1.7	2.0	1.5	17/12	85.00	75.00
566	*Panicum miliaceum*	AR 98	K2	1.9	1.6	1.4	17/12	118.75	87.50
567	*Panicum miliaceum*	AR 98	K2	1.5	1.8	1.5	17/12	83.33	83.33
568	*Panicum miliaceum*	AR 98	K2	1.9	1.5	1.2	17/12	126.67	80.00
569	*Panicum miliaceum*	AR 98	K2	1.9	1.5	1.6	28/12	126.67	106.67
570	*Panicum miliaceum*	AR 98	K2	2.0	1.8	1.4	28/12	111.11	77.78
571	*Secale cereale*	AR 98	K2	4.7	2.3	2.2	28/12	204.35	95.65
572	*Secale cereale*	AR 98	K2	6.8	2.4	2.3	28/12	283.33	95.83
573	*Secale cereale*	AR 98	K2	5.2	2.2	1.9	28/12	236.36	86.36
574	*Triticum aestivum*	AR 98	K2	4.6	3.5	2.3	28/12	131.43	65.71
575	*Triticum aestivum*	AR 98	K2	6.1	3.3	2.7	28/12	184.85	81.82
576	*Triticum aestivum*	AR 98	K2	4.3	3.0	2.5	28/12	143.33	83.33
577	*Triticum aestivum*	AR 98	K2	4.8	2.5	2.4	28/12	192.00	96.00
578	*Triticum aestivum*	AR 98	K2	4.4	2.9	2.3	28/12	151.72	79.31
579	*Triticum aestivum*	AR 98	K2	4.7	3.0	2.7	28/12	156.67	90.00
580	*Hordeum vulgare-vulgare*	AR 98	K3	4.7	3.0	1.8	27/12	156.67	60.00
581	*Panicum miliaceum*	AR 98	K3	2.1	1.7	1.5	27/12	123.53	88.24
582	*Secale cereale*	AR 98	K3	6.1	2.4	2.3	25/12	254.17	95.83
583	*Triticum aestivum*	AR 98	K6	4.2	3.2	2.1	29/12	131.25	65.63
584	*Triticum aestivum*	AR 98	K6	4.0	3.1	2.4	29/12	129.03	77.42
585	*Panicum miliaceum*	AR 98	K6	1.8	1.8	1.0	29/12	100.00	55.56
586	*Panicum miliaceum*	AR 98	K6	1.5	1.5	1.1	29/12	100.00	73.33
587	*Panicum miliaceum*	AR 98	K6	1.6	1.8	1.2	29/12	88.89	66.67
588	*Panicum miliaceum*	AR 98	K6	1.9	1.5	1.5	29/12	126.67	100.00
589	*Hordeum vulgare-vulgare*	AR 98	K5	5.8	2.8	1.6	15/12	207.14	57.14
590	*Hordeum vulgare-vulgare*	AR 98	K5	5.7	2.3	2.5	15/12	247.83	108.70
591	*Hordeum vulgare-vulgare*	AR 98	K5	5.1	2.2	2.0	15/12	231.82	90.91

TAB. 32 | Continuation 6

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
592	*Hordeum vulgare-vulgare*	AR 98	K5	6.1	3.1	2.2	15/12	196.77	70.97
593	*Hordeum vulgare-vulgare*	AR 98	K5	5.0	2.5	1.9	15/12	200.00	76.00
594	*Panicum miliaceum*	AR 98	K5	1.7	1.8	1.4	15/12	94.44	77.78
595	*Panicum miliaceum*	AR 98	K5	1.7	1.5	1.3	15/12	113.33	86.67
596	*Panicum miliaceum*	AR 98	K5	2.3	1.6	1.5	15/12	143.75	93.75
597	*Panicum miliaceum*	AR 98	K5	1.8	1.7	1.2	15/12	105.88	70.59
598	*Panicum miliaceum*	AR 98	K5	1.7	1.7	1.3	15/12	100.00	76.47
599	*Panicum miliaceum*	AR 98	K5	1.7	1.5	1.4	15/12	113.33	93.33
600	*Panicum miliaceum*	AR 98	K5	1.6	1.7	1.0	15/12	94.12	58.82
601	*Secale cereale*	AR 98	K5	4.1	2.2	2.1	15/12	186.36	95.45
602	*Secale cereale*	AR 98	K5	5.0	2.0	1.7	15/12	250.00	85.00
603	*Secale cereale*	AR 98	K5	4.8	1.8	1.8	15/12	266.67	100.00
604	*Secale cereale*	AR 98	K5	5.9	1.9	2.2	15/12	310.53	115.79
605	*Secale cereale*	AR 98	K5	6.0	2.3	2.2	15/12	260.87	95.65
606	*Secale cereale*	AR 98	K5	5.5	1.5	2.0	15/12	366.67	133.33
607	*Secale cereale*	AR 98	K5	4.6	2.0	1.8	15/12	230.00	90.00
608	*Triticum aestivum*	AR 98	K5	4.2	3.7	2.3	15/12	113.51	62.16
609	*Triticum aestivum*	AR 98	K5	4.6	3.9	2.5	15/12	117.95	64.10
610	*Triticum aestivum*	AR 98	K5	4.7	3.3	2.6	15/12	142.42	78.79
611	*Triticum aestivum*	AR 98	K5	4.1	3.4	2.7	15/12	120.59	79.41
612	*Triticum aestivum*	AR 98	K5	4.9	3.3	2.5	15/12	148.48	75.76
613	*Triticum aestivum*	AR 98	K5	4.3	3.0	2.2	15/12	143.33	73.33
614	*Triticum aestivum*	AR 98	K5	5.3	2.7	2.8	15/12	196.30	103.70
615	*Panicum miliaceum*	AR 90	K5	2.0	1.5	1.7	48/12	133.33	113.33
616	*Panicum miliaceum*	AR 90	K5	1.7	1.6	1.4	48/12	106.25	87.50
617	*Panicum miliaceum*	AR 90	K5	1.9	1.4	1.4	48/12	135.71	100.00
618	*Secale cereale*	AR 90	K5	5.2	2.1	1.9	48/12	247.62	90.48
619	*Triticum aestivum*	AR 90	K5	3.9	2.3	2.0	48/12	169.57	86.96
620	*Hordeum vulgare-vulgare*	AR 90	K29	5.6	3.3	2.7	54/12	169.70	81.82
621	*Hordeum vulgare-vulgare*	AR 90	K29	5.2	3.0	2.0	54/12	173.33	66.67
622	*Hordeum vulgare-vulgare*	AR 90	K29	4.6	2.8	2.0	54/12	164.29	71.43
623	*Hordeum vulgare-vulgare*	AR 90	K29	5.5	2.6	2.3	54/12	211.54	88.46
624	*Hordeum vulgare-vulgare*	AR 90	K29	5.4	2.9	2.5	54/12	186.21	86.21
625	*Hordeum vulgare-vulgare*	AR 90	K29	4.8	3.1	2.3	53/12	154.84	74.19
626	*Hordeum vulgare-vulgare*	AR 90	K29	5.4	2.6	2.1	53/12	207.69	80.77
627	*Hordeum vulgare-vulgare*	AR 90	K29	5.0	2.9	2.2	53/12	172.41	75.86
628	*Panicum miliaceum*	AR 90	K29	1.9	1.9	1.5	54/12	100.00	78.95
629	*Panicum miliaceum*	AR 90	K29	2.2	1.6	1.4	54/12	137.50	87.50
630	*Panicum miliaceum*	AR 90	K29	1.7	1.9	1.3	54/12	89.47	68.42
631	*Panicum miliaceum*	AR 90	K29	1.8	1.6	1.4	54/12	112.50	87.50
632	*Panicum miliaceum*	AR 90	K29	1.8	1.8	1.2	54/12	100.00	66.67
633	*Panicum miliaceum*	AR 90	K29	1.9	1.4	1.7	54/12	135.71	121.43
634	*Panicum miliaceum*	AR 90	K29	2.1	1.5	1.5	54/12	140.00	100.00
635	*Panicum miliaceum*	AR 90	K29	2.1	1.5	1.5	54/12	140.00	100.00
636	*Panicum miliaceum*	AR 90	K29	2.0	1.6	1.6	54/12	125.00	100.00
637	*Panicum miliaceum*	AR 90	K29	1.9	1.6	1.5	54/12	118.75	93.75
638	*Panicum miliaceum*	AR 90	K29	2.0	1.7	1.5	53/12	117.65	88.24
639	*Panicum miliaceum*	AR 90	K29	1.9	1.7	1.5	53/12	111.76	88.24
640	*Panicum miliaceum*	AR 90	K29	2.1	1.5	1.5	53/12	140.00	100.00
641	*Panicum miliaceum*	AR 90	K29	2.0	1.5	1.5	53/12	133.33	100.00
642	*Panicum miliaceum*	AR 90	K29	1.7	1.5	1.2	53/12	113.33	80.00
643	*Panicum miliaceum*	AR 90	K29	1.8	1.7	1.5	53/12	105.88	88.24
644	*Panicum miliaceum*	AR 90	K29	2.0	1.5	1.6	53/12	133.33	106.67
645	*Panicum miliaceum*	AR 90	K29	2.2	1.7	1.5	53/12	129.41	88.24

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
646	*Panicum miliaceum*	AR 90	K29	1.8	1.6	1.5	53/12	112.50	93.75
647	*Panicum miliaceum*	AR 90	K29	2.2	2.0	1.7	53/12	110.00	85.00
648	*Secale cereale*	AR 90	K29	5.5	2.6	2.3	54/12	211.54	88.46
649	*Secale cereale*	AR 90	K29	5.1	2.2	2.1	54/12	231.82	95.45
650	*Secale cereale*	AR 90	K29	5.5	2.3	2.0	54/12	239.13	86.96
651	*Secale cereale*	AR 90	K29	5.6	2.2	1.5	54/12	254.55	68.18
652	*Secale cereale*	AR 90	K29	4.7	2.2	2.0	54/12	213.64	90.91
653	*Secale cereale*	AR 90	K29	4.5	1.8	1.5	54/12	250.00	83.33
654	*Secale cereale*	AR 90	K29	5.0	2.0	1.7	54/12	250.00	85.00
655	*Secale cereale*	AR 90	K29	5.1	2.3	1.7	54/12	221.74	73.91
656	*Secale cereale*	AR 90	K29	4.4	1.8	1.7	54/12	244.44	94.44
657	*Secale cereale*	AR 90	K29	5.6	1.8	1.7	53/12	311.11	94.44
658	*Secale cereale*	AR 90	K29	5.6	2.2	1.8	53/12	254.55	81.82
659	*Secale cereale*	AR 90	K29	5.3	2.5	2.1	53/12	212.00	84.00
660	*Secale cereale*	AR 90	K29	4.0	2.0	2.0	53/12	200.00	100.00
661	*Secale cereale*	AR 90	K29	4.5	2.1	1.8	53/12	214.29	85.71
662	*Triticum aestivum*	AR 90	K29	4.8	3.5	2.6	54/12	137.14	74.29
663	*Triticum aestivum*	AR 90	K29	4.1	3.1	2.8	54/12	132.26	90.32
664	*Triticum aestivum*	AR 90	K29	4.3	3.6	2.9	54/12	119.44	80.56
665	*Triticum aestivum*	AR 90	K29	3.9	2.6	2.0	54/12	150.00	76.92
666	*Triticum aestivum*	AR 90	K29	4.5	2.5	2.1	54/12	180.00	84.00
667	*Triticum aestivum*	AR 90	K29	3.7	2.5	2.3	54/12	148.00	92.00
668	*Triticum aestivum*	AR 90	K29	3.8	3.8	2.0	54/12	100.00	52.63
669	*Triticum aestivum*	AR 90	K29	4.3	2.8	2.5	53/12	153.57	89.29
670	*Triticum aestivum*	AR 90	K29	5.2	3.5	2.6	53/12	148.57	74.29
671	*Triticum aestivum*	AR 90	K29	5.5	3.6	2.6	53/12	152.78	72.22
672	*Triticum aestivum*	AR 90	K29	4.7	2.8	2.2	53/12	167.86	78.57
673	*Triticum aestivum*	AR 90	K29	4.9	2.3	2.2	53/12	213.04	95.65
674	*Triticum aestivum*	AR 90	K29	4.2	3.6	2.5	53/12	116.67	69.44
675	*Triticum aestivum*	AR 90	K29	3.7	2.5	2.3	53/12	148.00	92.00
676	*Panicum miliaceum*	AR 96	K2	1.7	2.0	1.3	91/12	85.00	65.00
677	*Panicum miliaceum*	AR 96	K2	1.7	1.7	1.2	91/12	100.00	70.59
678	*Secale cereale*	AR 96	K2	4.7	2.2	2.3	91/12	213.64	104.55
679	*Hordeum vulgare-vulgare*	AR 96	K7	5.2	2.6	1.8	81/12	200.00	69.23
680	*Hordeum vulgare-vulgare*	AR 96	K7	5.1	2.4	1.7	70/12	212.50	70.83
681	*Secale cereale*	AR 96	K7	4.6	1.7	1.8	81/12	270.59	105.88
682	*Panicum miliaceum*	AR 96	K7	2.0	1.7	1.6	67/12	117.65	94.12
683	*Panicum miliaceum*	AR 96	K7	1.7	1.6	1.5	67/12	106.25	93.75
684	*Triticum aestivum*	AR 96	K7	5.2	3.1	2.5	67/12	167.74	80.65
685	*Secale cereale*	AR 96	K8	5.9	2.3	2.0	112/12	256.52	86.96
686	*Secale cereale*	AR 96	K8	4.3	1.6	1.5	112/12	268.75	93.75
687	*Secale cereale*	AR 96	K8	5.1	2.3	2.2	109/12	221.74	95.65
688	*Panicum miliaceum*	AR 96	K8	1.8	1.8	1.5	109/12	100.00	83.33
689	*Panicum miliaceum*	AR 96	K8	1.6	1.6	1.2	109/12	100.00	75.00
690	*Panicum miliaceum*	AR 96	K8	2.0	1.6	1.0	112/12	125.00	62.50
691	*Panicum miliaceum*	AR 96	K8	1.8	1.6	1.5	112/12	112.50	93.75
692	*Triticum aestivum*	AR 96	K8	4.3	2.5	2.3	112/12	172.00	92.00
693	*Triticum aestivum*	AR 96	K8	4.2	3.0	2.5	109/12	140.00	83.33
694	*Triticum aestivum*	AR 96	K8	4.2	3.5	2.6	109/12	120.00	74.29
695	*Triticum aestivum*	AR 96	K8	4.6	2.7	2.0	109/12	170.37	74.07
696	*Hordeum vulgare-vulgare*	AR 96	K9	5.7	2.9	2.6	128/12	196.55	89.66
697	*Panicum miliaceum*	AR 96	K9	1.7	1.8	1.6	125/12	94.44	88.89
698	*Panicum miliaceum*	AR 96	K9	2.1	1.6	1.3	128/12	131.25	81.25
699	*Panicum miliaceum*	AR 96	K9	1.9	2.0	1.5	128/12	95.00	75.00

TAB. 32 | Continuation 7

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
700	*Panicum miliaceum*	AR 96	K9	1.7	1.5	1.4	128/12	113.33	93.33
701	*Panicum miliaceum*	AR 96	K9	2.0	1.5	1.5	128/12	133.33	100.00
702	*Triticum aestivum*	AR 96	K9	4.3	3.2	2.1	128/12	134.38	65.63
703	*Panicum miliaceum*	AR 96	K21	1.8	1.7	1.6	130/12	105.88	94.12
704	*Panicum miliaceum*	AR 96	K21	1.9	1.6	1.5	130/12	118.75	93.75
705	*Panicum miliaceum*	AR 96	K21	2.0	1.6	1.1	130/12	125.00	68.75
706	*Panicum miliaceum*	AR 96	K21	1.8	1.7	1.4	130/12	105.88	82.35
707	*Triticum aestivum*	AR 96	K21	3.5	2.5	1.8	130/12	140.00	72.00
708	*Triticum aestivum*	AR 96	K21	4.6	3.1	2.8	130/12	148.39	90.32
709	*Triticum aestivum*	AR 96	K21	3.3	2.0	1.7	130/12	165.00	85.00
710	*Hordeum vulgare-vulgare*	AR 96	K22	5.0	2.7	2.3	121/12	185.19	85.19
711	*Hordeum vulgare-vulgare*	AR 96	K22	5.7	2.7	2.5	121/12	211.11	92.59
712	*Hordeum vulgare-vulgare*	AR 96	K22	5.7	2.9	2.5	121/12	196.55	86.21
713	*Hordeum vulgare-vulgare*	AR 96	K22	5.0	2.5	2.1	121/12	200.00	84.00
714	*Hordeum vulgare-vulgare*	AR 96	K22	5.4	2.2	2.0	121/12	245.45	90.91
715	*Hordeum vulgare-vulgare*	AR 96	K22	4.5	2.8	1.8	118/12	160.71	64.29
716	*Hordeum vulgare-vulgare*	AR 96	K22	5.0	2.8	1.9	118/12	178.57	67.86
717	*Secale cereale*	AR 96	K22	4.0	1.8	1.9	121/12	222.22	105.56
718	*Secale cereale*	AR 96	K22	4.4	2.3	1.7	137/12	191.30	73.91
719	*Secale cereale*	AR 96	K22	4.7	2.2	1.7	73/12	213.64	77.27
720	*Panicum miliaceum*	AR 96	K22	1.9	1.6	1.2	120/12	118.75	75.00
721	*Panicum miliaceum*	AR 96	K22	1.6	1.8	1.4	120/12	88.89	77.78
722	*Panicum miliaceum*	AR 96	K22	1.5	1.5	1.2	120/12	100.00	80.00
723	*Panicum miliaceum*	AR 96	K22	1.9	1.8	1.3	120/12	105.56	72.22
724	*Panicum miliaceum*	AR 96	K22	1.6	1.5	1.1	121/12	106.67	73.33
725	*Panicum miliaceum*	AR 96	K22	1.8	1.6	1.5	121/12	112.50	93.75
726	*Triticum aestivum*	AR 96	K22	4.5	3.3	2.4	136/12	136.36	72.73
727	*Triticum aestivum*	AR 96	K22	4.0	2.5	2.3	136/12	160.00	92.00
728	*Triticum aestivum*	AR 96	K22	4.0	3.4	2.3	72/12	117.65	67.65
729	*Triticum aestivum*	AR 96	K22	3.9	2.5	2.2	72/12	156.00	88.00
730	*Triticum aestivum*	AR 96	K22	3.8	2.8	2.3	120/12	135.71	82.14
731	*Triticum aestivum*	AR 96	K22	5.0	3.0	2.0	120/12	166.67	66.67
732	*Hordeum vulgare-vulgare*	AR 96	K24	5.6	2.8	3.0	140/12	200.00	107.14
733	*Hordeum vulgare-vulgare*	AR 96	K24	5.4	2.8	2.5	140/12	192.86	89.29
734	*Hordeum vulgare-vulgare*	AR 96	K24	6.1	2.8	2.1	126/12	217.86	75.00
735	*Hordeum vulgare-vulgare*	AR 96	K24	5.2	3.0	2.1	126/12	173.33	70.00
736	*Secale cereale*	AR 96	K24	6.3	2.5	2.1	140/12	252.00	84.00
737	*Secale cereale*	AR 96	K24	5.1	1.9	1.8	140/12	268.42	94.74
738	*Secale cereale*	AR 96	K24	5.2	2.2	1.7	140/12	236.36	77.27
739	*Secale cereale*	AR 96	K24	5.4	1.8	1.6	140/12	300.00	88.89
740	*Panicum miliaceum*	AR 96	K24	1.9	1.9	1.4	140/12	100.00	73.68
741	*Panicum miliaceum*	AR 96	K24	1.7	1.6	1.2	140/12	106.25	75.00
742	*Panicum miliaceum*	AR 96	K24	1.9	1.6	1.4	140/12	118.75	87.50
743	*Panicum miliaceum*	AR 96	K24	1.9	1.8	1.1	140/12	105.56	61.11
744	*Panicum miliaceum*	AR 96	K24	1.7	1.7	1.3	140/12	100.00	76.47
745	*Panicum miliaceum*	AR 96	K24	1.8	1.7	1.3	140/12	105.88	76.47
746	*Panicum miliaceum*	AR 96	K24	1.7	1.6	1.3	140/12	106.25	81.25
747	*Triticum aestivum*	AR 96	K24	4.3	2.8	2.4	140/12	153.57	85.71
748	*Triticum aestivum*	AR 96	K24	4.0	3.6	2.1	140/12	111.11	58.33
749	*Triticum aestivum*	AR 96	K24	4.4	2.7	2.1	140/12	162.96	77.78
750	*Triticum aestivum*	AR 96	K24	4.7	3.5	2.2	88/12	134.29	62.86
751	*Triticum aestivum*	AR 96	K24	4.1	2.9	2.3	88/12	141.38	79.31
752	*Hordeum vulgare-vulgare*	AR 96	K29	5.1	2.4	2.3	131/12	212.50	95.83
753	*Hordeum vulgare-vulgare*	AR 96	K29	4.5	2.3	1.7	131/12	195.65	73.91

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
754	*Secale cereale*	AR 96	K29	4.7	2.2	2.3	131/12	213.64	104.55
755	*Secale cereale*	AR 96	K29	5.3	2.6	2.0	131/12	203.85	76.92
756	*Secale cereale*	AR 96	K29	4.9	2.4	1.6	149/12	204.17	66.67
757	*Panicum miliaceum*	AR 96	K29	2.0	1.6	1.2	131/12	125.00	75.00
758	*Panicum miliaceum*	AR 96	K29	1.9	1.5	1.5	131/12	126.67	100.00
759	*Panicum miliaceum*	AR 96	K29	2.5	1.5	1.6	131/12	166.67	106.67
760	*Triticum aestivum*	AR 96	K29	4.2	2.3	1.5	131/12	182.61	65.22
761	*Triticum aestivum*	AR 96	K29	4.2	2.8	2.1	131/12	150.00	75.00
762	*Triticum aestivum*	AR 96	K29	4.6	2.6	1.9	131/12	176.92	73.08
763	*Hordeum vulgare-vulgare*	AR 96	K30	6.0	2.8	2.5	187/12	214.29	89.29
764	*Hordeum vulgare-vulgare*	AR 96	K30	4.5	2.5	2.0	187/12	180.00	80.00
765	*Hordeum vulgare-vulgare*	AR 96	K30	4.5	3.3	2.2	102/12	136.36	66.67
766	*Secale cereale*	AR 96	K30	6.1	1.8	2.2	187/12	338.89	122.22
767	*Secale cereale*	AR 96	K30	5.2	2.3	2.2	187/12	226.09	95.65
768	*Panicum miliaceum*	AR 96	K30	1.9	2.0	1.5	188/12	95.00	75.00
769	*Panicum miliaceum*	AR 96	K30	1.6	1.9	1.1	90/12	84.21	57.89
770	*Triticum aestivum*	AR 96	K30	4.5	3.1	1.5	84/12	145.16	48.39
771	*Triticum aestivum*	AR 96	K30	3.9	2.5	1.8	188/12	156.00	72.00
772	*Triticum aestivum*	AR 96	K30	4.3	2.3	1.9	90/12	186.96	82.61
773	*Panicum miliaceum*	AR 96	K69	2.0	1.8	1.3	111/12	111.11	72.22
774	*Hordeum vulgare-vulgare*	AR 96	K71	5.5	2.3	1.9	76/12	239.13	82.61
775	*Hordeum vulgare-vulgare*	AR 96	K71	5.6	2.5	2.1	76/12	224.00	84.00
776	*Hordeum vulgare-vulgare*	AR 96	K71	4.8	3.0	2.6	76/12	160.00	86.67
777	*Secale cereale*	AR 96	K71	4.8	1.7	1.7	76/12	282.35	100.00
778	*Triticum aestivum*	AR 96	K71	4.8	3.7	2.5	76/12	129.73	67.57
779	*Panicum miliaceum*	AR 96	K71	1.7	1.9	1.1	76/12	89.47	57.89
780	*Panicum miliaceum*	AR 96	K71	1.6	1.6	1.1	76/12	100.00	68.75
781	*Hordeum vulgare-vulgare*	AR 96	K74	6.0	3.1	2.6	104/12	193.55	83.87
782	*Hordeum vulgare-vulgare*	AR 96	K74	5.2	3.3	2.5	104/12	157.58	75.76
783	*Triticum aestivum*	AR 96	K74	4.8	2.9	3.0	104/12	165.52	103.45
784	*Triticum aestivum*	AR 96	K74	4.5	2.3	1.7	104/12	195.65	73.91
785	*Triticum aestivum*	AR 96	K74	4.3	3.2	2.0	104/12	134.38	62.50
786	*Triticum aestivum*	AR 96	K74	5.0	3.2	2.5	104/12	156.25	78.13
787	*Triticum aestivum*	AR 96	K74	3.6	2.1	1.8	104/12	171.43	85.71
788	*Panicum miliaceum*	AR 96	K74	1.8	1.7	1.5	104/12	105.88	88.24
789	*Panicum miliaceum*	AR 96	K74	1.8	1.5	1.5	104/12	120.00	100.00
790	*Panicum miliaceum*	AR 96	K74	2.2	1.9	1.5	104/12	115.79	78.95
791	*Panicum miliaceum*	AR 96	K74	1.9	1.7	1.5	104/12	111.76	88.24
792	*Secale cereale*	AR 96	K74	4.6	1.9	1.7	104/12	242.11	89.47
793	*Secale cereale*	AR 96	K74	4.9	2.0	1.7	104/12	245.00	85.00
794	*Panicum miliaceum*	AR 96	K75	2.2	1.5	1.5	82/12	146.67	100.00
795	*Triticum aestivum*	AR 96	K75	4.2	3.0	2.5	82/12	140.00	83.33
796	*Panicum miliaceum*	AR 103	K54	2.0	1.7	1.3	294/13	117.65	76.47
797	*Panicum miliaceum*	AR 103	K108	1.6	1.7	1.4	420/13	94.12	82.35
798	*Panicum miliaceum*	AR 103	K108	1.7	1.6	1.4	420/13	106.25	87.50
799	*Panicum miliaceum*	AR 103	K108	1.8	1.6	1.5	420/13	112.50	93.75
800	*Secale cereale*	AR 103	K88	5.0	2.0	1.8	395/13	250.00	90.00
801	*Panicum miliaceum*	AR 103	K88	2.1	1.8	1.5	395/13	116.67	83.33
802	*Panicum miliaceum*	AR 103	K88	1.8	1.5	1.3	395/13	120.00	86.67
803	*Hordeum vulgare-vulgare*	AR 103	K94	4.5	2.8	2.2	414/13	160.71	78.57
804	*Hordeum vulgare-vulgare*	AR 103	K94	5	2.6	2.5	414/13	192.31	96.15
805	*Secale cereale*	AR 103	K94	5.2	2.1	2.0	414/13	247.62	95.24
806	*Panicum miliaceum*	AR 103	K94	1.8	1.5	1.4	414/13	120.00	93.33
807	*Triticum aestivum*	AR 103	K94	4.0	3.3	2.7	414/13	121.21	81.82

TAB. 32 | Continuation 8

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
808	*Hordeum vulgare-vulgare*	AR 103	K87	4.4	2.8	2.2	354/13	157.14	78.57
809	*Hordeum vulgare-vulgare*	AR 103	K87	4.4	2.7	2.3	354/13	162.96	85.19
810	*Panicum miliaceum*	AR 103	K87	1.7	1.5	1.4	354/13	113.33	93.33
811	*Panicum miliaceum*	AR 103	K87	2.0	1.6	1.5	354/13	125.00	93.75
812	*Panicum miliaceum*	AR 103	K87	2.0	1.7	1.3	354/13	117.65	76.47
813	*Triticum aestivum*	AR 103	K87	4.0	2.2	2.0	354/13	181.82	90.91
814	*Triticum aestivum*	AR 103	K87	4.8	3.4	2.3	354/13	141.18	67.65
815	*Hordeum vulgare-vulgare*	AR 103	K69	5.6	2.7	2.3	362/13	207.41	85.19
816	*Hordeum vulgare-vulgare*	AR 103	K69	5.5	3.2	2.1	332/13	171.88	65.63
817	*Hordeum vulgare-vulgare*	AR 103	K69	4.3	2.5	2.3	297/13	172.00	92.00
818	*Panicum miliaceum*	AR 103	K69	1.5	1.5	1.4	362/13	100.00	93.33
819	*Panicum miliaceum*	AR 103	K69	2.2	1.6	1.3	332/13	137.50	81.25
820	*Panicum miliaceum*	AR 103	K69	2.0	1.7	1.4	318/13	117.65	82.35
821	*Panicum miliaceum*	AR 103	K69	2.1	1.6	1.2	318/13	131.25	75.00
822	*Secale cereale*	AR 103	K69	4.1	1.6	1.7	332/13	256.25	106.25
823	*Secale cereale*	AR 103	K69	4.2	1.4	1.5	332/13	300.00	107.14
824	*Secale cereale*	AR 103	K69	5.3	1.6	2.3	318/13	331.25	143.75
825	*Triticum aestivum*	AR 103	K69	4.3	3.0	2.4	318/13	143.33	80.00
826	*Triticum aestivum*	AR 103	K69	4.6	3.5	2.9	318/13	131.43	82.86
827	*Hordeum vulgare-vulgare*	AR 103	K99	4.8	2.7	2.0	393/13	177.78	74.07
828	*Hordeum vulgare-vulgare*	AR 103	K99	5.5	2.2	1.6	413/13	250.00	72.73
829	*Hordeum vulgare-vulgare*	AR 103	K99	5.3	2.0	1.9	406/13	265.00	95.00
830	*Panicum miliaceum*	AR 103	K99	2.0	1.7	1.5	393/13	117.65	88.24
831	*Panicum miliaceum*	AR 103	K99	1.5	1.5	1.1	393/13	100.00	73.33
832	*Panicum miliaceum*	AR 103	K99	1.6	1.7	1.3	406/13	94.12	76.47
833	*Panicum miliaceum*	AR 103	K99	1.9	1.5	1.5	378/13	126.67	100.00
834	*Panicum miliaceum*	AR 103	K99	1.7	1.6	1.3	378/13	106.25	81.25
835	*Secale cereale*	AR 103	K99	5.7	2.3	2.0	393/13	247.83	86.96
836	*Secale cereale*	AR 103	K99	5.5	2.6	1.9	413/13	211.54	73.08
837	*Triticum aestivum*	AR 103	K99	4.8	3.6	2.4	393/13	133.33	66.67
838	*Triticum aestivum*	AR 103	K99	4.6	3.3	3.0	413/13	139.39	90.91
839	*Panicum miliaceum*	AR 103	K46	2.0	2.2	1.9	336/13	90.91	86.36
840	*Panicum miliaceum*	AR 103	K46	1.6	1.7	1.3	336/13	94.12	76.47
841	*Panicum miliaceum*	AR 103	K46	1.8	1.5	1.1	336/13	120.00	73.33
842	*Triticum aestivum*	AR 103	K46	5.2	3.2	2.3	336/13	162.50	71.88
843	*Triticum aestivum*	AR 103	K46	4.5	2.8	2.0	336/13	160.71	71.43
844	*Hordeum vulgare-vulgare*	AR 103	K99	4.9	2.5	2.3	338/13	196.00	92.00
845	*Panicum miliaceum*	AR 103	K99	1.9	1.7	1.6	338/13	111.76	94.12
846	*Panicum miliaceum*	AR 103	K99	1.7	1.5	1.5	338/13	113.33	100.00
847	*Panicum miliaceum*	AR 103	K99	1.7	1.4	1.0	388/13	121.43	71.43
848	*Triticum aestivum*	AR 103	K99	4.7	2.9	2.1	388/13	162.07	72.41
849	*Hordeum vulgare-vulgare*	AR 103	K44	4.3	2.2	2.0	382/13	195.45	90.91
850	*Panicum miliaceum*	AR 103	K44	1.8	1.6	1.3	323/13	112.50	81.25
851	*Panicum miliaceum*	AR 103	K44	1.8	1.3	0.9	323/13	138.46	69.23
852	*Panicum miliaceum*	AR 103	K44	1.6	1.5	1.3	392/13	106.67	86.67
853	*Panicum miliaceum*	AR 103	K44	1.9	1.7	1.6	392/13	111.76	94.12
854	*Triticum aestivum*	AR 103	K44	3.9	2.5	2.6	382/13	156.00	104.00
855	*Triticum aestivum*	AR 103	K44	4.3	3.0	3.1	323/13	143.33	103.33
856	*Hordeum vulgare-vulgare*	AR 103	K89	5.1	2.8	2.1	300/13	182.14	75.00
857	*Hordeum vulgare-vulgare*	AR 103	K89	4.2	1.9	2.0	300/13	221.05	105.26
858	*Secale cereale*	AR 103	K89	4.9	2.5	2.3	300/13	196.00	92.00
859	*Panicum miliaceum*	AR 103	K89	1.8	1.8	1.6	300/13	100.00	88.89
860	*Panicum miliaceum*	AR 103	K89	1.6	1.7	1.2	300/13	94.12	70.59
861	*Panicum miliaceum*	AR 103	K89	1.6	1.5	1.2	300/13	106.67	80.00

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
862	*Triticum aestivum*	AR 103	K89	5.0	3.7	2.5	300/13	135.14	67.57
863	*Hordeum vulgare-vulgare*	AR 103	K14	5.7	2.5	1.9	381/13	228.00	76.00
864	*Hordeum vulgare-vulgare*	AR 103	K14	4.8	1.7	2.1	359/13	282.35	123.53
865	*Panicum miliaceum*	AR 103	K14	1.8	1.5	1.7	359/13	120.00	113.33
866	*Panicum miliaceum*	AR 103	K14	2.0	1.6	1.3	359/13	125.00	81.25
867	*Panicum miliaceum*	AR 103	K14	1.5	1.7	1.4	359/13	88.24	82.35
868	*Panicum miliaceum*	AR 103	K14	1.6	1.3	1.4	359/13	123.08	107.69
869	*Triticum aestivum*	AR 103	K14	4.5	3.1	2.5	381/13	145.16	80.65
870	*Hordeum vulgare-vulgare*	AR 103	K12	6.2	2.8	2.3	335/13	221.43	82.14
871	*Hordeum vulgare-vulgare*	AR 103	K12	4.6	2.3	1.6	335/13	200.00	69.57
872	*Hordeum vulgare-vulgare*	AR 103	K12	5.6	2.9	2.5	335/13	193.10	86.21
873	*Hordeum vulgare-vulgare*	AR 103	K12	5.7	3.0	2.6	335/13	190.00	86.67
874	*Hordeum vulgare-vulgare*	AR 103	K12	5.6	2.0	1.9	335/13	280.00	95.00
875	*Hordeum vulgare-vulgare*	AR 103	K12	7.0	3.2	2.5	335/13	218.75	78.13
876	*Hordeum vulgare-vulgare*	AR 103	K12	5.2	3.2	2.5	335/13	162.50	78.13
877	*Hordeum vulgare-vulgare*	AR 103	K12	5.5	2.8	1.8	335/13	196.43	64.29
878	*Hordeum vulgare-vulgare*	AR 103	K12	5.7	2.5	2.2	335/13	228.00	88.00
879	*Hordeum vulgare-vulgare*	AR 103	K12	6.0	3.0	2.1	335/13	200.00	70.00
880	*Panicum miliaceum*	AR 103	K12	1.8	1.5	1.6	335/13	120.00	106.67
881	*Panicum miliaceum*	AR 103	K12	1.7	1.9	1.8	335/13	89.47	94.74
882	*Panicum miliaceum*	AR 103	K12	1.9	1.6	1.3	335/13	118.75	81.25
883	*Panicum miliaceum*	AR 103	K12	1.8	1.6	1.2	335/13	112.50	75.00
884	*Secale cereale*	AR 103	K12	4.3	2.1	1.8	342/13	204.76	85.71
885	*Triticum aestivum*	AR 103	K12	4.0	3.2	2.0	277/13	125.00	62.50
886	*Hordeum vulgare-vulgare*	AR 103	K11	5.0	2.3	2.0	412/13	217.39	86.96
887	*Panicum miliaceum*	AR 103	K11	1.8	1.6	1.4	364/13	112.50	87.50
888	*Panicum miliaceum*	AR 103	K11	2.0	1.5	1.5	364/13	133.33	100.00
889	*Panicum miliaceum*	AR 103	K11	2.1	1.9	1.6	364/13	110.53	84.21
890	*Panicum miliaceum*	AR 103	K11	2.0	1.4	1.0	364/13	142.86	71.43
891	*Panicum miliaceum*	AR 103	K11	1.7	1.5	1.3	364/13	113.33	86.67
892	*Panicum miliaceum*	AR 103	K11	2.0	1.5	1.4	364/13	133.33	93.33
893	*Hordeum vulgare-vulgare*	AR 103	K29	4.9	2.2	1.7	319/13	222.73	77.27
894	*Hordeum vulgare-vulgare*	AR 103	K29	5.0	3.0	2.3	319/13	166.67	76.67
895	*Panicum miliaceum*	AR 103	K29	1.6	1.6	1.3	274/13	100.00	81.25
896	*Panicum miliaceum*	AR 103	K29	1.6	1.5	1.1	274/13	106.67	73.33
897	*Panicum miliaceum*	AR 103	K29	1.5	1.3	1.3	274/13	115.38	100.00
898	*Panicum miliaceum*	AR 103	K29	1.6	1.5	1.2	274/13	106.67	80.00
899	*Triticum aestivum*	AR 103	K29	3.5	2.2	2.0	266/13	159.09	90.91
900	*Triticum aestivum*	AR 103	K29	4.3	3.4	2.5	266/13	126.47	73.53
901	*Triticum aestivum*	AR 103	K29	4.0	2.4	2.0	266/13	166.67	83.33
902	*Hordeum vulgare-vulgare*	AR 103	K75	6.3	3.5	2.5	344/13	180.00	71.43
903	*Panicum miliaceum*	AR 103	K75	1.6	1.6	1.3	344/13	100.00	81.25
904	*Panicum miliaceum*	AR 103	K75	2.0	1.6	1.8	344/13	125.00	112.50
905	*Triticum aestivum*	AR 103	K75	4.0	3.5	3.0	356/13	114.29	85.71
906	*Hordeum vulgare-vulgare*	AR 103	K85	6.1	2.7	2.0	357/13	225.93	74.07
907	*Hordeum vulgare-vulgare*	AR 103	K85	5.7	2.8	(?)	357/13	203.57	.
908	*Secale cereale*	AR 103	K85	4.2	2.3	2.0	357/13	182.61	86.96
909	*Panicum miliaceum*	AR 103	K85	2.0	2.0	1.5	357/13	100.00	75.00
910	*Panicum miliaceum*	AR 103	K85	2.1	1.8	1.5	357/13	116.67	83.33
911	*Panicum miliaceum*	AR 103	K85	1.8	1.5	1.2	341/13	120.00	80.00
912	*Panicum miliaceum*	AR 103	K85	1.8	1.9	1.5	341/13	94.74	78.95
913	*Triticum aestivum*	AR 103	K85	4.3	2.7	1.9	357/13	159.26	70.37
914	*Triticum aestivum*	AR 103	K85	3.5	2.5	1.9	357/13	140.00	76.00
915	*Triticum aestivum*	AR 103	K85	3.7	2.5	2.3	341/13	148.00	92.00

TAB. 32 | Continuation 9

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
916	*Hordeum vulgare-vulgare*	AR 103	K34	5.2	2.8	2.6	347/13	185.71	92.86
917	*Panicum miliaceum*	AR 103	K34	1.4	1.4	1.0	347/13	100.00	71.43
918	*Panicum miliaceum*	AR 103	K34	1.6	1.7	1.3	371/13	94.12	76.47
919	*Hordeum vulgare-vulgare*	AR 103	K84	6.6	2.6	2.1	374/13	253.85	80.77
920	*Hordeum vulgare-vulgare*	AR 103	K84	5.2	3.1	2.6	374/13	167.74	83.87
921	*Panicum miliaceum*	AR 103	K84	1.5	1.7	1.3	374/13	88.24	76.47
922	*Panicum miliaceum*	AR 103	K84	2.0	1.5	1.5	374/13	133.33	100.00
923	*Panicum miliaceum*	AR 103	K84	1.6	1.7	1.2	374/13	94.12	70.59
924	*Secale cereale*	AR 103	K84	5.0	1.8	1.4	374/13	277.78	77.78
925	*Triticum aestivum*	AR 103	K84	4.3	3.5	3.0	374/13	122.86	85.71
926	*Triticum aestivum*	AR 103	K84	4.7	3.0	2.5	374/13	156.67	83.33
927	*Secale cereale*	AR 103	K15	4.5	1.9	1.7	399/13	236.84	89.47
928	*Panicum miliaceum*	AR 103	K15	1.8	1.8	1.4	399/13	100.00	77.78
929	*Panicum miliaceum*	AR 103	K15	1.8	1.7	1.3	399/13	105.88	76.47
930	*Triticum aestivum*	AR 103	K15	4.9	3.5	2.6	410/13	140.00	74.29
931	*Hordeum vulgare-vulgare*	AR 103	K77	6.0	3.4	2.6	291/13	176.47	76.47
932	*Hordeum vulgare-vulgare*	AR 103	K77	6.6	3.1	2.5	291/13	212.90	80.65
933	*Panicum miliaceum*	AR 103	K77	2.0	1.7	1.4	291/13	117.65	82.35
934	*Panicum miliaceum*	AR 103	K77	2.2	1.7	1.9	291/13	129.41	111.76
935	*Panicum miliaceum*	AR 103	K77	2.2	1.5	1.6	291/13	146.67	106.67
936	*Panicum miliaceum*	AR 103	K77	2.3	1.9	1.5	291/13	121.05	78.95
937	*Panicum miliaceum*	AR 103	K77	1.8	1.5	1.2	291/13	120.00	80.00
938	*Panicum miliaceum*	AR 103	K77	2.0	1.7	1.5	291/13	117.65	88.24
939	*Panicum miliaceum*	AR 103	K77	2.1	1.6	1.5	291/13	131.25	93.75
940	*Panicum miliaceum*	AR 103	K77	2.2	1.9	1.6	291/13	115.79	84.21
941	*Panicum miliaceum*	AR 103	K77	1.7	1.7	1.4	291/13	100.00	82.35
942	*Panicum miliaceum*	AR 103	K77	2.1	1.6	1.4	291/13	131.25	87.50
943	*Panicum miliaceum*	AR 103	K77	2.1	1.8	1.7	291/13	116.67	94.44
944	*Panicum miliaceum*	AR 103	K77	1.7	1.9	1.1	291/13	89.47	57.89
945	*Panicum miliaceum*	AR 103	K77	1.8	1.5	1.3	291/13	120.00	86.67
946	*Triticum aestivum*	AR 103	K77	3.0	2.0	1.4	291/13	150.00	70.00
947	*Triticum aestivum*	AR 103	K77	4.2	3.0	2.1	306/13	140.00	70.00
948	*Hordeum vulgare-vulgare*	AR 103	K62	6.6	3.7	2.7	320/13	178.38	72.97
949	*Hordeum vulgare-vulgare*	AR 103	K62	5.2	2.5	2.4	320/13	208.00	96.00
950	*Panicum miliaceum*	AR 103	K62	2.0	1.6	1.4	320/13	125.00	87.50
951	*Panicum miliaceum*	AR 103	K62	2.5	1.5	1.5	320/13	166.67	100.00
952	*Panicum miliaceum*	AR 103	K62	2.0	1.7	1.5	320/13	117.65	88.24
953	*Panicum miliaceum*	AR 103	K62	2.2	1.8	1.5	320/13	122.22	83.33
954	*Panicum miliaceum*	AR 103	K62	2.2	1.6	1.5	320/13	137.50	93.75
955	*Panicum miliaceum*	AR 103	K62	2.0	1.6	1.5	320/13	125.00	93.75
956	*Panicum miliaceum*	AR 103	K62	2.0	1.6	1.4	320/13	125.00	87.50
957	*Panicum miliaceum*	AR 103	K62	2.3	1.5	1.3	320/13	153.33	86.67
958	*Panicum miliaceum*	AR 103	K62	1.6	1.5	1.2	320/13	106.67	80.00
959	*Panicum miliaceum*	AR 103	K62	2.0	1.7	1.7	320/13	117.65	100.00
960	*Secale cereale*	AR 103	K62	4.0	2.0	1.8	320/13	200.00	90.00
961	*Secale cereale*	AR 103	K62	5.2	2.5	2.8	322/13	208.00	112.00
962	*Triticum aestivum*	AR 103	K62	4.5	3.3	2.5	320/13	136.36	75.76
963	*Triticum aestivum*	AR 103	K62	4.5	2.8	2.2	301/13	160.71	78.57
964	*Hordeum vulgare-vulgare*	AR 103	K47	4.6	3.0	2.1	365/13	153.33	70.00
965	*Hordeum vulgare-vulgare*	AR 103	K47	5.9	3.2	2.5	325/13	184.38	78.13
966	*Panicum miliaceum*	AR 103	K47	1.7	1.6	1.5	325/13	106.25	93.75
967	*Panicum miliaceum*	AR 103	K47	1.7	1.6	1.4	325/13	106.25	87.50
968	*Panicum miliaceum*	AR 103	K47	1.7	1.6	1.1	325/13	106.25	68.75
969	*Triticum aestivum*	AR 103	K47	4.1	2.8	2.4	325/13	146.43	85.71

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
970	*Triticum aestivum*	AR 103	K47	4.5	3.5	2.4	325/13	128.57	68.57
971	*Panicum miliaceum*	AR 103	K104	1.7	1.7	1.3	391/13	100.00	76.47
972	*Panicum miliaceum*	AR 103	K104	1.8	1.5	1.4	391/13	120.00	93.33
973	*Panicum miliaceum*	AR 103	K13	1.9	1.7	1.6	418/13	111.76	94.12
974	*Panicum miliaceum*	AR 103	K13	1.8	1.7	1.5	418/13	105.88	88.24
975	*Panicum miliaceum*	AR 103	K13	1.5	1.3	0.8	418/13	115.38	61.54
976	*Triticum aestivum*	AR 103	K13	4.2	3.3	2.5	272/13	127.27	75.76
977	*Secale cereale*	AR 103	K110	4.2	2.0	2.2	421/13	210.00	110.00
978	*Panicum miliaceum*	AR 103	K110	1.9	1.6	1.5	421/13	118.75	93.75
979	*Panicum miliaceum*	AR 103	K110	2.1	1.7	1.6	421/13	123.53	94.12
980	*Panicum miliaceum*	AR 103	K110	1.9	1.5	1.4	421/13	126.67	93.33
981	*Triticum aestivum*	AR 103	K110	4.2	2.6	2.8	421/13	161.54	107.69
982	*Triticum aestivum*	AR 103	K110	4.6	3.0	2.4	421/13	153.33	80.00
983	*Triticum aestivum*	AR 103	K110	5.0	2.8	2.4	421/13	178.57	85.71
984	*Triticum aestivum*	AR 103	K110	4.5	3.1	2.3	421/13	145.16	74.19
985	*Hordeum vulgare-vulgare*	AR 103	K19	4.8	2.3	2.3	415/13	208.70	100.00
986	*Panicum miliaceum*	AR 103	K19	2.1	1.6	1.3	415/13	131.25	81.25
987	*Panicum miliaceum*	AR 103	K19	2.2	1.8	1.6	415/13	122.22	88.89
988	*Hordeum vulgare-vulgare*	AR 103	K86	6.1	3.5	2.4	263/13	174.29	68.57
989	*Hordeum vulgare-vulgare*	AR 103	K86	6.5	3.0	2.5	263/13	216.67	83.33
990	*Hordeum vulgare-vulgare*	AR 103	K86	5.1	2.4	1.8	263/13	212.50	75.00
991	*Hordeum vulgare-vulgare*	AR 103	K86	6.9	3.0	2.6	268/13	230.00	86.67
992	*Hordeum vulgare-vulgare*	AR 103	K86	5.1	2.9	2.1	268/13	175.86	72.41
993	*Hordeum vulgare-vulgare*	AR 103	K86	5.7	2.7	2.5	268/13	211.11	92.59
994	*Hordeum vulgare-vulgare*	AR 103	K86	4.3	2.2	2.1	268/13	195.45	95.45
995	*Hordeum vulgare-vulgare*	AR 103	K86	6.7	2.6	2.2	268/13	257.69	84.62
996	*Secale cereale*	AR 103	K86	5.2	2.3	1.9	263/13	226.09	82.61
997	*Secale cereale*	AR 103	K86	6.5	2.3	2.4	263/13	282.61	104.35
998	*Secale cereale*	AR 103	K86	5.0	2.3	2.0	263/13	217.39	86.96
999	*Secale cereale*	AR 103	K86	6.0	2.5	2.5	263/13	240.00	100.00
1000	*Secale cereale*	AR 103	K86	4.9	2.1	1.7	263/13	233.33	80.95
1001	*Secale cereale*	AR 103	K86	4.8	2.0	1.9	263/13	240.00	95.00
1002	*Panicum miliaceum*	AR 103	K86	1.7	1.6	1.3	263/13	106.25	81.25
1003	*Panicum miliaceum*	AR 103	K86	1.9	1.6	1.4	263/13	118.75	87.50
1004	*Panicum miliaceum*	AR 103	K86	1.7	1.7	1.3	263/13	100.00	76.47
1005	*Panicum miliaceum*	AR 103	K86	1.6	1.7	1.3	263/13	94.12	76.47
1006	*Panicum miliaceum*	AR 103	K86	1.9	1.7	1.2	263/13	111.76	70.59
1007	*Panicum miliaceum*	AR 103	K86	1.5	1.6	1.3	263/13	93.75	81.25
1008	*Panicum miliaceum*	AR 103	K86	1.7	1.7	1.2	263/13	100.00	70.59
1009	*Panicum miliaceum*	AR 103	K86	1.8	1.5	1.3	263/13	120.00	86.67
1010	*Panicum miliaceum*	AR 103	K86	1.9	1.6	1.2	263/13	118.75	75.00
1011	*Panicum miliaceum*	AR 103	K86	1.6	1.5	1.3	263/13	106.67	86.67
1012	*Panicum miliaceum*	AR 103	K86	2.1	1.4	1.5	263/13	150.00	107.14
1013	*Panicum miliaceum*	AR 103	K86	1.7	1.6	1.4	278/13	106.25	87.50
1014	*Panicum miliaceum*	AR 103	K86	1.7	1.7	1.5	278/13	100.00	88.24
1015	*Panicum miliaceum*	AR 103	K86	2.1	1.4	1.4	278/13	150.00	100.00
1016	*Panicum miliaceum*	AR 103	K86	2.0	1.7	1.5	278/13	117.65	88.24
1017	*Triticum aestivum*	AR 103	K86	3.9	3.3	2.5	278/13	118.18	75.76
1018	*Triticum aestivum*	AR 103	K86	4.2	3.5	2.9	263/13	120.00	82.86
1019	*Triticum aestivum*	AR 103	K86	5.0	2.6	2.2	263/13	192.31	84.62
1020	*Triticum aestivum*	AR 103	K86	5.2	3.0	2.2	263/13	173.33	73.33
1021	*Triticum aestivum*	AR 103	K86	4.3	2.6	2.3	263/13	165.38	88.46
1022	*Triticum aestivum*	AR 103	K86	4.6	2.9	2.0	263/13	158.62	68.97
1023	*Triticum aestivum*	AR 103	K86	3.6	2.9	2.5	263/13	124.14	86.21

TAB. 32 | Continuation 10

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
1024	*Triticum aestivum*	AR 103	K86	3.6	2.5	2.0	263/13	144.00	80.00
1025	*Hordeum vulgare-vulgare*	AR 103	K1	5.7	3.4	2.3	400/13	167.65	67.65
1026	*Hordeum vulgare-vulgare*	AR 103	K1	5.3	2.8	2.4	326/13	189.29	85.71
1027	*Hordeum vulgare-vulgare*	AR 103	K1	5.2	2.5	1.8	334/13	208.00	72.00
1028	*Hordeum vulgare-vulgare*	AR 103	K1	5.0	2.6	2.6	396/13	192.31	100.00
1029	*Hordeum vulgare-vulgare*	AR 103	K1	5.7	3.4	3.0	419/13	167.65	88.24
1030	*Secale cereale*	AR 103	K1	4.2	1.7	1.8	352/13	247.06	105.88
1031	*Secale cereale*	AR 103	K1	3.8	2.8	1.6	400/13	135.71	57.14
1032	*Secale cereale*	AR 103	K1	6.2	2.5	2.1	273/13	248.00	84.00
1033	*Panicum miliaceum*	AR 103	K1	1.8	1.6	1.3	386/13	112.50	81.25
1034	*Panicum miliaceum*	AR 103	K1	1.7	1.8	1.2	386/13	94.44	66.67
1035	*Panicum miliaceum*	AR 103	K1	1.7	1.7	1.2	386/13	100.00	70.59
1036	*Panicum miliaceum*	AR 103	K1	1.5	1.7	1.5	386/13	88.24	88.24
1037	*Panicum miliaceum*	AR 103	K1	2.3	1.5	1.7	386/13	153.33	113.33
1038	*Panicum miliaceum*	AR 103	K1	1.7	1.6	1.2	334/13	106.25	75.00
1039	*Panicum miliaceum*	AR 103	K1	1.7	1.7	1.0	334/13	100.00	58.82
1040	*Panicum miliaceum*	AR 103	K1	1.6	1.7	1.1	334/13	94.12	64.71
1041	*Panicum miliaceum*	AR 103	K1	1.8	1.5	1.5	396/13	120.00	100.00
1042	*Panicum miliaceum*	AR 103	K1	1.7	1.4	1.0	396/13	121.43	71.43
1043	*Triticum aestivum*	AR 103	K1	3.5	3.0	2.7	287/13	116.67	90.00
1044	*Triticum aestivum*	AR 103	K1	3.7	2.4	2.0	380/13	154.17	83.33
1045	*Triticum aestivum*	AR 103	K1	3.8	2.3	1.8	380/13	165.22	78.26
1046	*Triticum aestivum*	AR 103	K1	4.3	3.2	2.3	380/13	134.38	71.88
1047	*Triticum aestivum*	AR 103	K1	3.8	2.6	2.5	315/13	146.15	96.15
1048	*Hordeum vulgare-vulgare*	AR 103	K30	5.1	2.8	2.3	269/13	182.14	82.14
1049	*Hordeum vulgare-vulgare*	AR 103	K30	5.6	2.9	2.1	269/13	193.10	72.41
1050	*Hordeum vulgare-vulgare*	AR 103	K30	4.9	2.8	1.7	372/13	175.00	60.71
1051	*Hordeum vulgare-vulgare*	AR 103	K30	4.7	3.3	1.9	372/13	142.42	57.58
1052	*Hordeum vulgare-vulgare*	AR 103	K30	4.2	2.2	2.2	372/13	190.91	100.00
1053	*Secale cereale*	AR 103	K30	5.0	2.1	1.9	269/13	238.10	90.48
1054	*Secale cereale*	AR 103	K30	4.4	2.3	1.8	269/13	191.30	78.26
1055	*Secale cereale*	AR 103	K30	4.6	1.8	1.8	269/13	255.56	100.00
1056	*Secale cereale*	AR 103	K30	4.9	2.5	2.1	269/13	196.00	84.00
1057	*Panicum miliaceum*	AR 103	K30	1.8	1.6	1.3	269/13	112.50	81.25
1058	*Panicum miliaceum*	AR 103	K30	2.2	1.4	1.4	269/13	157.14	100.00
1059	*Panicum miliaceum*	AR 103	K30	1.6	1.5	1.4	269/13	106.67	93.33
1060	*Panicum miliaceum*	AR 103	K30	1.8	1.5	1.2	269/13	120.00	80.00
1061	*Panicum miliaceum*	AR 103	K30	1.9	1.6	1.5	269/13	118.75	93.75
1062	*Panicum miliaceum*	AR 103	K30	1.9	1.5	1.5	269/13	126.67	100.00
1063	*Panicum miliaceum*	AR 103	K30	2.0	1.6	1.4	269/13	125.00	87.50
1064	*Panicum miliaceum*	AR 103	K30	1.5	1.8	1.4	269/13	83.33	77.78
1065	*Panicum miliaceum*	AR 103	K30	1.9	1.6	1.3	269/13	118.75	81.25
1066	*Panicum miliaceum*	AR 103	K30	2.1	1.5	1.3	269/13	140.00	86.67
1067	*Triticum aestivum*	AR 103	K30	5.2	3.3	2.5	269/13	157.58	75.76
1068	*Triticum aestivum*	AR 103	K30	4.1	2.7	2.4	269/13	151.85	88.89
1069	*Triticum aestivum*	AR 103	K30	4.2	2.5	1.8	269/13	168.00	72.00
1070	*Triticum aestivum*	AR 103	K30	4.5	3.3	2.2	288/13	136.36	66.67
1071	*Triticum aestivum*	AR 103	K30	4.3	3.1	2.9	350/13	138.71	93.55
1072	*Hordeum vulgare-vulgare*	AR 103	K98	5.6	3.1	2.3	385/13	180.65	74.19
1073	*Hordeum vulgare-vulgare*	AR 103	K98	4.2	2.1	2.0	403/13	200.00	95.24
1074	*Secale cereale*	AR 103	K98	5.2	2.3	2.4	383/13	226.09	104.35
1075	*Panicum miliaceum*	AR 103	K98	1.6	1.7	1.2	383/13	94.12	70.59
1076	*Panicum miliaceum*	AR 103	K98	1.7	1.3	1.0	383/13	130.77	76.92
1077	*Panicum miliaceum*	AR 103	K98	2.0	2.0	1.6	383/13	100.00	80.00

No	Taxon	Location	Context	Length	Width	Thickness	Abč	Length index	Thickness index
1078	*Panicum miliaceum*	AR 103	K98	2.0	1.5	1.7	383/13	133.33	113.33
1079	*Triticum aestivum*	AR 103	K98	4.5	2.7	2.3	383/13	166.67	85.19
1080	*Triticum aestivum*	AR 103	K98	4.5	3.5	2.5	383/13	128.57	71.43
1081	*Triticum aestivum*	AR 103	K98	3.7	2.6	2.2	383/13	142.31	84.62
1082	*Hordeum vulgare-vulgare*	AR 103	K74	4.2	2.2	1.9	353/13	190.91	86.36
1083	*Hordeum vulgare-vulgare*	AR 103	K74	5.1	2.5	2.6	285/13	204.00	104.00
1084	*Secale cereale*	AR 103	K74	4.3	2.0	1.7	317/13	215.00	85.00
1085	*Panicum miliaceum*	AR 103	K74	1.8	1.8	1.2	317/13	100.00	66.67
1086	*Panicum miliaceum*	AR 103	K74	1.8	1.4	1.4	317/13	128.57	100.00
1087	*Panicum miliaceum*	AR 103	K74	2.1	1.5	1.3	317/13	140.00	86.67
1088	*Panicum miliaceum*	AR 103	K74	2.2	1.5	1.5	317/13	146.67	100.00
1089	*Triticum aestivum*	AR 103	K74	3.8	2.8	2.1	317/13	135.71	75.00
1090	*Triticum aestivum*	AR 103	K74	5.1	3.3	2.5	353/13	154.55	75.76
1091	*Panicum miliaceum*	AR 103	K48	1.7	1.5	1.3	358/13	113.33	86.67
1092	*Panicum miliaceum*	AR 103	K48	2.2	1.6	1.4	358/13	137.50	87.50
1093	*Panicum miliaceum*	AR 103	K48	1.6	1.5	1.3	358/13	106.67	86.67
1094	*Panicum miliaceum*	AR 103	K48	1.6	1.6	1.1	358/13	100.00	68.75
1095	*Triticum aestivum*	AR 103	K48	4.6	3.4	3.0	282/13	135.29	88.24

TAB. 33 | Classification of physical properties of wild species used in the taphonomic analyses.

Taxon	Category by G. Jones (1984)	Category by Fuller/Stevens (2009)
Aethusa cynapium	SFH	small
Agrimonia eupatoria	SFH	small
Agrostemma githago	SFH	small
Althea spp.	BFH	big
Anchusa officinalis	BFH	big
Arctium minus	BFH	big
Arenaria serpyllifolia	SFH	small
Arnoseris minima	BFH	big
Artemisia campestris	SFH	small
Artemisia vulgaris	SFH	small
Asperula arvensis	BFH	big
Atriplex sp.	SFH	small
Avena/Bromus	BFH	big
Barbarea vulgaris	SFH	small
Brassica rapa	BFH	big
Brassica/Sinapis	SFH	small
Bromus arvensis	SFH	small
Bromus secalinus	BFH	big
Bupleurum rotundifolium	SFL	small
Capsella bursa-pastoris/ Lep rud Barbarea	SFH	small
Cardaria draba	SFH	small
Carduus crispus	BFH	big
Caucalis platycarpos	SFH	small
Centaurea cyanus	BHH	big
Centaurea/Carduus/ Cirsium	BFH	big
Diplotaxis muralis	SFH	small
Echinochloa crus-galli	SFH	small
Fallopia convolvulus	BFH	big
Fallopia dumetorum	BFH	big
Fragaria cf. moschata	BFH	big
Fragaria vesca	SFH	small
Fumaria officinalis	BFH	big
Galeopsis angustifolia	SHH	big
Galeopsis cf. ladanum	BFH	big
Galeopsis sp.	SHH	big
Galium aparine	BFH	big
Galium mollugo	SFH	small
Galium palustre	BFH	big
Galium spurium	SHH	small
Galium/Asperula	SHH	small
Genista pilosa	BFH	big
Geranium cf. pratense	BFH	big
Glaucium flavum	SFH	big
Glechoma hederacea	SHH	small
Gypsophila muralis	SFH	small
Hyoscyamus niger	SFH	small
Chelidonium majus	SFH	small
Chenopodium album agg	SHH	small
Chenopodium hybridum	SFH	small
Inula oculus-christi	SFH	small
Inula salicina	SFH	small
Lamium amplexicaule	SFH	small
Lepidium campestre	SFH	big
Lepidium ruderale	BHH	big
Linaria vulgaris	SFH	small
Lithospermum arvense	BFH	big
Lycopus europaeus	BFH	big
Malva moschata	SFH	small
Marrubium vulgare	BFH	big
Medicago falcata	SHH	small
Medicago lupulina	SHH	small
Medicago sp.	SHH	small
Melilotus officinalis/ alba	SHL	small
Melilotus sp.	SHL	small
Mentha cf. arvensis	SFH	small
Mentha/Salvia	SFH	small
Neslia paniculata	SHH	small
Origanum vulgare/ Satureja vulgare	SFH	small
Oxalis europaea	SFH	small
Papaver cf. argemone	SHL	small
Papaver rhoeas	SFH	small
Phyteuma spicatum/orbiculare	SFH	small
Plantago lanceolata	SFH	small
Polycnemum arvense	SFH	small
Polygonum aviculare	SFH	small
Polygonum hydropiper	SFH	small
Polygonum lapathifolium	SFH	small
Polygonum persicaria	SFH	small
Portulaca oleracea	SFH	small
Potentilla reptans	SFH	small
Potentilla argentea	SFH	small
Potentilla erecta	SFH	small
Potentilla pulchella	SFH	big
Potentilla recta	SFH	small
Prunella vulgaris	SFH	small
Ranunculus acris	SFH	small
Ranunculus cf. bulbosum	SFL	small
Ranunculus repens	SFH	small
Reseda lutea	SFH	small
Rumex acetosa	BFH	big
Rumex acetosella	SFH	small
Rumex conglomeratus	BFH	big
Rumex crispus/ obtusifolius	BFH	big
Salsola kali	SFH	small
Scleranthus sp.	SFH	small
Setaria spp.	SFH	small
Setaria viridis/verticillata	SFH	small
Sideritis montana	SFH	small
Silene noctiflora	SFH	small

Taxon	Category by G. Jones (1984)	Category by Fuller/Stevens (2009)
Silene nutans	SFH	small
Silene vulgaris	SFH	small
Sinapis sp.	SFH	small
Sisymbrium cf. altissima	SFH	small
Solanum nigrum	SHH	small
Sonchus arvensis	BFH	big
Stachys arvensis	SFH	small
Stachys palustris	SFH	small
Stellaria graminea	SFH	small
Stellaria graminea/ palustris	SFH	small
Stellaria media	SFH	small
Stellaria pallida	SFH	small
Thalictrum flavum	SFH	small
Thalictrum minus	SFH	small
Thalictrum sp.	SFH	small
Thlaspi arvense	SFH	small
Trifolium sp.	BHH	big
Urtica dioica	SFH	small
Verbena officinalis	SFH	small
Veronica hederifolia	SFL	small
Vicia tetrasperma	BFH	big
Vicia hirsuta	BFH	big
Viola arvensis	SFH	small
Xanthium strumarium	SFL	small

TAB. 34 | Classification of ecological properties of wild species used in environmental analyses.

Taxon	Site	L	T	K	Pv	Pd	Pr	Fk	Life form	Class
Acer campestre	Woody plants	5	6	4	2.5	i	4	3	Tree	*Querco-Fagetea*
Aethusa cynapium	Field wheet	6	6	3	3	3.5	4.5	5*	Annual	*Artemisietea vulgaris*
Agrimonia eupatoria	Meadow	7	6	4	2.5	3	i	5*	Rerennial	*Querco-Fagetea*
Agrostemma githago	Field wheet	7	i	i	3	3.5	i	4	Annual	*Secalietea*
Ajuga reptans	Forest	6	i	2	3	i	i	3	Rerennial	*Molinio-Arrhenatheretea*
Alisma plantago-aquatica	Water	7	5	i	5	3.5	i	5	Rerennial	*Phragmitetea*
Altea cf. officinalis	Meadow	6	7	6	3.5	2.5	i	6	Rerennial	*Phragmitetea*
Anchusa officinalis	Meadow/ruderal	9	7	5	1.5	2.5	4	4*	Rerennial	*Artemisietea vulgaris*
Arctium minus	Field wheet	9	5	3	3	5	4	6	Rerennial	*Artemisietea vulgaris*
Arenaria serpyllifolia	Field wheet	8	i	i	2.5	i	i	3*	Annual	*Secalietea*
Arnoseris minima	Field wheet	7	6	2	2.5	2.5	2.5	4*	Annual	*Secalietea*
Artemisia campestris	Meadow	9	6	5	2	1.5	4	5*	Rerennial	*Sedo-Scleranthetea*
Artemisia vulgaris	Field wheet	7	6	i	2.5	3.5	i	6	Rerennial	*Artemisietea vulgaris*
Asperula arvensis	Field wheet	7	7	3	i	2	5	3*	Annual	*Secalietea*
Atropa bella - donna	Forest	6	i	2	3	4.5	4	5	Rerennial	*Epilobietea angustifolii*
Barbarea vulgaris	Ruderal	8	6	3	3.5	3.5	i	3	Rerennial	*Phragmitetea*
Berula erecta	Hydrophilic	8	6	3	5	4	i	5	Rerennial	*Phragmitetea*
Betula pendula	Woody plants	7	i	i	2.5	2.5	i	3	Tree	*Querco-Fagetea*
Brassica nigra	Field wheet	8	7	5	3.5	3.5	3.5	4*	Annual	*Chenopodietea*
Brassica rapa	Field wheet	i	i	i	3	4	3	3*	Annual	*Chenopodietea*
Bromus arvensis	Field wheet	6	6	4	2.5	2.5	4	5	Annual	*Secalietea*
Bromus secalinus	Field wheet	6	6	3	3	2.5	2.5	5	Annual	*Secalietea*
Bupleurum rotundifolium	Field wheet	8	7	4	2	3	4.5	3	Annual	*Secalietea*
Capsella bursa-pastoris	Field wheet	7	i	i	i	3.5	i	3*	Annual	*Chenopodietea*
Cardaria draba	Field wheet	8	7	7	2.5	2.5	3.5	3	Rerennial	*Secalietea*
Carduus crispus	Field wheet	7	6	i	3.5	5	i	6	Rerennial	*Artemisietea vulgaris*
Carpinus betulus	Woody plants	4	6	4	3	i	i	3	Tree	*Querco-Fagetea*
Caucalis platycarpos	Field wheet	6	6	5	2	2.5	5	4	Annual	*Secalietea*
Centaurea cyanus	Field wheet	7	6	5	2.5	3.5	i	4*	Annual	*Secalietea*
Cerasus avium	Gathered crops	4	5	4	3	3.5	4	3	Tree	*Querco-Fagetea*
Ceratophyllum demersum	Water	6	7	i	6	4	4.5	5*	Rerennial	*Lemnetea*
Chelidonium majus	Ruderal	6	6	i	3	4.5	i	3*	Rerennial	*Artemisietea vulgaris*
Chenopodium album agg.	Field wheet	9	7	7	2.5	4	i	6	Annual	*Chenopodietea*
Chenopodium hybridum	Field wheet	7	6	7	3	4	i	*	Annual	*Chenopodietea*
Cornus mas	Gathered crops	6	7	4	2.5	3	4	1	Shrub	*Querco-Fagetea*
Cornus sanguinea	Woody plants	7	5	4	3	3	4	4	Shrub	*Querco-Fagetea*
cf. Corylus avellana	Gathered crops	6	5	3	2.5	i	i	1	Shrub	*Querco-Fagetea*
Diplotaxis muralis	Field wheet	8	8	3	2	3	4	5*	Annual	*Chenopodietea*
Echinochloa crus-galli	Field wheet	6	7	5	3.5	3.5	i	5*	Annual	*Chenopodietea*
Fallopia convolvulus	Field wheet	7	6	5	i	i	i	6	Annual	*Chenopodietea*
Fallopia dumetorum	Field wheet	6	6	4	3	2.5	i	6	Annual	*Artemisietea vulgaris*
Fragaria cf. moschata	Meadow	6	6	4	3	3	3	4	Rerennial	*Querco-Fagetea*
Fragaria vesca	Meadow	7	i	5	3	3	i	3	Rerennial	*Epilobietea angustifolii*
Fumaria officinalis	Field wheet	6	6	3	3	3	3	3*	Annual	*Chenopodietea*
Galeopsis angustifolia	Field wheet	8	7	4	2	2	4.5	5*	Annual	*Secalietea*
Galeopsis cf. ladanum	Field wheet	8	5	5	2	2	4	5*	Annual	*Secalietea*
Galeopsis tetrahit	Field wheet	7	i	3	3	3	i	6	Annual	*Epilobietea angustifolii*
Galium aparine	Field wheet	7	6	3	3.5	4.5	i	4*	Annual	*Chenopodietea*
Galium mollugo	Field wheet	7	6	3	2.5	i	i	4*	Rerennial	*Molinio-Arrhenatheretea*
Galium palustre	Field wheet	6	5	3	4.5	i	4.5	3	Rerennial	*Phragmitetea*
Galium spurium	Field wheet	7	i	5	2.5	2.5	3.5	4*	Annual	*Secalietea*
Genista pilosa	Meadow	7	5	4	2.5	1.5	i	4	Shrub	*Festuco-Brometea*
Geranium cf. pratense	Field wheet	8	6	5	2.5	3	4	5*	Rerennial	*Molinio-Arrhenatheretea*
Glaucium flavum	Field wheet	9	6	6	2	3	3	5	Rerennial	*Artemisietea vulgaris*
Glechoma hederacea	Field wheet	6	6	3	2.5	2.5	i	2	Rerennial	*Salicetea purpureae*

Taxon	Site	L	T	K	Pv	Pd	Pr	Fk	Life form	Class
Gypsophila muralis	Field wheet	8	6	5	4	2.5	3.5	5*	Annual	*Isoeto-Nanojuncetea*
Humulus lupulus	Gathered crops	7	6	3	3.5	3.5	3	6	Shrub	*Querco-Fagetea*
Hyoscyamus niger	Ruderal	8	6	i	2.5	4.5	i	5*	Rerennial	*Artemisietea vulgaris*
cf. Juniperus communis	Gathered crops	8	i	i	1.5	2	i	3	Shrub	*Erico-Pinetea*
Inula oculus-christi	Meadow	8	6	6	2.5	i	4	5	Rerennial	*Festuco-Brometea*
Inula salicina	Meadow	8	6	6	i	2.5	4.5	5	Rerennial	*Molinio-Arrhenatheretea*
Iris pseudacorus	Hydrophilic	7	6	3	5	3.5	i	4	Rerennial	*Phragmitetea*
Lamium amplexicaule	Field wheet	6	6	5	3	3.5	i	1*	Annual	*Chenopodietea*
Lamium maculatum	Forest	5	i	4	3	i	i	5	Rerennial	*Molinio-Arrhenatheretea*
Lepidium campestre	Field wheet	7	6	3	2.5	3	4	5	Annual	*Chenopodietea*
Lepidium ruderale	Field wheet	9	6	7	2.5	3.5	i	4	Annual	*Chenopodietea*
Linaria vulgaris	Field wheet	8	6	5	2.5	3	4	5*	Rerennial	*Artemisietea vulgaris*
Lithospermum arvense	Field wheet	5	6	5	2.5	2.5	4.5	4	Rerennial	*Querco-Fagetea*
Lycopus europaeus	Field wheet	7	6	5	5	3	3.5	5	Rerennial	*Phragmitetea*
Malus sylvestris	Gathered crops	7	6	i	i	4	4	4*	Tree	*Querco-Fagetea*
Malva moschata	Meadow	8	6	3	2.5	3.5	4	4	Rerennial	*Molinio-Arrhenatheretea*
Marrubium vulgare	Field wheet	9	7	5	2.5	3.5	4	5	Rerennial	*Artemisietea vulgaris*
Medicago cf. sativa	Field wheet	8	6	6	2.5	2.5	4	4*	Rerennial	*Molinio-Arrhenatheretea*
Medicago falcata	Field wheet	8	6	7	2.5	2	4.5	5	Rerennial	*Festuco-Brometea*
Medicago lupulina	Field wheet	7	5	i	2.5	i	4.5	4*	Rerennial	*Secalietea*
Melilotus albus	Field wheet	9	6	6	2.5	2.5	i	4	Annual	*Artemisietea vulgaris*
Melilotus altissimus	Field wheet	8	6	5	3	2	4	6	Rerennial	*Artemisietea vulgaris*
Mentha cf. arvensis	Field wheet	7	i	i	3.5	3.5	i	6	Rerennial	*Chenopodietea*
Neslia paniculata	Field wheet	6	6	5	2.5	2.5	4	4	Annual	*Secalietea*
Oenanthe aquatica	Hydrophilic	7	6	5	5	3.5	4	4*	Rerennial	*Phragmitetea*
Papaver cf. argemone	Field wheet	6	6	2	2	2.5	2.5	4	Annual	*Chenopodietea*
Papaver rhoeas	Field wheet	6	6	3	2.5	3.5	4	4	Annual	*Secalietea*
Phleum pratense	Meadow	7	6	5	3	3	i	3*	Rerennial	*Molinio-Arrhenatheretea*
Physalis alkekengi	Gathered crops	5	7	5	2.5	3.5	3.5	4*	Rerennial	*Querco-Fagetea*
Plantago lanceolata	Field wheet	6	i	3	i	3.5	i	4*	Rerennial	*Plantaginetea maioris*
Poa palustris	Hydrophilic	7	5	5	i	3.5	4	5	Rerennial	*Phragmitetea*
Polycnemum arvense	Field wheet	8	8	7	2.5	2.5	3	6	Annual	*Secalietea*
Polygonum aviculare	Field wheet	7	6	i	2.5	i	i	6	Annual	*Plantaginetea maioris*
Polygonum hydropiper	Field wheet	7	6	i	3.5	3	3	5*	Annual	*Chenopodietea*
Polygonum lapathifolium	Field wheet	6	6	8	3.5	3.5	i	5	Annual	*Chenopodietea*
Portulaca oleracea	Field wheet	7	8	3	2	3.5	i	5*	Annual	*Chenopodietea*
Potamogeton crispus	Water	6	5	3	6	3	3.5	4	Rerennial	*Lemnetea*
Potamogeton natans	Water	6	5	5	6	2.5	3.5	5	Rerennial	*Lemnetea*
Potamogeton pusillus	Water	6	5	5	6	3.5	3	5	Rerennial	*Lemnetea*
Potentilla reptans	Field wheet	6	6	3	3.5	2.5	i	5	Rerennial	*Plantaginetea maioris*
Potentilla argentea	Meadow	7	7	4	1.5	2.5	i	4*	Rerennial	*Sedo-Scleranthetea*
Potentilla collina	Meadow	9	8	4	2	2	5	4	Rerennial	*Festuco-Brometea*
Potentilla erecta	Meadow	6	i	3	i	1.5	i	4*	Rerennial	*Scheuchzerio-Caricetea fuscae*
Potentilla recta	Meadow	9	7	5	1.5	2	i	5	Rerennial	*Festuco-Brometea*
Potentilla supina	Hydrophilic	7	7	5	4.5	2.5	3	5*	Rerennial	*Plantaginetea maioris*
Prunella vulgaris	Field wheet	7	i	3	3.5	i	i	4*	Rerennial	*Molinio-Arrhenatheretea*
Prunus padus	Woody plants	5	5	3	4	3.5	3.5	3	Tree	*Querco-Fagetea*
Prunus spinosa	Gathered crops	7	5	5	i	2.5	i	3	Shrub	*Querco-Fagetea*
Ranunculus acris	Field wheet	7	i	3	i	i	i	4*	Rerennial	*Molinio-Arrhenatheretea*
Ranunculus cf. bulbosum	Meadow	8	6	3	2	2	i	4*	Rerennial	*Festuco-Brometea*
Ranunculus lanuginosus	Forest	3	6	4	3.5	3.5	i	4	Rerennial	*Querco-Fagetea*
Ranunculus polyanthemos	Meadow	6	6	5	2	2	i	4	Rerennial	*Molinio-Arrhenatheretea*
Ranunculus repens	Field wheet	6	i	i	3.5	i	i	4*	Rerennial	*Betulo-Adenostyletea*
Reseda lutea	Ruderal	7	6	3	2.5	2	4	4*	Rerennial	*Artemisietea vulgaris*

TAB. 34 | Continuation 1

Taxon	Site	L	T	K	Pv	Pd	Pr	Fk	Life form	Class
Rubus caesius	Gathered crops	6	5	4	i	3.5	i	5*	Shrub	*Querco-Fagetea*
Rubus fruticosus	Gathered crops	6	5	4	3	4	3	5*	Shrub	*Querco-Fagetea*
Rubus idaeus	Gathered crops	7	i	i	3	3.5	i	4	Shrub	*Epilobietea angustifolii*
Rumex acetosa	Field wheet	8	i	i	i	2.5	i	4	Rerennial	*Molinio-Arrhenatheretea*
Rumex acetosella	Field wheet	8	5	3	i	1.5	1.5	3*	Rerennial	*Sedo-Scleranthetea*
Rumex aquaticus	Hydrophilic	7	6	7	3.5	3.5	3.5	6	Rerennial	*Phragmitetea*
Rumex cf. palustris	Hydrophilic	8	7	3	3.5	4	3.5	6	Annual	*Plantaginetea maioris*
Rumex conglomeratus	Ruderal	8	6	3	i	3.5	i	5	Rerennial	*Plantaginetea maioris*
Rumex crispus/obtusifolius	Field wheet	7	5	3	i	3.5	i	5	Rerennial	*Plantaginetea maioris*
Rumex maritimus	Hydrophilic	8	7	i	3.5	4.5	4	6	Annual	*Bidentetea tripartiti*
Salsola kali	Meadow	9	7	8	1.5	2.5	4	6	Annual	*Chenopodietea*
Sambucus ebulus	Gathered crops	7	5	3	3	3.5	i	6	Shrub	*Epilobietea angustifolii*
Sambucus nigra	Gathered crops	8	6	3	3	4.5	i	5	Shrub	*Querco-Fagetea*
Saponaria officinalis	Field wheet	7	6	3	i	2.5	3.5	5	Rerennial	*Querco-Fagetea*
Setaria glauca	Field wheet	7	7	4	3	3	3	6	Annual	*Chenopodietea*
Setaria cf. italica	Field wheet	8	8	5	3	4.5	4	6	Annual	*Chenopodietea*
Setaria viridis/verticillata	Field wheet	7	7	4	3	3.5	i	6*	Annual	*Chenopodietea*
Sideritis montana	Meadow	8	8	5	2	2	5	5	Annual	*Chenopodietea*
Silene noctiflora	Field wheet	7	6	4	2.5	3.5	i	6	Annual	*Secalietea*
Silene nutans	Meadow	7	i	5	2.5	2	i	5	Rerennial	*Trifolio-Geranietea sanguinei*
Silene vulgaris	Ruderal	8	i	i	2.5	i	3.5	4*	Rerennial	*Festuco-Brometea*
cf. Sinapis arvensis	Field wheet	7	5	i	2.5	3.5	4	5	Annual	*Secalietea*
Sisymbrium cf. altissima	Ruderal	8	6	7	2	3.5	i	4	Annual	*Chenopodietea*
Solanum dulcamara	Forest	7	5	i	4.5	3.5	i	5	Rerennial	*Querco-Fagetea*
Solanum nigrum	Field wheet	7	6	3	3	4.5	i	4*	Annual	*Chenopodietea*
Sonchus arvensis	Field wheet	7	5	i	i	3.5	i	6	Rerennial	*Chenopodietea*
Sorbus aucuparia	Woody plants	6	i	i	3	2.5	i	4	Tree	*Quercetea-robori-petraeae*
Stachys arvensis	Field wheet	7	6	2	3	3	2.5	5*	Annual	*Chenopodietea*
Stachys palustris	Field wheet	7	5	i	4.5	3	3.5	6	Rerennial	*Phragmitetea*
Stachys recta	Forest	7	6	4	1.5	2	4.5	5*	Rerennial	*Festuco-Brometea*
Stellaria graminea	Field wheet	6	i	i	2.5	2.5	2.5	4	Rerennial	*Molinio-Arrhenatheretea*
Stellaria holostea	Forest	5	6	3	3	2.5	3	3	Rerennial	*Querco-Fagetea*
Stellaria media	Field wheet	6	i	i	2.5	3.5	i	1*	Annual	*Chenopodietea*
Stellaria pallida	Ruderal	5	4	3	2	4	3	2*	Rerennial	*Chenopodietea*
cf. Taxus baccata	Woody plants	4	5	i	3	2	4	2	Tree	*Querco-Fagetea*
Teucrium scorodonia	Meadow	6	5	2	2	2	1.5	6	Rerennial	*Querco-Fagetea*
Thalictrum flavum	Hydrophilic	7	6	5	4	2	4.5	5	Rerennial	*Querco-Fagetea*
Thalictrum minus	Meadow	6	i	7	1.5	2	4.5	4	Rerennial	*Querco-Fagetea*
Thlaspi arvense	Field wheet	6	5	i	3	3.5	i	3*	Annual	*Chenopodietea*
cf. Tilia cordata	Woody plants	5	5	4	2.5	3	i	5	Tree	*Querco-Fagetea*
Trifolium hybridum	Field wheet	7	6	5	4	2.5	3	4*	Rerennial	*Plantaginetea maioris*
Trifolium repens	Field wheet	8	i	i	i	3	i	4*	Rerennial	*Plantaginetea maioris*
Typha sp.	Hydrophilic	8	7	5	5	3.5	i	5	Rerennial	*Phragmitetea*
Urtica dioica	Ruderal	i	i	i	3.5	4.5	i	6	Rerennial	*Querco-Fagetea*
Verbena officinalis	Field wheet	9	6	3	2.5	3.5	i	6	Rerennial	*Plantaginetea maioris*
Veronica hederifolia	Field wheet	6	6	3	3	3	3.5	2*	Annual	*Chenopodietea*
Vicia tetrasperma	Field wheet	6	6	5	3	2	i	5	Annual	*Secalietea*
Vicia cf. sylvatica	Forest	7	i	4	3	2	i	5	Rerennial	*Querco-Fagetea*
Vicia hirsuta	Field wheet	7	6	5	i	i	i	4*	Annual	*Chenopodietea*
Viola arvensis	Field wheet	6	5	i	2.5	i	i	3*	Annual	*Secalietea*
Viola cf. reichenbachiana	Forest	4	i	4	3	2.5	3.5	3	Rerennial	*Querco-Fagetea*
Vitis sylvestris	Gathered crops	6	8	4	4	3	4	4	Shrub	*Querco-Fagetea*
Xanthium strumarium	Field wheet	8	7	5	3	5	3	6*	Annual	*Chenopodietea*

Captions:

Light		Temperature		Continentality		Soil moisture	
L3	shadow plants	T3	cood climate	K2	Oceanic	Pv1.5	very dry stand
L4	plants between L3–L5	T4	between T3–T5	K3	between T2–T4	Pv2	dry
L5	half shadow plants	T5	moderate climate	K4	suboceanic	Pv2.5	dry to fresh
L6	plants between L5–L7	T6	between T5–T7	K5	transitional	Pv3	fresh
L7	plants of half light	T7	warm climate	K6	subcontinental	Pv3.5	fresh to damp
L8	plants between L7–L9	T8	between T7–T9	K7	between T6–T8	Pv4	damp
L9	plants of full light	T9	very warm climate	K8	continental	Pv4.5	damp to wet
Li	indifferent	Ti	indifferent	Ki	indifferent	Pv5	wet
						Pvi	indifferent

Soil nitrogen		Soil pH		Phenophase of flowering	
Pd1.5	very poor to poor	Pr1.5	strongly acidic to acidic	Fk1	before spring
Pd2	poor	Pr2.5	acidic to mildly acid	Fk2	early spring
Pd2.5	poor to medium	Pr3	mildly acid	Fk3	full spring
Pd3	medium	Pr3.5	weakly acid to neutral	Fk4	end of spring
Pd3.5	medium to rich	Pr4	neutral	Fk5	full summer
Pd4	rich	Pr4.5	neutral to basic	Fk6	late summer
Pd4.5	rich to very rich	Pr5	basic	Fki	long-blooming
Pd5	very rich	Pri	indifferent		
Pdi	indifferent				

TAB. 35 | List of botanical taxa from the site Horky, classified based on their relation to soil reaction. Captions: Pr1 – strongly acidic, Pr1.5 – between strongly acidic and acidic, Pr2 – acidic, Pr2.5 – between acidic to mildly acid, Pr3 – mildly acid, Pr3.5 – between mildly acid and neutral, Pr4 – neutral, Pr4.5 – between neutral and basic, Pr5 – basic, Pri – indifferent to soil reaction.

Taxon	Classification
Adonis vernalis	Pr4.5
Allium flavum	Pri
Anthericum ramosum	Pr4.5
Astragalus danicus	Pr5
Astragalus onobrychis	Pr5
Campanula sibirica	Pr5
Carex humilis	Pr4.5
Echium maculatum	Pr5
Eryngium campestre	Pr4
Falcaria vulgaris	Pr4–5
Festuca valesiaca	Pr4
Filipendula vulgaris	Pr4
Galium verum	Pr4.5
Gypsophila paniculata	Pr4
Helichrysum arenarium	Pr3
Chamaecytisus ratisbonensis	Pr5
Inula oculus-christi	Pr4
Orchis morio	Pr3.5
Oxytropis pilosa	Pr5
Phlomis tuberosa	Pr5
Potentilla alba	Pr3.5
Primula elatior	Pr4
Prunus spinosa	Pri
Pseudolysimachion spicatum	Pri
Pyrethrum corymbosum	Pr3.5
Ranunculus illyricus	Pri
Rapistrum perenne	Pr4
Rosa canina	Pri
Rosa gallica	Pr3.5
Scorzonera purpurea	Pr4
Stipa capillata	Pr4
Stipa pennata	Pr3.5
Stipa tirsa	Pr3
Taraxacum serotinum	Pr3.5
Tephroseris integrifolia	Pr4
Verbascum phoeniceum	Pr3.5
Viola ambigua	Pr4

TAB. 36 | List of botanical taxa from the site Hodonínská doubrava, classified based on their relation to soil reaction. Captions: Pr1 – strongly acidic, Pr1.5 – between strongly acidic and acidic, Pr2 – acidic, Pr2.5 – between acidic to mildly acid, Pr3 – mildly acid, Pr3.5 – between mildly acid and neutral, Pr4 – neutral, Pr4.5 – between neutral and basic, Pr5 – basic, Pri – indifferent to soil reaction.

Taxon	Classification
Betonica officinalis	Pri
Calamagrostis epigejos	Pri
Campanula persicifolia	Pr4
Cardamine parviflora	Pr4
Carex buxbaumii	Pr5
Carex fritschii	Pr3.5
Carex riparia	Pr4
Carex supina	Pr5
Centaurea scabiosa	Pr4
Cerastium arvense	Pr3
Clinopodium vulgare	Pr4
Convallaria majalis	Pri
Crepis setosa	Pri
Daphne cneorum	Pr4.5
Dianthus pontederae	Pr4
Dianthus superbus	Pr4
Echium vulgare	Pri
Euphorbia cyparissias	Pri
Euphorbia villosa	Pr3
Festuca amethystina	Pr4
Galium boreale	Pr4
Geranium sanguineum	Pr3.5
Gladiolus palustris	Pr4
Hottonia palustris	Pr3
Hypericum perforatum	Pri
Impatiens parviflora	Pr3
Iris sibirica	Pr4
Iris variegata	Pri
Laserpitium prutenicum	Pr3
Lilium martagon	Pr4
Lysimachia vulgaris	Pri
Melampyrum cristatum	Pr4
Muscari comosum	Pr4
Peucedanum oreoselinum	Pri
Platanthera chlorantha	Pr4
Potentilla alba	Pr3
Ranunculus illyricus	Pri
Selinum carvifolia	Pr3
Silene vulgaris	Pr3.5
Solidago canadensis	Pri
Stachys recta	Pr4.5
Teucrium chamaedrys	Pr4
Thalictrum simplex	Pr3.5
Verbascum phoeniceum	Pr3.5
Vincetoxicum hirundinaria	Pr4

TAB. 37 | List of botanical taxa from the site Bzenec, classified based on their relation to soil reaction. Captions: Pr1 – strongly acidic, Pr1.5 – between strongly acidic and acidic, Pr2 – acidic, Pr2.5 – between acidic to mildly acid, Pr3 – mildly acid, Pr3.5 – between mildly acid and neutral, Pr4 – neutral, Pr4.5 – between neutral and basic, Pr5 – basic, Pri – indifferent to soil reaction.

Taxon	Classification
Achillea pannonica	Pr4.5
Anthemis ruthenica	Pr2.5
Arabidopsis thaliana	Pr2.5
Arabis glabra	Pr4
Armeria vulgaris	Pr5
Artemisia campestris	Pr4
Asparagus officinalis	Pri
Astragalus glycyphyllos	Pr3.5
Berteroa incana	Pri
Calamagrostis epigejos	Pri
Carex hirta	Pri
Carex praecox	Pri
Carex supina	Pr5
Centaurea scabiosa	Pr4
Cichorium intybus	Pr4
Consolida regalis	Pri
Corynephorus canescens	Pr1.5
Cynoglossum officinale	Pr3.5
Dianthus pontederae	Pr4
Eragrostis minor	Pri
Erigeron acris	Pri
Erodium cicutarium	Pri
Eryngium campestre	Pr4
Euphorbia cyparissias	Pri
Falcaria vulgaris	Pr4.5
Festuca dominii	Pr4
Galium aparine	Pri
Gypsophila paniculata	Pr4
Helichrysum arenarium	Pr3
Hieracium pilosella	Pri
Hylotelephium maximum	Pri
Hypericum perforatum	Pri
Chelidonium majus	Pri
Chondrilla juncea	Pr4
Jasione montana	Pr1.5
Lathyrus tuberosus	Pr4
Lepidium campestre	Pr4
Linaria genistifolia	Pr4
Linaria vulgaris	Pr4
Melampyrum pratense	Pr4
Melica transsilvanica	Pr4
Muscari comosum	Pr4
Origanum vulgare	Pr3.5
Papaver argemone	Pr2.5
Papaver rhoeas	Pr4
Petrorhagia prolifera	Pri
Pseudolysimachion spicatum	Pri
Salvia nemorosa	Pr4
Scabiosa ochroleuca	Pr5
Scleranthus annuus	Pr2.5
Silene nutans	Pri
Silene viscosa	Pr3
Spergula morisonii	Pr2
Spergula pentandra	Pr1
Stipa borysthenica	Pr4
Stipa capillata	Pr4
Thymus serpyllum	Pr2
Tragopogon dubius	Pr4
Trifolium arvense	Pr2
Verbascum austriacum	Pr3.5
Verbascum phoeniceum	Pr3.5
Vincetoxicum hirundinaria	Pr4
Viola arvensis	Pri

TAB. 38 | List of botanical taxa from the area of Mikulčice Archaeological Monument, classified based on their relation to soil reaction. Captions: Pr1 – strongly acidic, Pr1.5 – between strongly acidic and acidic, Pr2 – acidic, Pr2.5 – between acidic to mildly acid, Pr3 – mildly acid, Pr3.5 – between mildly acid and neutral, Pr4 – neutral, Pr4.5 – between neutral and basic, Pr5 – basic, Pri – indifferent to soil reaction.

Taxon	Classification
Aegopodium podagraria	Pr4
Agrimonia eupatoria	Pri
Achillea millefolium	Pri
Ajuga reptans	Pri
Allium senescens	Pr5
Allium ursinum	Pr3.5
Alopecurus pratensis	Pr3
Amaranthus powellii	Pri
Anagallis arvensis	Pri
Anemone ranunculoides	Pr4
Anethum graveolens	Pri
Anchusa officinalis	Pr3.5
Anthoxanthum odoratum	Pr3
Anthriscus sylvestris	Pri
Arabidopsis thaliana	Pr2.5
Arctium tomentosum	Pr4.5
Aristolochia clematitis	Pr4.5
Armoracia rusticana	Pr3.5
Arrhenatherum elatius	Pr4
Artemisia vulgaris	Pri
Arum maculatum	Pr4
Aster lanceolatus	Pr3.5
Avenula pubescens	Pri
Barbarea vulgaris	Pri
Betonica officinalis	Pri
Bromus hordeaceus	Pri
Calystegia sepium	Pr3.5
Campanula rotundifolia	Pri
Capsella bursa-pastoris	Pri
Carduus crispus	Pri
Centaurea jacea	Pr3.5
Cerastium holosteoides	Pri
Cichorium intybus	Pr4
Circaea lutetiana	Pr3.5
Cirsium arvense	Pri
Cirsium vulgare	Pr3
Clematis vitalba	Pr3.5
Colchicum autumnale	Pr3.5
Convallaria majalis	Pri
Convolvulus arvensis	Pri
Conyza canadensis	Pri
Cornus mas	Pr4
Cornus sanguinea	Pr4
Coronilla varia	Pri
Corydalis solida	Pr4
Corylus avellana	Pri
Dactylis glomerata	Pri
Echinochloa crus-galli	Pri
Elytrigia repens	Pri
Epilobium roseum	Pr3.5
Equisetum balustre	Pri
Eragrostis minor	Pri
Erigeron annuus	Pr3
Erodium cicutarium	Pri
Erophila verna	Pri
Euonymus europaeus	Pr4
Festuca pratensis	Pri
Ficaria verna	Pri
Gagea lutea	Pr3.5
Galanthus nivalis	Pr4
Galium aparine	Pri
Galium Boreale	Pr3.5
Galium odoratum	Pri
Galium verum	Pr4.5
Geranium palustre	Pr4
Geranium pratense	Pr4
Geranium robertianum	Pri
Geum urbanum	Pri
Glechoma hederacea	Pri
Gratiola officinalis	Pri
Hedera helix	Pr3
Heracleum sphondylium	Pri
Hieracium umbellatum	Pri
Holcus lanatus	Pri
Humulus lupulus	Pr3
Hypericum hirsutum	Pr4
Chaerophyllum temulum	Pri
Chelidonium majus	Pri
Chenopodium album	Pri
Impatiens glandulifera	Pr4
Impatiens parviflora	Pr3
Knautia arvensis	Pri
Lamium album	Pri
Lamium purpureum	Pr3.5
Lathyrus pratensis	Pr3.5
Leontodon hispidus	Pri
Lepidium campestre	Pr3.5
Leucanthemum vulgare	Pri
Linaria vulgaris	Pr3.5
Lolium perenne	Pri
Lotus corniculatus	Pri
Lycopsis arvensis	Pr3
Lychnis flos-cuculi	Pri
Lythrum salicaria	Pr4
Matricaria recutita	Pri
Medicago lupulina	Pr4.5
Mercurialis annua	Pr3.5
Myosotis palustris	Pri
Myosoton aquaticum	Pri
Oxalis fontana	Pr3
Papaver rhoeas	Pr4
Paris quadrifolia	Pr4

TAB. 39 | Summary of the results of discriminant analysis for DCA1 to DCA11.

DCA 1

Axes	1	2	3	4	Total inertia
Eigenvalues	0.781	0.274	0.214	0.170	6.733
Lengths of gradient	4.814	3.362	3.229	6.546	
Cumulative % var. of species data	11.6	15.7	18.8	21.4	
Sum of all eigenvalues					6.733

DCA 2

Axes	1	2	3	4	Total inertia
Eigenvalues	0.510	0.253	0.192	0.161	8.670
Lengths of gradient.	5.291	3.989	3.594		
Cumulative % var. of species data	5.9	8.8	11.0	12.9	
Sum of all eigenvalues					8.670

DCA 3

Axes	1	2	3	4	Total inertia
Eigenvalues	0.393	0.337	0.271	0.211	9.743
Lengths of gradient	5.698	4.356	5.748	3.443	
Cumulative % var. of species data	4.0	7.5	10.3	12.5	
Sum of all eigenvalues					9.743

DCA 4

Axes	1	2	3	4	Total inertia
Eigenvalues	0.393	0.337	0.271	0.211	9.743
Lengths of gradient	5.698	4.356	5.748	3.443	
Cumulative % var. of species data	4.0	7.5	10.3	12.5	
Sum of all eigenvalues					9.743

DCA 5

Axes	1	2	3	4	Total inertia
Eigenvalues	0.544	0.424	0.309	0.238	10.186
Lengths of gradient	6.010	4.438	4.947	3.492	
Cumulative % var. of species data	5.3	9.5	12.5	14.9	
Sum of all eigenvalues					10.186

DCA 6

Axes	1	2	3	4	Total inertia
Eigenvalues	0.544	0.424	0.309	0.238	10.186
Lengths of gradient	6.010	4.438	4.947	3.492	
Cumulat. % var. of species data	5.3	9.5	12.5	14.9	
Sum of all eigenvalues					10.186

DCA 7

Axes	1	2	3	4	Total inertia
Eigenvalues	0.194	0.108	0.074	0.037	0.652
Lengths of gradient	3.061	2.322	1.703	3.067	
Cumulative % var. of species data	29.8	46.4	57.7	63.4	
Sum of all eigenvalues					0.652

DCA 8

Axes	1	2	3	4	Total inertia
Eigenvalues	0.194	0.108	0.074	0.037	0.652
Lengths of gradient	3.061	2.322	1.703	3.067	
Cumulative % var. of species data	29.8	46.4	57.7	63.4	
Sum of all eigenvalues					0.652

DCA 9

Axes	1	2	3	4	Total inertia
Eigenvalues	0.544	0.424	0.309	0.238	10.186
Lengths of gradient	6.010	4.438	4.947	3.492	
Cumulative % var. of species data	5.3	9.5	12.5	14.9	
Sum of all eigenvalues					10.186

DCA 10

Axes	1	2	3	4	Total inertia
Eigenvalues.	0.713	0.451	0.357	0.306	12.592
Lengths of gradient	5.080	4.134	4.881	4.647	
Cumulative % var. of species data	5.7	9.2	12.1	14.5	
Sum of all eigenvalues					12.592

DCA 11

Axes	1	2	3	4	Total inertia
Eigenvalues	0.498	0.422	0.326	0.307	7.345
Cumulative % var. of species data	6.8	12.5	17.0	21.1	
Sum of all eigenvalues					7.345

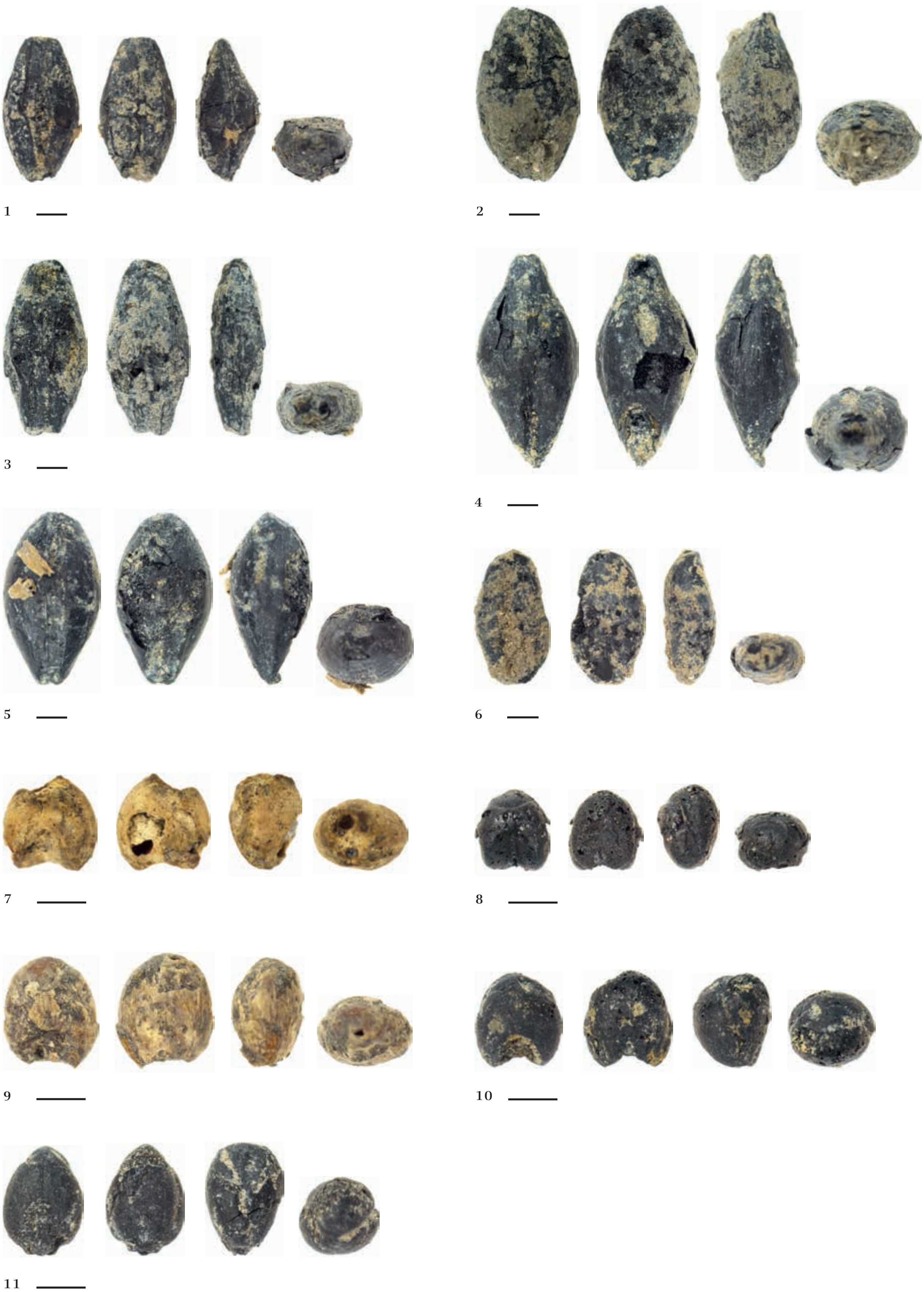


PLATE 1 | Mikulčice-Kopčany. Finds of cultivated crops: cereals, 1-5 - *Hordeum vulgare-vulgare*, 6 - *Hordeum vulgare - coeleste*, 7-11 - *Panicum miliaceum*. Scale 1 mm.

PLATE 2 | Mikulčice-Kopčany. Finds of cultivated crops: cereals, 1-5 – *Secale cereale*, 6-10 – *Triticum aestivum*. Scale 1 mm.

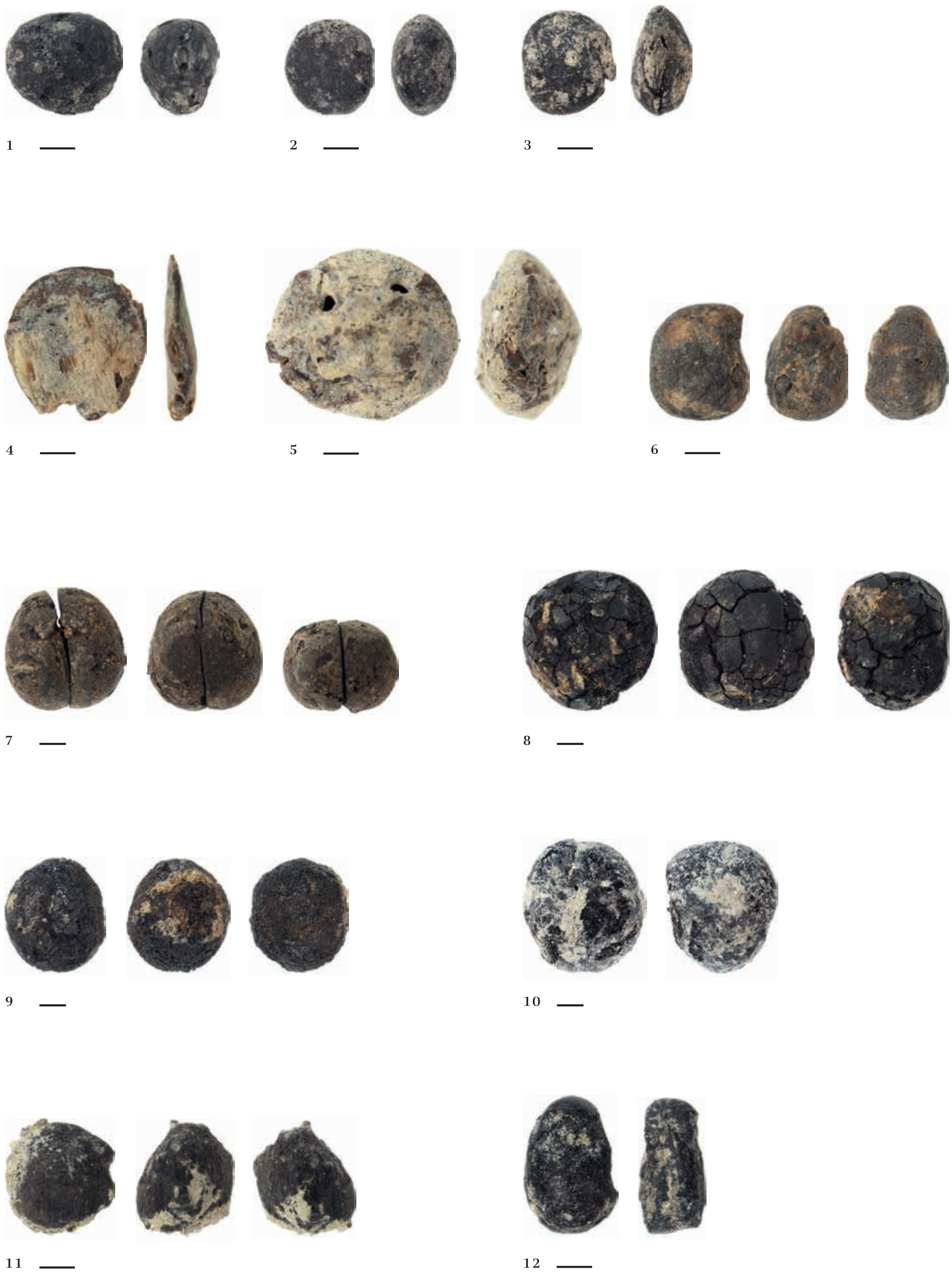


PLATE 3 | Mikulčice-Kopčany. Finds of cultivated crops: legumes, 1–5 – *Lens culinaris*, 6 – *Lathyrus sativus*, 7–10 – *Pisum sativum*, 11 – *Vicia ervilia*, 12 – *Vicia faba*. Scale 1 mm.

PLATE 4 | Mikulčice-Kopčany. Finds of cultivated crops: fruits and nuts, 1 – *Juglans regia*, 2 – *Malus domestica*, 3 – *Prunus cf. domestica*, 4 – *Prunus domestica*, *insititia*, 5–6 – *Persica vulgaris*. Scale 1 mm.

PLATE 5 | Mikulčice-Kopčany. Finds of cultivated crops: grape wine *(Vitis vinifera)*. Scale 1 mm.

PLATE 6 | Mikulčice-Kopčany. Finds of cultivated crops: grape wine *(Vitis vinifera)*. Scale 1 mm.

PLATE 7 | Mikulčice-Kopčany. Finds of cultivated crops: vegetables and oil or fiber crops, 1–2 – *Cucumis sativus*, 3 – *Petroselinum crispum*, 4–5 – *Daucus carota*, 6–11 – *Cannabis sativa*. Scale 1 mm.

PLATE 8 | Mikulčice-Kopčany. Finds of wild species: field weeds, 1–2 – *Xanthium strumarium*, 3 – *Caucalis platycarpos*, 4–5 – *Solanum nigrum*, 6 – *Arnoseris minima*, 7 – *Centaurea cyanus,* 8 – *Aethusa cynapium*, 9 – *Melilotus altissimus*, 10 – *Asperula arvensis,* 11 – *Agrostemma ghitago*. Scale 1 mm.

PLATE 9 | Mikulčice-Kopčany. Finds of wild species: field weeds, 1–2 – *Bupleurum rotundifolium*, 3 – *Verbena officinalis*, 4 – *Glaucium flavum*, 5 – *Linaria vulgaris*, 6 – *Malva cf. verticillata*, 7 – *Lycopus europaeus*, 8–9 – *Thlaspi arvense*, 10–11 – *Setaria viridis/verticillata*. Scale 1 mm.

PLATE 10 | Mikulčice-Kopčany. Finds of gathered crops: 1–2 – *Crataegus sp.*, 3 – *Cerasus avium*, 4 – *Vaccinium myrtillus*, 5–7 *Prunus spinosa*, 8 – *Rubus fruticosus*, 9 – *Rubus caesius*, 10 – *Rubus idaeus*. Scale 1 mm.

PLATE 11 | Mikulčice-Kopčany. Finds of gathered crops: 1 – *Fragaria vesca*, 2 – *Humulus lupulus*, 3 – *Sorbus aucuparia*, 4 – *Cornus mas*, 5 – *Cornus sanguinea*, 6-7 – *Carpinus betulus*. Scale 1 mm.

PLATE 12 | Mikulčice-Kopčany. Finds of wild species: meadow species, 1 – *Agrimonia eupatoria*, 2 – *Litospermum arvense*, 3 – *Inula salicina*, 4 – *Inula oculus-christi*, 5 – *Slasola kali*, 6 – *Potentilla erecta*, 7–8 – *Potentilla argentea*, 9 – *Potentilla reptans*, 10 – *Phleum pratense*, 11 – *Poa pratensis*. Scale 1 mm.

PLATE 13 | Mikulčice-Kopčany. Finds of wild species: water and hygrophilous species, 1 – *Ceratophyllum demersum*, 2 – *Alisma plantago-aquatica*, 3 – *Potamogeton natans*, 4 – *Rumex aquaticus*, 5 – *Iris pseudacorus*, 6 – *Potentilla supina*, 7 – *Typha sp.*, 8 – *Thalictrum flavum*. Scale 1 mm.

PLATE 14 | Mikulčice-Kopčany. Finds of wild species: forest herbs and shrubs, ruderal, settlement species, 1 – *Thalictrum minus*, 2 – *Vicia sylvestris*, 3 – *Viola cf. reichenbachiana*, 4 – *Physalis alkekengi*, 5 – *Atropa bella-donna*, 6 – *Hyoscyamus niger*, 7 – *Solanum dulcamara*, 8 – *Reseda lutea*, 9 – *Urtica dioica*, 10 – *Scleranthus sp.*, 11 – *Stellaria holostea*, 12 – *Arctium minus*. Scale 1 mm.

Studien zum Burgwall von Mikulčice
Band XI

Michaela Látková
The Archaeobotany of Mikulčice
Food Supply to the Early Medieval Stronghold

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