Farmers in Transition

The archaeobotanical analysis of the Carpathian Basin from the Late Neolithic to the Late Bronze Age (5000-900 BC)

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Kelly Reed

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ATTENTION

Since the completion of this thesis, new information has been released concerning the chronology of the Bronze Age settlement at Feudvar, as well as new archaeobotanical identifications. It is now believed that the Late Bronze Age levels, described in this thesis, actually date to the Early-Middle Bronze Age. In addition, the previous identification of cf. *Secale* sp. (Rye), has now been re-classified by Prof Helmut Kroll as the species *Dasypyrum villosum*, which is a grass similar in morphology to rye and wheat. Although these changes do not have a large impact on the results and conclusions of this thesis, it is important to be aware that some sections, such as in Chapters 5, 6 and 7, which focus solely on the Feudvar results, will not be accurate.

Abstract

This thesis examines the development of agriculture within the Carpathian Basin from the Late Neolithic to the Late Bronze Age. Information on prehistoric crop practices within Croatia have been absent from current debates on the spread and development of agriculture in Southeast Europe. The aim of the study is to examine new archaeobotanical data and provide information on subsistence practices within Croatia and integrate these results with those available from the wider region of the Carpathian Basin. The re-examination of archaeobotanical material from Late Bronze Age Feudvar has also allowed the identification of crop husbandry regimes at the site level.

The results indicate continuous crop cultivation, as well as the collection of wild resources, within Croatia from the Late Neolithic to the Late Bronze. At Feudvar, crop processing analysis indicated that a number of socio-economic factors dictated whether a crop was fully cleaned after the harvest, sieved at a later stage or left full of impurities. Further investigation into ecological characteristics of weed species within three groups of samples (unsieved spikelets, products and fine sieving by-products) identified the practice of two distinct crop husbandry regimes at Feudvar. The first represents small-scale intensive cultivation associated with the wheat crops (einkorn and emmer) and the second, a more large-scale extensive husbandry regime associated with barley. Integrating these results within the wider geographical area showed regional and temporal variations in the crops cultivated that are likely linked to personal choice and socio-economic influences rather than environmental constraints.

This study advances our knowledge on farming practices within the Carpathian Basin and demonstrates the importance of archaeobotanical data to debates on socio-economic and technological change in prehistory.

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VOLUME I

Chapter one
Introduction

This thesis examines new archaeobotanical information from Croatia and northern Serbia in order to investigate crop husbandry in relation to changing socio-economic and technological changes within the Carpathian Basin from the Late Neolithic to the Late Bronze Age. The transition from the Neolithic to the Bronze Age in Central and Southeast Europe marks a dramatic period of social, cultural and economic change, including the introduction of new technologies requiring specialisation (e.g. copper and bronze metallurgy), the development of social hierarchies and the centralization of power. As these were still entirely agricultural societies, appreciating the agrarian base of their economies is an essential component of understanding the changes that took place. Work in Greece, Bulgaria and Central Europe highlight the importance of archaeobotanical work to infer agricultural practice and contribute to theories of social ranking, labour, land use, animal husbandry and settlement occupation (e.g. Bogaard 2004; Kreuz *et al.* 2005; Popova 2010; Valamoti 2004); however, in the Carpathian Basin agricultural practices are poorly understood.

The Carpathian Basin is the main corridor through which early farming spread from the Mediterranean (ca. 6000 BC), providing a favourable environment for the transmission of crop cultivation into the cooler environment of Central Europe. Since the 1950s archaeobotanical research in the Carpathian Basin has focused mainly on Late Neolithic and Late Bronze Age tell sites located in northern Serbia (e.g. Bottema and Ottaway 1982; Hopf 1974; Kroll 1990; McPherron and Srejović 1988; Renfrew 2003; Van Zeist 1975) and Bosnia Herzegovina (e.g. Hofmann *et al.* 2006; Hopf 1958; Hopf 1967). The excavation of these tell sites e.g. Gomolava (Jovanović 1988), Vinča (Chapman 1981), Opovo (Tringham *et al.* 1985, 1992; Borojević 2006) and Feudvar (Hänsel and Medović 1998), provided for the first time large archaeobotanical datasets with the potential to examine agricultural practices in the region. For example, Borojević (2006) inferred crop husbandry methods, seasonality and explored possible theories on land use and social differentiation from archaeobotanical data collected from the Late Neolithic site of Opovo; however, further interpretations are rare. Typically, archaeobotanical investigations are aimed at producing inventories of plant species grown rather than understanding the role of prehistoric crop husbandry regimes. This is crucial if we are to understand the development of societies in the region at this time. The absence of sufficient numbers of weed seeds and chaff remains in the region has posed many problems in the interpretation of past human activities e.g. crop processing and agricultural practices (*cf.* Hillman 1981; Jones 1984; Van der Veen 1992; Bogaard 2004). In addition, the limited number of excavations and environmental recovery at Copper Age sites has also resulted in farming practices during this period being largely ignored.

Recently, Gyulai (2010) compiled for the first time an archaeobotanical history of Hungary from the Neolithic to the Middle Age, providing archaeobotanical data from over 250 prehistoric sites. This synthesis highlighted two key periods of change in the archaeobotanical material in Hungary. The first change was seen during the transition to the Copper Age, when the reduction in plant species and quantity of seeds is suggested to be linked with a reduction in crop production and an increasingly nomadic lifestyle (Gyulai 2010:87). The second change is seen during the Bronze Age, when farmers once again became settled and plough agriculture developed (Gyulai 2010:100).

Within Croatia, Neolithic and Bronze Age research has concentrated mainly on settlement patterns and material culture, with few studies examining archaeobotanical remains. Over the last twenty years only six sites have provided evidence of crop cultivation from the Neolithic to the Bronze Age (Borojević 2008; Chapman *et al.* 1996; Reed 2006; Reed *et al.* in prep). These sites are also located along the coast, which means there is no archaeobotanical information from mainland Croatia. Thus, information on the development of agriculture is essentially absent in the country. Over the last decade floatation has begun to increase at archaeological excavations within Croatia and this thesis will present the archaeobotanical results of 18 new sites located across the country.

Three archaeobotanical datasets are subsequently examined within this thesis. The first incorporates new archaeobotanical material from Croatia, collected from 18 sites ranging in date from the Middle Neolithic to the Late Bronze Age. The data are unique to this area providing for the first time a continuous history of farming in prehistoric Croatia. The second includes a large archaeobotanical dataset from Late Bronze Age levels at Feudvar (Serbia), which was previously examined by Prof Helmut Kroll. The dataset from Feudvar will allow a comprehensive analysis of crop processing activities and crop husbandry regimes employed at the micro-level. The third dataset involves the compilation of archaeobotanical evidence available from the whole of the Carpathian Basin in order to provide a context within which to explore further patterns in crop husbandry in relation to socio-economic and technological changes in the region.

The research aims of this project operate on two levels: the site level (micro-scale) and a regional level (macro-scale). The first aim is to provide new information about agricultural practices in Croatia and northern Serbia from the Late Neolithic to the Late Bronze Age at the site-specific level. The second aim is to improve our understanding of agricultural systems during this period within the wider region of the Carpathian Basin (macro-scale). This will fit closely into broader debates on subsistence change during the Late Neolithic to the Late Bronze Age in the region.

The main objectives of the study are as follows:

1) to document the agricultural base of the Late Neolithic, Copper and Bronze Age within Croatia and Serbia, by establishing which crops were cultivated and when they were introduced.
2) to reconstruct the nature of farming systems in Croatia and Serbia, in terms of intensity and variability, from the analysis of crop and weed assemblages.
3) to establish whether there are regional and chronological differences in crop cultivation within Croatia and Serbia and to assess potential explanations; and
4) to integrate the results from Croatia and Serbia within the wider geographic region of the Carpathian Basin and explore how agriculture developed over time in relation to socio-cultural, economic and technological changes.

The thesis is organised into nine chapters. Chapter 2 provides a broad overview of the Carpathian Basin from the Late Neolithic to the Late Bronze Age. The archaeological literature will be introduced under four primary themes: settlement, ritual, exchange systems and farming. Chapter 3 outlines the methodology devised for the analyses of the archaeobotanical data. Chapter 4 presents the results from the eighteen Croatian sites, exploring formation processes and patterns through time. Chapter 5 presents the general results of the archaeobotanical material collected from the Late Bronze Age levels at Feudvar. In Chapter 6 the archaeobotanical remains from Feudvar are analysed in relation to crop processing activities. The aim of this chapter is twofold: first to determine formation processes at the site and thus past human activities. The second is to determine which samples are from the same crop processing stage. This will allow samples of the same composition to be compared in the following chapter. In Chapter 7 the Feudvar samples, grouped according to the crop processing stage they represent, are examined in relation to their weed ecology. Within this chapter the methods and results are presented and possible crop husbandry regimes employed at the site are discussed. Chapter 8 presents the study sites within the wider geographic context of the Carpathian Basin, through the examination of previously published archaeobotanical remains. Within this context the chapter explores potential temporal and spatial patterns in the distribution of archaeobotanical data. In Chapter 9 the overall patterns within the archaeobotanical data are discussed in relation to possible explanations linked to taphonomy, climate and the socio-economic and technological changing seen in the Carpathian Basin from the Mid/Late Neolithic to the Late Bronze Age. Chapter 10 presents the final conclusions of the thesis and suggestions for further work in the region.

Chapter two
Environment and Society in the Carpathian Basin: Late Neolithic to the Late Bronze Age (5000-900 BC)

With the establishment of farming in Southeast Europe (*ca.* 6000 BC), agriculture became central to everyday life, influencing and influenced by environment and society. The period from the Late Neolithic (*ca.* 5000 BC) to the end of the Late Bronze Age (*ca.* 900 BC), covering a span of *ca.* 4,000 years, is not surprisingly characterised by numerous socio-economic and technological changes. Before we can fully understand the agricultural evidence it is important to examine both the physical and cultural context within which it resides. In order to assess the archaeological context of this project, this chapter begins with a brief discussion of the environment of the Carpathian Basin and the study area in relation to topography (2.1.1), climate (2.1.2), and soil and vegetation (2.1.3). Due to the complexities of the periods under study the chronology and cultural context of the Carpathian Basin is summarised (2.2.1), followed by a review of current archaeological research with a particular focus on settlement (2.2.2), ritual (2.2.3), exchange systems (2.2.4), and farming (2.2.5). This chapter concludes with a discussion of each key area and how they link with agriculture at this time (2.3).

2.1 Environment

2.1.1 Topography

The Carpathian Basin is bordered by the Carpathian Mountains, the Alps, the Dinaric Alps and the Balkan Mountains, and includes present day Hungary, eastern Slovenia, Croatia, Serbia, Bosnia Herzegovina and western Romania. The area covers *ca.* 300,000 km² (Rudner and Sümegi 2001) and consists of two main geographical units, the peripheral mountains (the Carpathians, Alps, Dinaric Alps, and Transylvanian Mountain Range) and the central fertile alluvial plains, i.e. Pannonian Plain. The Pannonian Plain includes the Little Hungarian Plain, the Great

Hungarian Plain, the Transylvanian Basin, and the Drava-Sava Interfluves. The basin has a lowland elevation of *ca.* 200-600m above sea level, surrounded by mountains reaching up to 2,000m (Ollier and Pain 2000:98). The region is approximately dissected by the rivers Danube and Tisza. These rivers have been utilised not only as a food source but also as a conduit for communication, social interaction, and used as a natural territorial border. The Danube in particular is believed to be one of the major pathways along which agriculture spread (Davison *et al.* 2006). The study area is located within the south-western area of the Carpathian Basin and extends to central Dalmatia, situated in present day Croatia and Serbia (Fig. 2.1).

2.1.2 Climate

Climate, in combination with other factors, has a direct influence on farming parameters. It can, for example, restrict the types of crops that can be grown, affect the length of the growing season and can cause periods of drought or flooding. Palaeoenvironmental and climatological data suggests that the Carpathian Basin has been a meeting point of four different climatic zones from the Pleistocene (*ca.* 2.5 million – 12,000 BP) to the present day (Sümegi *et al.* 2002). The west of the Carpathian Basin is influenced by an oceanic climate which is generally cooler with greater precipitation; the southern part of the Great Hungarian Plain and Transdanubia come under a sub-Mediterranean influence resulting in more humid autumns and relatively warmer winters; the eastern and central parts are affected by a continental climate resulting in hot, dry summers; a highland and submontane climate prevails in the mountain ranges (Rudner and Sümegi 2001).

Within the eastern part of the study area a continental climate dominates, while to the west, along the Adriatic coast, hot, dry summers and cold winters predominate. Within the study area annual precipitation is *ca.* 500-900 mm in the lowlands, while the mountain slopes can receive over 2,000 mm (Schiller *et al.* 2010:38). Evaporation is particularly intensive in Vojvodina due in part to the high summer temperatures as well as strong winds (Filipovski and Ćirić 1969:271). Temperatures inland range from 0-2°C in January to *ca*. 18-22°C in July, while the Dalmatian coast ranges from *ca.* 5°C in January (Bonacci 1993) to *ca*. 24-26°C in July (Polunin 1980:18-20).

Two climatic periods occurred between the Neolithic and Late Bronze Age: the warmer and moister Atlantic (*ca.* 5500-3000 BC) (Bozilova and Tonkov 2000) and the cooler Sub-Boreal (*ca.* 3300-800 BC) (Neumann 1993). Although the Sub-boreal is characterised by a cooler and wetter climate than the preceding Atlantic period, it is suggested that the climate was actually similar to that of today, differing by only 1-2°C (Velichko and Nechaev 2005:65).The Atlantic period has been traditionally regarded as a 'climatic optimum', characterised by higher than present day temperatures that were relatively stable, and therefore supporting the establishment of agriculture in Europe (Kalis *et al.* 2003). In the Carpathian Basin the effect of the region's four different climatic zones has made reconstruction of past climatic conditions difficult. Climatic reconstructions are also restricted within the Carpathian Basin due to the limited availability of potential sedimentary sequences suitable for multiproxy analyses. As a result, a number of large lakes within Hungary and Romania have been the main areas from which palaeoenvironmental information has been retrieved.

Palaeoecological data from Lake Balaton (Hungary) has shown an increase in plants requiring higher temperatures, humidity and a moderate climate, e.g. honeysuckle (*Lonicera*), ivy (*Hedera*), grape vine (*Vitis*) and holly (*Ilex*), during the Atlantic period (Nagy-Bodor *et al.* 2000). A similar shift towards moister conditions is also inferred from the increase in hornbeam (*Carpinus*) and beech (*Fagus*) pollen in the Gutaiului Mountains (NW Romania) *ca.* 3750 BC (Feurdean 2005). Lithological changes during the Atlantic are also seen in the palaeolakes of Turbuta (NW Romania), Lake Saint Ana (Romania), and Lake Balaton (Hungary), which indicate a rise in water level from *ca.* 5000 BC (Feurdean *et al.* 2007; Magyari *et al.* 2006). The analysis of testate amoebae (unicellular animals that live in wetlands) in Hungary and Romania also suggest that from *ca.* 6000 BC the water table began to rise with minor wet phases *ca.* 5100 BC, 3910 BC, 3100-2700 BC, reaching its peak *ca.* 1570 BC (Schnitchen *et al.* 2006).

From pollen records at Lake Balaton (Hungary), the onset of the Sub-Boreal is characterised by a reduction of *Vitis* and *Hedera*, the disappearance of *Ilex* and the absence of steppe flora, suggesting an overall decrease in temperature within the region (Nagy-Bodor *et al.* 2000). Thus, in the Great Hungarian Plain the climate became cooler and slightly arid, although it was still relatively humid. Along the Adriatic Sea, research on planktic and benthic foraminifera assemblages within sediment cores has shown that episodes of warm and dry conditions occurred during the Copper and Late Bronze Age (Piva *et al.* 2008). By the end of the Bronze Age some suggest that climatic conditions deteriorated, with oscillating periods of high rainfall and droughts (Neumann 1993; Weiss 1982).

2.1.3 Soil and vegetation

Soils are complex ecosystems of living organisms and non-living matter that have a direct effect on its physical structure and chemical content. As such, soils are not simply dependent on the geology of a region but also on the climate, vegetation, water table and other factors including human impact. The physical structure (e.g. well drained soils, dense heavy clays) and the chemical content (e.g. nitrogen, oxygen, potassium) of soils are extremely important for agriculture and will dictate the types of crop husbandry techniques that are employed (See Chapter 7 and 9 for further discussion).

The Carpathian Basin is a complex mosaic of several different soil types. The lowlands are characterised by alluvial soils, gleys, grey-brown podozolic soils, brown forest soils and Chernozem, while in the upland regions, lithosols, rankers and shallow rendzinas occur (Fig 2.2a). Today Chernozem soils are regarded as the most fertile agricultural soils of Hungary (Szeder *et al.* 2006). Examination of past hydrological events from alluvial deposits in Europe indicates distinct episodes of river flooding *ca.* 4790-4820 BC and 2840-2860 BC (Macklin *et al.* 2006). These episodes would have been instrumental in the creation of new alluvial deposits and, depending on its extent, could have distinctly changed the soil composition of an area, affecting both settlement and field systems.

The Titel plateau (*ca.* 16x8km), upon which Feudvar is located, is situated near the confluence of the Tisza (running to the east of the site) and the Danube (running along the south). The area is therefore directly influenced by fluvial erosion, flooding and waterlogging. Today the soils consist of alluvial soils, deposited by the two rivers, and chernozem, which is the main soil type within the region including the Plateau itself (Fig 2.2b). Chernozem and the loamy alluvial soils found along the rivers are particularly well drained, although the alluvials are at a much greater risk of flooding. The chemical properties of chernozem in Vojvodina are on average slightly alkaline, with a high availability of potassium and phosphate (Ubavic and Bogdanovic 1995). As a result, this type of soil is particularly well suited for obtaining high quality crops with high stable yields (*ibid.*).

It is suggested that the formation of chernozem soils in Serbia developed due to the influences of the continental climate and forest steppe during the Pre-Boreal *ca.*11,500 BP (Thater and Stahr 1991). The mechanism by which these soils were formed are still debated, with some suggesting a link between the development of chernozem and human activity such as deforestation during the Neolithic (e.g. Gerlach *et al.* 2006); however, in Central Europe this has been largely disproved within areas of LBK settlement (Lorz and Saile 2011). In Hungary, others suggest that the appearance of steppe vegetation in the Great Hungarian Plain during the early Holocene triggered the formation of chernozem soils (Joó *et al.* 2007).

The next group of soils which surround the Titel plateau are hydromorphic smoniza and black soils, which are types of alluvial soils that formed as a result of the two rivers, but contain a higher percentage of clay. These are very poorly drained soils with the occurrence of groundwater in the top 30cm for 6 months of the year and the emergence of salinisation (Rudić *et al.* 2004). Because of their abundant moisture they are unsuitable for cultivation, although today drainage systems have been implemented in Serbia to allow them to be utilised (*ibid.*). These soils are also known as 'minute' soils, as they require a short optimal period of cultivation as well as increased mineral fertilisation (Lazic and Lazic 1997).

Vegetation in the Carpathian Basin is also determined by a complex interaction between soil, climate, topography and hydrology, where flora from the eastern European plains, Central Europe, and the Mediterranean meet (Fig 2.3). The Pannonian forest steppe, which occupies much of the lowlands, typically includes oak (*Quercus robur*, *Q. pubescens*), lime (*Tilia tomentosa*), and maple (*Acer tataricum*), while the mountain ranges are mainly characterised by pine (*Picea abies*, *Pinus cembra*, *P. sylvestris*) with a scrub layer of juniper (*Juniperus communis*) and alder (*Alnus viridis*) (Rudner and Sümegi 2001; Sümegi *et al.* 2002).

Vegetation is extremely diverse in the Carpathian Basin and today Serbia alone has > 3,600 taxa identified from areas of forest, meadows, pasture, marshland and alpine tundra (Lugić *et al.* 2010). In addition, areas of Serbia are today heavily utilised for agriculture. In 2006, 59% of agricultural land was used for grain crops (mainly maize and wheat and some barley), 12% was dedicated to industrial crops (e.g. sunflower, soya, sugar beet, and tobacco), 9% vegetable crops (e.g. potatoes and peas), 14% fodder crops, and 6% of the arable fields were left fallow (Njegovan and Bošković 2006).

Palaeoenvironmental research in the Carpathian Basin is providing a clearer estimation of the paleovegetation during the Holocene (*ca.* 10,000 BC – present) (e.g. Rudner and Sümegi 2001; Willis 1997). The increase in moisture within the Carpathian Basin, indicative of the Atlantic and Pre-Boreal, resulted in the population increase and expansion of beech (*Fagus*) and hornbeam (*Carpinus*) from *ca.* 3400 BC (Magyari 2002). In northeast Hungary, pollen sequences have also shown changes in the local vegetation during the study period (Table 2.1). Further to this, Magyari *et al.* (2010), studying pollen and microcharcoal remains from Sarló-hát Lake (Hungary), identified the continued persistence of temperate deciduous wooded steppe from *ca.* 5800 BC until anthropogenic activities impacted on the forest creating a 'cultural' rather than natural steppe *ca.* 1100 BC.

Archaeozoological evidence of great bustards (*Otis tarda*) and eastern European wild horses (*Equus ferus* subsp. *gmelini*) supports the view of an extensive steppe habitat in the Great Hungarian Plain throughout the Early-Middle Holocene (Magyari *et al.* 2010). Avian evidence from Neolithic to Iron Age sites in the Carpathian Basin also indicate that many of the sites were located in areas surrounded by swamps, reed beds and humid meadows (Gál 2004). For example, the most common species found at settlements included waterfowl, such as swans (*Cygnus*), geese (*Anser*), and duck, (*Anas*, *Aythya*), wading birds such as grey herons (*Ardea*) and egrets (*Egretta*), and terrestrial birds attracted to swamps and humid meadows, e.g. storks (*Ciconia*) and *Crane* (Gál 2007).

Human impact on the environment has been inferred from changes in forest composition (Gardner 2002; Lawson *et al.* 2005; Magri 1995; Willis and Bennett 1994), increased charcoal concentration (Sadori and Giardini 2007) and increased abundance of indicator species of pastureland, weeds, ruderal species and cereals (Andrič 2007; Bodnariuc *et al.* 2002). In Slovenia, evidence suggests that human impact on the landscape was in the form of small-scale forest clearance until the Late Bronze Age (*ca*. 1000 BC) when large-scale forest clearance occurred (Andrič and Willis 2003). In the Harghita Mountain range (Romania), evidence of human impact occurs in the Early Bronze Age, *ca.* 2700-2200 BC, when pollen sequences from Lake Saint Ana contained disturbance indicator species (e.g. plantain (*Plantago major*), sheep's sorrel (*Rumex acetosella*)) and increased macrocharcoal remains (Magyari *et al.* 2006). This evidence fits well with Bronze Age research in Central Europe and the Mediterranean, where studies in pollen, charcoal and alluvial sequences have generally recognised this period as indicative of significant human impact on the landscape (Grove and Rackham 2001; Jacob *et al.* 2009; Tinner *et al.* 2005). In northeast Hungary, however, peat bog sequences show a decrease in arboreal vegetation, including elm (*Ulmus*), coinciding with an increase in cereals and mugwort (*Artemisia*) *ca.* 5000 BC, pointing to the establishment of arable fields by the Late Neolithic Tisza-Herpály Csöszhalom cultures in the region (Magyari *et al.* 2001).

In summary, the palaeoenvironmental evidence suggests that in most regions agriculture shows little to no impact on the landscape in the Carpathian Basin until the Bronze Age. Does this suggest an increase in agricultural production, or a reaction to increasing populations and the rise of social centres during the Bronze Age? Could geography and/or vegetation impact on this pattern, as the flat plains of Hungary, which are covered in steppe vegetation rather than forest, show human impact during the Late Neolithic. Could changes in climate effect agricultural production between the Late Neolithic and Bronze Age? These questions will be explored further in Chapters 8, 9 and 10.

2.2 Archaeological context

2.2.1 Chronology and cultural context

The chronological period under study includes the Late Neolithic (*ca.* 5000-4500), the Copper Age (*ca.* 4500-2700) and the Bronze Age (*ca.* 2500-900). The Carpathian Basin is an area now covered by several modern nation states, which has led to the development of different terminologies and chronologies for periods, cultures and regions. To date, the archaeological record provides a mosaic of small and large-scale studies throughout the region (e.g. Bailey *et al.* 1998; Bailey 2000; Dimitrijević *et al.* 1998; Gimbutas 1965; Harding 2000; Jovanovic 1988; Kalicz and Raczky 1987a; Sherratt 1983). The different cultural groups identified are generally distinguished by differences in ceramic assemblages, but in some areas, such as eastern Hungary, the distinctions extend beyond ceramics to settlement organization and even to subsistence practices (Kalicz and Raczky 1987a; Visy 2003). The distribution of cultural traditions/iconography changes through time, with territories regularly expanding and contracting. As a result, cultural boundaries are not clearly defined and tend to blend with neighbouring groups, except where naturally delineated boundaries exist. As such, figures 2.4-2.9 summarise the cultural history and terminology used for the Carpathian Basin; however, the borders are not exact and are only used to illustrate generally recognised cultural areas from which the archaeological background can be explored.

2.2.2 Settlement

Settlements form a basic component of any agricultural analysis as they are indicative of where farmers spend their daily lives. The nature, location and organisation of settlements impact greatly on the accessibility of resources, land-use and the production of food and goods. During the Early Neolithic, settlement in the Carpathian Basin was characterised by small open settlements and pit-dwellings situated along river courses. By the Late Neolithic (*ca.* 5000 BC) some sites began to be densely settled, with episodes of vertical rebuilding of small nuclear family houses, generating large ‘tell’ settlements of *ca.* 5-10 ha, e.g. Divostin and Vinča (Serbia) (Fig 2.10). Two further settlement types are also found: ‘tell like’ sites, which are less densely occupied resulting in a flatter form, and horizontal settlements, which are single layered settlements and can be more difficult to identify archaeologically (Kalicz and Raczky 1987a). At Late Neolithic sites, especially in Hungary, buildings were larger (up to 20m long) and multi-roomed, which probably housed an extended family unit (Visy 2003:101). Fortifications, such as ditches and palisades, become a common feature at Late Neolithic tell sites e.g. Berettyóújfalu-Herpály (Hungary) and Sopot (Croatia). The shape of the buildings becomes more rectangular, with evidence of internal partitioning and, in some cases, a second story floor, e.g. Gradac-Zlokućani and Gumnište (Serbia)

(Raczky 1987; Srejović and Tasić 1990). Settlement locations generally persist near rivers or streams; Tisza culture settlements, for example, are typically located on elevated ground above the Hungarian floodplains (Kalicz and Raczky 1987a).

Indications of greater permanence and organisation within settlements is possibly seen during the Late Neolithic. For example, at Divostin (Serbia) the Early Neolithic phase is characterised by irregularly situated pit-huts which by the Later Neolithic become organised buildings sharing a NE-SW orientation, with larger and deeper floors, more substantial walls and the use of more durable materials (Bailey 2000: 57; McPherron and Christopher 1988). Research at Selevac (Serbia) also suggests that settlement patterns changed from semi-sedentary to fully sedentary, and subsistence strategies transformed from low producing horticulturalism and herding to relatively intensive agriculture by the Late Neolithic (Kaiser and Voytek 1983; Tringham and Krstić 1990).

In the final phases of the Late Neolithic many of the large tell sites like Selevac, Potporanj, Divostin, Opovo and Vinča (Serbia) (Fig 2.10), as well as smaller villages of the Vinča culture, are abandoned (Bankoff and Winter 1990). At some settlements there is also evidence of a distinct final burning phase (Tringham 1994). Settlement continuation from the Late Neolithic to the Early Copper Age is seen at some sites, such as Gomolava (Jovanovic 1988), and in some regions, e.g. Lengyel culture (western Hungary) (Visy 2003:126); however, some show an occupation hiatus indicated by a sterile soil layer, such as at Berettyóújfalu-Herpály (Hungary) (Kalicz and Raczky 1987b; Parkinson *et al.* 2002-2004). In some regions, such as the Tiszapolgár area of eastern Hungary, settlements changed from large tells and single layered sites to a denser network of smaller settlements of *ca.* 0.5-1 ha located not only in the lowland plains but also in the upland areas (Bognar-Kutzian 1972; Chapman 1997; Sherratt 1983; Whittle 1996).

In the Körös River Valley (Hungary), an area of approximately 2,000 km², researchers in the 1980s identified only 34 Late Neolithic sites, but *ca.* 243 Early Copper Age sites (Parkinson *et al.* 2004), supporting the view that populations dispersed and formed smaller communities. Rebuilding episodes reverted to horizontal rather than vertical construction, with new structures being erected adjacent to the abandoned ones, e.g. Vésztő-Bikeri (Hungary) (Yerkes *et al.* 2009).

Domestic structures also changed from large multi-roomed buildings, to small (*ca.* 5m long) less substantial single-roomed dwellings (Bognar-Kutzian 1972; Kalicz and Raczky 1987a). This has important implications for household and settlement organisation. No significant change is seen in the distribution of cultural groups, although a number of new traditions occur, which suggests a degree of continuation from the Late Neolithic. Similarities in site layout and ceramic assemblages also suggest widespread interaction between settlements.

The restructuring of Early Copper Age societies into smaller communities has been traditionally seen as a move from sedentary farming to a more mobile, pastoral-based system (Barker 1985; Bognar-Kutzian 1972; Gimbutas 1977; Kalicz 1970); however, until recently most Copper Age research was focused mainly on cemeteries (Bognar-Kutzian 1963; Derevenski 1997). New settlement excavations are presenting a far more complex picture. Research in the Körös region of Hungary has revealed great variability in the formation, duration and layout of Early Copper Age settlements with some retaining Late Neolithic traditions (e.g. ‘tell like’ settlements and burials) while others show the move to smaller Copper Age sites (Parkinson *et al.* 2010). Sládek *et al.* (2006) point out that numerous Copper Age settlements are located in similar environments to those of the Neolithic and that the recovery of specialised agricultural artefacts and archaeobotanical remains suggest that agriculture played a larger part in Copper Age society than previously believed. The rise of large cemeteries is suggested by some authors to indicate a change in society’s focus, with the cemetery symbolising the permanence of a community rather than the settlement (Kalicz 1970); however, some settlements, such as Vésztő-Bikeri (Hungary), show a distinct level of permanence with organised buildings and ditches, indicating labour investment, and discrete activity areas suggesting a compact social and economic unit (Parkinson *et al.* 2002-2004).

By the Late Copper Age (*ca.* 3000 BC) large settlements once again begin to develop, as seen at Vučedol (Croatia) (Balen 2005a), with evidence of fortifications. Some suggest that the increase in fortified settlements was a response to population incursions into the Carpathian Basin from Eastern Europe, the Aegean and northwestern-Anatolia (Ecsedy 1979; Gimbutas 1973). The series of fortifications found at the settlements of the Vučedol Culture, located along the Danube, are suggested to be a protective border from external forces (Tasić 2003-2004). It is unclear, however, whether these are invasions or peaceful migrations (Bankoff and Winter 1990). On the other hand, these fortifications may have resulted from the amassing of new wealth in response to the emergence of new copper metallurgical centres in the Carpathians (Jovanovic and Ottaway 1976; Jovanović 1971). The expenditure of labour required to fortify settlements would suggest longer occupation than that associated with a more mobile subsistence base (Yerkes *et al.* 2007). The existence of socio-economic centres, with potential strategic, hierarchical and communication roles has also been proposed for a number of large Kostolac and Vučedol culture sites in Croatia, such as Vučedol and Sarvaš (Balen 2002).

The European Bronze Age (*ca.* 2500-750 BC) is a period characterised by the rise of 'élites' and social ranking (Earle 2002; Harding 2000; Kristiansen and Larsson 2005). The new structure of Bronze Age societies had a direct effect on settlements, resulting in the appearance of larger more substantial sites (Kovács 1977). Tell sites become widespread during the Bronze Age, along with the appearance of 'tell cultures', particularly found along the Danube and Tisza, on islands surrounded by water or swamps (e.g. Nagyrév, Hatvan, Ottomány cultures) (Gogâltan 2011; Visy 2003:142). The defensible location of tells and the development of fortifications suggest a change in society, especially as these characterise a number of cultural groups during the Bronze Age. People of the Hatvan culture (*ca.* 2300-1500 BC) had networks of fortified settlements located at a distance of no more than 5-10 km, with ditches and/or ramparts (Visy 2003:145). Not all tells were fortified, e.g. Vărşand and Socodor (Romania) (Gogâltan 2008), and settlement types and their location varied from open villages in the lowlands to fortified hilltop settlements (Bailey 2000:242). Within the settlements, buildings were similar to the Copper Age single-family houses, although larger in some cases, consisting of one or two roomed timber framed dwellings, either rectangular or circular in shape with outer buildings for specialised activities, such as weaving or leather working (Harding 2000; Kovács 1977, 1999; Čović 2010). Sites with regularly spaced houses and roads, such as Middle Bronze Age Füzesabony-Öregdomb (Hungary) and Late Bronze Age Feudvar (Serbia), suggest organised planning of the streets and buildings during the construction of the settlement (Hänsel and Medović 1991; Stig Sørensen and Rebay-Salisbury 2008; Whittle 1996).

The Bronze Age (*ca.* 2500-900 BC) in Southeast Europe is also recognised as a period of large population migrations from the Russian steppes, the Aegean and Anatolia (Childe 1950; Kovács 1977; Price *et al.* 1998; Todorova 1989). Anthony (1997) suggests migrations occurred in a circular pattern, where populations moved only to familiar steppe environments of the plains whilst keeping open long-distance social contacts back to the Pontic steppe zone. The development of numerous smaller cultural groups in the Early Bronze Age would, to some extent, be linked to these migrations; however, it has been suggested that social change occurred gradually as a result of other economic and social factors (O'Shea 1996).

The expert metallurgical and mining knowledge cultivated through the Copper Age allowed the Carpathians to once again become a significant metallurgical centre, especially after the decline of the Únětice societies of Central Europe at the end of the Early Bronze Age (Kristiansen and Larsson 2005). The rise of wealthy bronze-producing societies during the Middle Bronze Age, who were supplying large areas with their products, were possibly organised around a central tell, many of which were fortified (Kovács and Stanczik 1988; Kristiansen and Larsson 2005; Sherratt and Sherratt 1993). Gogâltan (2008), examining micro-regions in the Carpathian Basin, identified a distinct pattern involving a central tell with periphery settlements and cemeteries. He suggests that the central tell was a political centre that protected the surrounding territory, as well as being a major place of manufacture which likely controlled exchange in the region (*ibid.*). The smaller outer settlements, on the other hand, grew the crops and raised the animals.

By the end of the Middle Bronze Age (*ca.* 1200 BC) many of these tells were abandoned, e.g. Jászdózsa-Kápolnahalom (Hungary), with some showing evidence of a burning phase e.g. Szakáld (Hungary) (Gogâltan 2008; Hänsel and Medović 1991; Tóth *et al.* 2005). Pollen evidence from the Polgár region in Hungary indicates renewed forest growth *ca.* 1000-850 BC, supporting the theory of settlement abandonment (Chapman *et al.* 2009). After a hiatus in occupation many settlements were re-occupied e.g. Százhalombatta (Hungary) (Sofaer 2006); however, the reasons behind this are still uncertain. The occupation of large tells in the Late Bronze Age are seen at sites such as Feudvar, Židovar and Gomolava (Serbia) (Tasić 2003-2004). In addition, the Late Bronze Age sees the establishment of a new type of fortified settlement located on high promontories within the Carpathian Basin. Hillforts have been found particularly in the mountainous regions of Croatia at sites such as Kompolji, Vrebec, Smiljan and Prozor (Dimitrijević *et al.* 1998); however, it is not until the Iron Age that hillforts become a widespread settlement type in the region.

2.2.3 Ritual

Daily life was, and still is, infused by various rituals, ceremonies and festivals, with the enactment of ritual behaviours and traditions bringing communities together as well as setting them apart. Rituals are based on a sequence of predetermined actions; however, archaeologically only the physical results of such activities (e.g. burials, remains of feasts or symbolic objects) are recovered and much of their meaning is lost. Burials are particularly useful in revealing aspects of the living community, social differentiation and their attitudes towards death and the afterlife. In relation to agriculture, rituals would impact and be impacted upon by the production and availability of food. Some of these may include fertility rituals to ensure a good harvest, the availability of special foods for feasting, or the availability of labour. Ritual activities will also have an effect on formation processes at an archaeological site and can affect the interpretation of archaeological and archaeobotanical remains (See Chapter 6 for further discussion).

In Southeast Europe, Early Neolithic burials tend to be found within settlements and/or buildings. For example, nine individuals were discovered in the early levels at Vinča (Serbia), and two people were found buried inside pit-huts at Golokut (Hungary) (Bailey 2000:123). Grave goods were few and simple and included different animal bones, quartzite and pottery (Borić 1996). By the Late Neolithic cemeteries become more common, although to varying extents. At Gomolava (Serbia), people were buried in a distinct area within the settlement with an array of grave goods including malachite, polished axes, flint and copper ornaments (Bailey 2000; Kalicz 1992; Siklósi 2004). At Berettyóújfalu-Herpály (Hungary), several inhumations were placed in disused parts of the site (Kalicz and Raczky 1987a). During the Late Neolithic, ritual objects such as figurines are frequently found as well as ritual deposits within pits, wells, shafts and house foundations (Bailey 2005; Gimbutas 1991; Siklósi 2004). At Lengyel culture and other Central European sites, rondels (circular earthworks of concentric ditches ca. 70m wide cut by causeways) have been identified and are believed to be multi-purpose monuments with a distinct ritual function that served as a central point for a number of settlements (Pásztor *et al.* 2008).

In Southeast Europe, at the end of the Late Neolithic/Early Copper Age, house burning is commonly identified. Although other explanations have been suggested, such as accidental fire, invasion, or fumigation practices, some take the view that the burning of the houses was part of a ritual act (Stevanović 1997; Tringham and Krstić 1990). This has been suggested due to the presence of artefacts found in the burnt houses that would not have been found in typical occupation debris. For example, within many of the burnt houses in Hungary large collections of whole pots (in some cases up to 200) were found within the remains, while others contained formally laid out skeletons, suggesting a possible burial ritual (Raczky 1982-83, 1987). At Opovo and Gomolava some of the houses show a layer of burning followed by a secondary deposit of animal and plant remains, interpreted by Tringham as a reluctance to let the house completely die (Tringham and Krstić 1990).

During the Early Copper Age, large long-lived formal cemeteries appear that are isolated and unassociated with settlement sites (Bognar-Kutzian 1963, 1972; Chapman 1997, 2000). The largest known cemetery, at Tiszapolgar-Basatanya (*ca.* 4500-3600 BC) (Hungary), contained 166 burials and was estimated to have been used for over 900 years (Bognar-Kutzian 1963); however, not all communities buried their dead in this fashion. In the Tisza region of Transdanubia, few burial grounds are found in the Early and Middle Copper Age and it seems the Neolithic style of inhumation burial persists (Visy 2003:132). Other changes in mortuary practice include an increase of grave goods found in burials such as pottery, animal bone, tools, copper and gold (Derevenski 2000; Renfrew 1978). Differentiation between sex and gender in burial practices is also present during the Late Neolithic/Early Copper Age. In Hungary, Tiszapolgár burials are complex, with specific grave goods being allocated to different age groups, as well as to different burial positions (Derevenski 2000). The animal and human figurines present during the Neolithic are conspicuously absent during the Early Copper Age (Makkay 1994:73) and it is not until the Middle/Late Copper Age that human and animal figurines once again appear (Visy 2003:133), usually as a complementary part of a vessel. The famous ‘Vučedol dove’, a 20cm clay vessel in the shape of a dove or possibly a partridge, is believed to have been used as a ritual drinking vessel (Težak-Gregl 2008). By the Late Copper Age, Baden culture cemeteries are characterised by new animal burials, predominantly cattle, as well as fired clay cart models (Anthony 2007:159; Chapman 2000:312).

Burial customs during the Bronze Age are particularly complex, varying from region to region and between cultures, becoming, in some cases, a distinct cultural tradition. This is seen particularly within the Urnfield culture of the Late Bronze Age, which had a distinct urn burial tradition (*cf.* Fig 2.9). In the Late Copper/Early Bronze Age, single-graves and family groups in large cemeteries appear, along with élite or high status inhumations in barrows (or Kurgans) (Chapman 2000:165; Anthony *et al.* 1986; Kovács 1977). Thousands of these barrows litter the Carpathian Basin, supporting theories on population movement during the Early Bronze Age from the eastern European Pit Grave culture (Gimbutas 1965, 1991). Typically, these barrows are single graves placed in rectangular pits, lined with textiles and a timber structure which is covered by a soil mound (Bátora 1999).

Other forms of burial were performed at the Nagyrév culture cemetery of Nagyrév–Zsidóhalom (Hungary), including a mixture of cremations and inhumations, located in clusters around the cemetery, possibly indicating distinct family groups (Visy 2003:145). An array of grave goods was also found, especially in the cremation burials, and included food remains left in jugs, decorated pots, bowls, and weaponry (*ibid.*). The location of different types of burials is also seen within the Cetina culture where inhumations generally concentrated in the valley of the upper Cetina River, while cremations dominated the surrounding areas (Della Casa 1995). Age discrimination can be seen in the Maros culture traditions in Hungary, where infants below 4 years were not buried within the main ‘adult’ cemeteries but were found buried with grave goods in building foundations or middens (O'Shea 1995:129).

By the Middle Bronze Age, some groups had begun to differentiate themselves from their neighbouring cultural groups. For example, in Hungary each cultural group had a distinctive burial rite: the Encrusted Ware culture implemented scattered cremations; the Vatya culture performed urn burials; and the Füzesabony culture carried out inhumations (*cf.* Fig 2.8). These traditions continued into the Late Bronze Age with the distinct Urnfield and Tumulus burial traditions as well as the emergence of élite inhumations, such as the lavish ‘warrior’ and wagon graves (Boos 1999; Pare 1999). The specific organisation and ritual behaviours associated with burials during the Bronze Age could reflect an increase in social organisation and/or the rise of ‘elites’.

2.2.4 Exchange systems

The beginnings of market systems in prehistory are poorly understood; however, systems of exchange would have been an important economic, social and cultural endeavour that allowed communities to not only exchange goods but also people (e.g. through marriage or migration) and knowledge. The network of river systems within the Carpathian Basin would have facilitated the interaction of different communities as well as providing a conduit through which people could migrate to new regions. Thus, exchange and the networks created would have had a distinct influence on different cultural groups and their traditions. In terms of agriculture, exchange would have facilitated the introduction of new technologies, new plant and animal species, new crop husbandry techniques, as well as allowing the trading of surplus goods.

During the Neolithic, interregional exchange networks seem to be relatively widespread throughout Southeast Europe with the trading of stone, flint, obsidian, and in the later period the trading of copper (Ammerman *et al.* 1990; Shackleton and Elderfield 1990; Thorpe *et al.* 1984). In addition, relations with the Aegean can be seen in the large number of *Spondylus* and other marine shells found at sites within the Carpathian Basin. By the Late Neolithic, copper trinkets and personal adornments begin to circulate from copper mines within the Balkans and Transylvania (Kalicz and Raczky 1987a). Connections can also be seen between neighbouring cultures through similarities in pottery styles. At the site of Csóka

(Hungary), a Vinča style vessel containing 'prestige' items was assumed to indicate Vinča culture imports from the south (Antonović 2006).

The transition from the Neolithic to the Copper Age, as seen in the change in cultural groups, settlement and burials, also sees an increase in interaction over a wide geographical area. Small copper items originating from the Carpathians have been found as far as Scandinavia and the Ukraine (Sherratt 1998:10). In addition, the long-distance exchange networks of the Neolithic (which brought 'exotic' goods such as *Spondylus* bracelets from as far away as the Black Sea) would have needed to be re-structured in order to distribute these new goods (e.g. copper, gold, and chert) to the cultures of the Carpathian Basin, Central Europe and the Mediterranean (Parkinson *et al.* 2004). The development of local metallurgical centres in the Carpathian Mountains may have encouraged more intense local exchange as well as expanding long distance regional exchanges (Jovanović 2009; Šljivar 2006). The emergence of these metallurgical centres, due largely to the uneven distribution of resources, allowed the unequal growth of material wealth in many regions (Todorova 1978). Therefore, the nature of Copper Age societies varied regionally, depending on local geography, accessibility and socio-economic inclinations. It is suggested that the strong metallurgical base of the Vučedol culture, seen in the arc of mines along the mountains of the Carpathian Basin, would have resulted in faster technological innovations closer to these centres, while those further afield would have developed at a slower rate, holding on longer to Late Neolithic values/traditions (Jovanović 1971).

Exchange networks developed further in the Bronze Age, with goods travelling both by land and sea from the Near East to Britain at a local, regional and inter-regional level (Harding 2000:195). From ceramic studies in Hungary, exchange was suggested to be highly localised (up to 10 km) and conducted through personalised community networks (Earle *et al.* 2011). Exchange would have been greatly helped with the widespread adoption of the wheel, which first appears in Europe during the Copper Age (Harding 2000:165), and would have been used to construct vehicles not only for exchange but for agriculture and warfare. At the same time the horse first appears in Beaker and Early Bronze Age contexts in various parts of Europe and soon becomes harnessed for traction purposes (Dietz 1999; Harding 2000).

Seafaring also came into its own during the Bronze Age with extensive trading along the coasts of Europe and the Near East (Agouridis 1997; Gale 1991; Webb *et al.* 2006).

Evidence suggests that local trading of food stuffs was commonly practised, either as a result of different regional growing conditions or as a consequence of specialisation by particular groups; however, due to issues of preservation, only foodstuffs that are dried or salted are likely to have been transported. *Lallemantia* seeds, from which oil is extracted, are not found in Greece until the Early Bronze Age (Jones and Valamoti 2005). As the plant is not native to Greece, its appearance suggests long distance networks with communities in Anatolia (*ibid.*).

The Bronze Age can also be seen as a period of metallurgical innovation, especially with the development of bronze weapons, such as swords and spears, as well as armour. Possible objects of prestige and power are also indicated from the highly decorated weapons, such as battleaxes and shields (Visy 2003:157). The Late Bronze Age is characterised by a massive increase in bronze production and consumption with large numbers of weapons, mainly swords and spearheads, and sheet metal for making items such as body armour, being circulated around the whole of Europe (Harding 2007). Northeast Hungary in particular becomes an important metal-working centre (Chapman 2009). The increased demand for bronze items, especially weapons and prestige goods, once again reflects society at the time, highlighting rising warfare and the segregation of social ranks. Work by Kristiansen (2007) in northern Europe suggests that during the Early Bronze Age, societies were decentralised and self-organised with no need of a 'chief', but by the Late Bronze Age these societies developed institutionalised hierarchies, with central places of power.

2.2.5 Farming

2.2.5.1 Animal husbandry

From the time when domesticated animals first appeared in Southeast Europe *ca.* 6000 BC, animal husbandry played a key role in the lives of early farmers. Sheep and goats (ovicaprids) were the most common animals kept by Neolithic communities, followed by pigs then cattle (Bökönyi 1971); however, this pattern was not universal. Animal remains from sites of the Körös culture (Hungary), suggest that cattle and not pigs were the second most important domestic animal (Bökönyi 1971). Animal management strategies would have involved the movement of ovicaprids and cattle to adequate grazing areas, while pigs could have been left to roam freely for much of the year. The archaeobotanical analysis of animal dung, recovered from Late Neolithic sites in northern Greece, identified different seasonal grazing patterns between flat and tell sites (Valamoti 2004, 2007a). By examining the weed species present within samples characterised as animal dung, Valamoti (2007a) was able to identify that animals were kept near the tell settlements during the summer months (characterised by summer annuals and perennials). At the flat sites, the animal dung lacked these summer weed species, suggesting that the herds were seasonally moved away from the sites between late spring and early autumn (*ibid.*). Animal mortality rates have also been used to identify the year-round occupation of a number of tell sites in Serbia, such as Gomolava, Divostin and Opovo (Greenfield 1991), suggesting a sedentary animal husbandry regime.

Although the introduction of domestic sheep, goat, cattle and pigs would have allowed greater control over food procurement, hunting was still a major activity for Neolithic societies. At some Early Neolithic sites, such as Röszke-Ludvár (Hungary), up to 50% of the animal bone assemblage contained wild species (Bökönyi 1987); however, more recently work by Bartosiewicz (2005), examining over 50 sites in Hungary, has shown that hunting was generally less important during the Early Neolithic, but increased during the Late Neolithic. He also observed that overall over half the animal remains dominated by wild species originated from tell sites, while at horizontal sites domestic species dominated the assemblages (*ibid*.).

During the Late Neolithic and Early Copper Age, a shift in assemblage composition occurs, where cattle become the most dominant, followed by pigs and then ovicaprids (Bognar-Kutzian 1972; Bökönyi 1988; Greenfield 2005). This shift in animal exploitation has been suggested by Sherratt (1981) as a time of *Secondary Products Revolution*. His model suggests that the end of the Neolithic is marked by a process of socio-economic changes resulting from certain technological innovations, which diffused from the Near East, the Caucasus Mountains and the north Pontic steppes. These technological innovations and subsistence changes included the introduction of the light plough, the wheel and animal traction, and wool and milk production, which led to the spread of agriculture to marginal areas, widespread practice of grazing animals in open areas (incorporating the practice of transhumance), the establishment of a pastoral subsistence strategy, and greater population mobility and long-distance transportation of goods.

This model was, however, based largely on artefacts and iconographic representations from the Near East, such as ploughing and milking scenes, and from Europe, where evidence of wool textiles, yokes, ards, plough marks and models of carts and yoked cattle are found. More recently, changes in the way animals were utilised have been identified from other sources, e.g. zooarchaeological harvest profiles, bone morphologies and lipid studies (Evershed *et al.* 2002; Legge 2005). As to when these innovations began, some suggest that many aspects of the ‘revolution’ were already present in the Neolithic (Bogucki 1984; Chapman 1982). Lipid analysis has identified small-scale milking in the Late Neolithic (Copley *et al.* 2003; Craig *et al.* 2003; Spangenberg *et al.* 2006, 2008), and soil micromorphology analysis has identified traces of ploughing at early Linearbandkeramik (LBK) sites in Belgium (Craig *et al.* 2005; Fokkens 2008). The preservation and dating of plough marks are problematic and it is not until after 3500 BC when the construction of tumulus burials allows the soil under the mound to be preserved and securely dated (Greenfield 2010). Additionally, cattle mortality profiles and pathologies consistently show evidence of secondary products exploitation (e.g. traction, milking) in the Early Copper Age, although for ovicaprids this is not evident until the Late Bronze Age (Greenfield 2005).

The impact of these innovations would have been considerable in regards to food production and mobility. The use of the plough would have significantly increased the agricultural potential of lands previously uncultivated due to the time or effort needed to prepare the ground. Halstead (1995b:13) estimated that an ard plough was 15x faster than manual cultivation when it came to preparing the ground. In relation to labour, through the use of these new technologies, fewer people could have performed the same task with an increased product return. The use of wagons and pack animals would have allowed greater mobility of goods for local and regional exchanges. In terms of the effect on animal husbandry, milking would have allowed humans to harvest animal protein without slaughtering the animal and the use of wool would have allowed the development of new forms of textiles. The penetration of communities into 'marginal' environments during the Copper Age may indicate the adoption of the plough, allowing previously unused areas to be utilised for cultivation (Halstead 1995b). The movement of peoples into the highland areas, best suited for animal grazing, would have also allowed the development of secondary products to expand (Greenfield 1986; Sherratt 1981). It is unlikely, however, that all these innovations would have been incorporated everywhere at the same time, and they would have depended greatly on specific cultural, economic and environmental factors.

Other elements to be considered include the social aspects involved in the storage and redistribution of goods and the added status which may be associated with keeping livestock. Strong symbolic and ceremonial values may have also existed with certain domestic animals; for example, Russell (1998:50) suggests that cattle signified an important symbol of wealth and played a key role in rituals in Neolithic Europe. In particular, cattle burials are found either near or within human graves after 3500 BC in Germany and Poland (Pollex 1999). The plough in turn may therefore have signified a level of prestige or ritual significance (cf. Rowley-Conwy 1987).

As previously discussed, the Copper Age is characterised by changes in settlement patterns, with many suggesting that this period is indicative of a shift towards cattle herding rather than crop cultivation. Strontium isotope research on Neolithic and Copper Age human and animal tooth enamel, from the Great Hungarian Plain, indicate a shift from a narrow range of values during the Neolithic to a wider range during the Copper Age (Giblin 2009). This is suggested to be indicative of a change in how land and resources were utilised, which subsequently affected how strontium was absorbed into the body (*ibid.*). Soil analysis has also been used to demonstrate changes in animal husbandry, revealing a shift from local to more mobile strategies during the Copper Age (Lillios 1992, 1999).

Cattle continued to be the dominant species during the Early Bronze Age; however, by the Middle/Late Bronze Age the rearing of ovicaprids and pigs expanded considerably (Roblickova 2003; Shennan 1993). The increase in ovicaprids has been suggested by some as an increase in wool products, perhaps in response to the cooler climate which prevailed during the second half of the Bronze Age (Harding 2000:134). Bökönyi (1971) also suggests that the increase in pigs by the Late Bronze Age is evidence of a cooler climate as pigs would have adapted more easily to the climate change; however, site variability does exist and domestic stock-keeping would have been tailored to the local environment and economy. Wild fauna becomes exploited less at many Bronze Age sites and may be due to the reduction in wooded areas (Bökönyi 1987; Harding 2000:134). Where wild fauna is recovered there is a general trend away from wild aurochs towards red deer (Bökönyi 1987).

The beginning of the Bronze Age marks the introduction of the horse into the Carpathian Basin from the steppe areas of Eastern Europe. The utilisation of wild horses, possibly for food, is well attested from sites in Eastern Europe during the Neolithic (*ca.* 6000-4000 BC) (Kavar and Dovč 2008); however, evidence of domestication does not occur until *ca*. 4000 - 3000 BC, when horseback riding is indicated from items of horse tackle (*ibid.*). The introduction of this species into communities at this time would have had a significant impact on the socio-economic environment of the steppe people. The horse would have allowed people to move further and at a faster rate, resulting in greater exchange networks, as well as providing a military advantage over communities without the horse. Analogies with modern nomadic tribes of Mongolia and Kazakhstan, who practice equine pastoralism, demonstrate social and economic links between people and horses that permeate everyday life (Levine 1999). Socially, the number of horses a family has determines their wealth and status (*ibid.*). Economically the horse is used for both traction and food (e.g. horse flesh and milk), which is especially important in the winter months (*ibid.*).

The movement of people and goods between the Carpathian regions and the Pontic Steppes is believed to have contributed greatly to the introduction of the horse into the area (Anthony 2007; Manzura 1994). During the Late Copper Age/Early Bronze Age, the horse begins to appear in animal assemblages in the Carpathian Basin and is a characteristic element throughout the Bronze Age (Bökönyi 1971). Finds of bits with cheek-pieces and strap distributors carved from bone and antler have also been found at a number of sites in Hungary such as Tószeg–Laposhalom and Füzesabony–Öregdomb (Visy 2003:143).

2.2.5.2 Crop agriculture

The 'Neolithic package' of eight founder crops (i.e. emmer (*Triticum dicoccum*), einkorn (*Triticum monococcum*), barley (*Hordeum vulgare*), lentil (*Lens culinaris*), common pea (*Pisum sativum*), chick pea (*Cicer arietinum*), bitter vetch (*Vicia ervilia*), and flax (*Linum usitatissimum*)), was first introduced into the Carpathian Basin from the Near East *ca.* 6000 BC (Colledge *et al.* 2004; Price 2000; Zohary 1996). Since then crop cultivation became the staple of resident populations in the region; however, archaeobotanical evidence in the Carpathian Basin is sporadic, depending largely on the period or country being studied.

Greece, Bulgaria and Serbia are also relatively rich in archaeobotanical material for the Late Neolithic and Bronze Age (e.g. Dennell 1978; Jones 1981; Kroll 1991b; Renfrew 1979; Valamoti 2004), while only a handful of studies occur in Croatia, Bosnia Herzegovina, Romania, Albania, Macedonia and Slovenia, and no archaeobotanical finds have been recovered from Montenegro. Archaeobotanical evidence from the Copper Age is even less frequent. Recently, Gyulai (2010) published the archaeobotanical history of Hungary, cataloguing over 400 sites ranging from the Neolithic to the Late Middle Ages, contributing greatly to current agricultural evidence. The plant remains are generally carbonised, although some waterlogged and mineralised remains are also found, as well as impressions from pottery and daub. Due to the complexities of examining such a large area, this section will summarise general trends in the archaeobotanical literature (See Chapter 8 and 9 for further discussion).

In the Early Neolithic, naked barley (*Hordeum vulgare* var. *nudum*), emmer, einkorn, lentil, pea, grass pea and bitter vetch are the most common finds at sites in Southeast Europe (Table 2.2). Club wheat (*Triticum compactum*) is also identified at a number of Early Neolithic Starčevo sites, such as Obre I, Kakanj, Anza I, Mesarci (Borojevic 2006:66-7). Throughout the Neolithic, einkorn and emmer are the principle crops grown, although in varying proportions. Some suggest that emmer and einkorn remains may represent a mixed or 'maslin' crop (cf. Jones and

Halstead 1995). At Gomolava, however, van Zeist suggests that einkorn may have been the predominant crop during the Late Neolithic, with emmer being only a minor admixture (Van Zeist 2003). Einkorn is also more prominent at Central European Bandkeramik sites (Kreuz *et al.* 2005).

Over the last decade a ‘new’ type of glume wheat, identified by Jones *et al.* (2000b) at Late Neolithic Makri, Arkadikos and Makriyialos (Greece) and Bronze Age Assiros Toumba (Greece), is becoming more commonly identified at sites across Central and Southeast Europe (e.g. Kohler-Schneider 2003). More recently, a large quantity of ‘new’ glume wheat glume bases (6,226) was identified at the Late Neolithic site of Hódmezővásárhely-Gorzsa (Hungary), suggesting it was the main crop cultivated at the site (Medović and Horváth 2011). Although evidence of ‘new’ glume wheat is still relatively rare, its presence across Europe suggests that it was widely cultivated at this time.

Barley, mainly naked and hulled six-row varieties, is frequently encountered at Late Neolithic sites in the Carpathian Basin, although usually only in relatively small quantities. In addition, bread, durum and club wheat (*Triticum aestivum/durum* and *Triticum compactum*), spelt (*Triticum spelta*) and broomcorn millet (*Panicum miliaceum*) are only encountered sporadically (Füzes 1990, 1991). Evidence of rye (*Secale cereale*) is rare and has only been recorded at Skoteini Cave (Greece) (Kroll 1997a) and Polgár 31 (Hungary) (Gyulai 2010); the exact role of these crops is as yet uncertain. Broomcorn millet has, however, been found in quantity at Kleiner Anzingerberg (Austria) (Kohler-Schneider and Caneppele 2009), and shows the early westward spread of the species.

The main pulses recovered from Late Neolithic sites in the Carpathian Basin include lentils, pea, bitter vetch and grass pea. At Berettyóújfalu-Herpály and Tizapolgar-Csőszhalom, large deposits of pea attest to its agricultural importance (Gyulai 2010). Broad bean (*Vicia faba*) is rare in the Late Neolithic, only being found at Lengyel, Hungary (Gyulai 1993) and Skoteini Cave, Greece (Kroll 1997a). Small quantities of flax have been found across Southeast Europe at sites such as Opovo (Serbia), Uivar (Romania), Battonya-Parázstanya (Hungary) and relatively rich concentrations at Makriyalos, Arkadikos and Mandalo (Greece) (Borojević 2006; Fischer and Rösch 2004; Gyulai 2010; Valamoti 2004). The recovery of a textile fragment from Opovo also provides evidence of flax fibres being utilised at this time (Borojević 2006; Tringham *et al.* 1992). Wild fruits are consistently recovered throughout the region, indicating the utilisation of wild resources by the local populations. The most common fruits found include cornelian cherry (*Cornus mas*), elderberry (*Sambucus* sp.) and blackberries (*Rubus* sp.).

Other sources of evidence of agricultural activity can be seen from various artefacts and agriculturally associated structures or features that have been identified from a number of Late Neolithic sites. The construction of storage pits found within settlements and buildings can be seen at Vésztó-Bikeri (Hungary) and Selevac (Serbia), as well as clay storage bins at Berettyóújfalu-Herpály (Hungary) (Raczky 1987; Sarris *et al.* 2004; Whittle 1996:109). The production and use of large, wide-mouthed lidded storage vessels, which became more common in the Late Neolithic, is further evidence of grain storage (Bailey 2000; Perlés 2001). Flint sickles and grinding stones are common features at many sites, and in Bulgaria grinding stones are frequently found imbedded in building floors near hearths and silos (Bailey 2000).

Evidence of Copper Age agriculture in the Carpathian Basin is relatively infrequent and less investigated. Recently, Gyulai (2010:82) suggested that the minimal recovery of crops at a number of Early Copper Age sites in Hungary supports the view that agriculture became ‘less important’ at this time, with a shift towards barley cultivation. He suggests this is either a distinct choice, resulting from the shift towards animal husbandry, or a reaction to environmental changes; however, distinguishing between Late Neolithic and Early Copper Age sites can be difficult as a number of tell sites have been dated to this transitional period with no discernible difference in the botanical assemblage.

Most of the archaeobotanical remains are recovered from Middle to Late Copper Age settlements (Table 2.3). The botanical assemblage is similar to that of the Late Neolithic, with a predominance of emmer and einkorn, as well as remains of naked and hulled barley, bread wheat, common and foxtail millet, and occasionally spelt. In Hungary, rye (*Secale cereale*) first appears at Keszthely-Fenékpuszta (Hartyányi *et al.* 1967-68).

Lentil, pea, grass pea and bitter vetch are found sporadically at sites such as Slatino (Bulgaria) (Marinova *et al.* 2002). Chickpea, which is found in Neolithic sites within Bulgaria and Greece, has also been recovered at the Late Copper Age sites of Yunatzite and Hotnitza (Bulgaria) (Marinova and Popova 2008). Chickpea is not found further northwest until the Middle/Late Bronze Age and in Hungary only as a rare find at Tószeg-Laposhalom (Gyulai 2010). Evidence of flax is scarce during the Copper Age, although this may be due to poor recovery techniques and poor preservation rather than its absence at the time. Other oil plants recovered include poppy (*Papaver somniferum)* found at Hočevarica (Slovenia), and the presence of charlock (*Sinapis arvensis*) at Öcsöd-Kendereshalom (Hungary) may also indicate oil extraction (Gyulai 2010). Evidence for the collection of acorns (*Quercus* sp.) at sites such as Csepel-Vízumű (Hungary) (Gyulai 2010) provides information not only about consumption behaviours but also aids in the reconstruction of the local environment.

Archaeobotanical remains from Bronze Age sites are far more frequent than those from the Copper Age, especially in areas of Hungary and Greece (Table 2.4). Although only three sites are present from this period in Serbia, the plant remains are from two large tells, Židovar and Feudvar, both of which produced a large quantity and wide range of plant remains (Kroll 1998; Medović 2002). The most important crops were einkorn and emmer, followed less regularly by barley, bread wheat, spelt and millet (both *Panicum milliaceum* and *Setaria italica*). Many authors suggest that there is a shift in the importance of emmer and einkorn cultivation, where emmer is more commonly grown in the Early Bronze Age and einkorn during the Late Bronze Age (Gyulai 2010; Kroll 1983, 1998); however, this trend does not occur at all sites; for example, emmer remains the dominant crop at Gór-Kápolnadomb (Hungary) (Gyulai 2010).

At the Late Bronze Age site of Dunakeszi-Székesdűlő (Hungary), a large number of broomcorn millet was recovered (Gyulai 2010) which may suggest a possible increase in the crop’s importance. The infrequent recovery of bread, club and spelt wheat throughout the Bronze Age suggests that they continue to be unimportant or may even be weeds in the main crops. Identification of domestic oat (*Avena sativa*) is extremely rare and rye, although recovered more frequently, is only found in small quantities. Lentils, peas, bitter vetch and grass pea all occur with regular frequency with the occasional find of broad bean (*Vicia faba*). Chickpea, which was largely restricted to Greece and Bulgaria, is found by the Late Bronze Age at Feudvar (Serbia) and Tószeg-Laposhalom (Hungary), although in small numbers (Gyulai 2010; Kroll 1997b). Oil plants found at this time include flax, poppy (*Papaver somniferum*) and gold of pleasure (*Camelina sativa*). In particular, gold of pleasure was recovered in large numbers from the Late Bronze Age sites of Židovar and Feudvar (Serbia) (Kroll 1997b; Medović 2002). Safflower (*Carthamus tinctorius*) is seen for the first time at Late Bronze Age Feudvar (Serbia) and Túrkeve-Terehalom (Hungary) and although it has connections with cosmetic use, Gyulai suggests it could have been used as a food colouring (Gyulai 2010:105; Kroll 1997b).

Fruit and nuts continue to be collected throughout the Bronze Age and a greater variety are recovered including more numerous finds of the woodland European grape (*Vitis vinifera ssp. silvestris*). The cultivated grape, *Vitis vinifera*, is closely related to the woodland species and morphological similarities between the seeds make it difficult to distinguish (Smith and Jones 1990). Woodland grape has been found in Greece since the Mesolithic (Franchthi cave); however, it is not until the Bronze Age that the exploitation of grape intensified (Renfrew 1995). Renfrew (1995) suggests that the development of viniculture and olive oil production in Greece characterised the Bronze Age and influenced the rise of the élites through the specialisation, centralisation and distribution of wine and oil. At Dikili Tash (northern Greece), evidence of grape pressing has been identified by Valamoti (2007b) from the charred remains of grape pips with skins. Eleven sites on Crete dating between 2000-1000 BC also have evidence of wine press instillation and numerous drinking vessels, especially at the palace at Knossos (Crete) (Hamilakis 1999; Palmer 1995), supporting the idea that wine was an important luxury commodity. In the rest of Southeast Europe woodland grape is found at a number of sites from the late Neolithic to the Late Bronze Age (Table 2.2-4), although there is little evidence to suggest the production and consumption of wine.

In addition to the range of crops found at this time, there are also a wide variety of other species that could have supplemented the diet. A number of medicinal plants have been identified at the Late Bronze Age site of Monosonmagyaróvár-Németdőlő (Hungary), including yarrow (*Achillea millefolium*), soapwort (*Saponaria officinalis*) and vervain (*Verbena officinalis*) (Gyulai 2010). At Dunakeszi-Székesdűlő (Hungary) herbs such as oregano (*Origanum vulgare*) were also recovered (*ibid.*). The increase in species generally seen during the Bronze Age may suggest a regime of crop diversification. Diversification is a strategy that can be used to minimise the risk of crop failure through the cultivation of a wide range of crops with different growing conditions. Authors also refer to increased diversification during the Bronze Age in areas of Western and Central Europe (Bakels 1991, 1998), and the Mediterranean (Valamoti and Jones 2003).

Agricultural methods during the Bronze Age are believed to have involved clearing new land through burning, then ploughing the soil and growing the crop without the use of manure until the land is exhausted and abandoned to be left fallow until it can be grown on again (Gyulai 2010:106). Examination of the weed species at Túrkeve-Terehalom, Monosonmagyaróvár-Németdőlő and Dunakeszi-Székesdűlő (Hungary) all suggest autumn-sown crops (Gyulai 2010). Other aspects of farming have also been inferred from the archaeobotanical remains. At sites such as Poroszló-Aporhát (Hungary), the recovery of weeds indicative of pasturing, as well as the recovery of short-handled Bronze Age scythes, effective for harvesting grass, suggests an increase in hay production during the Bronze Age (Gyulai 1993). The expansion of plough land is also inferred from the increase in open-ground herbaceous species, such as cornflower (*Centaurea* sp.), knotweeds (*Polygonum* sp.) and docks (*Rumex* sp.); at the same time that increased cereal pollen is recorded (Gardner 2002; Gyulai 1993). Sickles, commonly found in hoards along with bronze axes, are seen to increase during the Bronze Age. This may support the idea of increasing agricultural importance (Gyulai 1993; Harding 2000:130), although some suggest ritual connotations or simply the storing of sickles by community leaders over winter (Kristiansen 1998:106). Evidence of other cultivation tools, such as spades, mattocks and ards made of wood, which are present in northern Europe, are rare in the Carpathian Basin (Harding 2000:124).

2.3 Farming in context

The complex environmental and archaeological context of the Carpathian Basin, presented above, has highlighted trends that suggest distinctive changes in the socio-economic and technological setting of communities between the Late Neolithic/Early Copper Age and the Late Copper Age/Early Bronze Age. In addition, the two distinct climatic periods occur between the Middle Neolithic and the Middle/Late Copper Age (*ca.* 5500 BC - 3300 BC) and between the Late Copper Age and the Late Bronze Age (*ca.* 3000 – 1000 BC). But how do these patterns help us to understand the nature of farming systems during this period in Croatia and Serbia? This final section will briefly summarise issues and hypotheses which arise from these relationships.

2.3.1 Settlements

In summary, settlement patterns change from concentrated tell sites to small dispersed farms back to concentrated settlements in the Carpathian Basin. The changing dynamics in house and settlement size would have had an impact on the amount of food required and the amount of labour available, ultimately determining the parameters of the crop regime adopted. In addition, the adoption of new agricultural techniques may have allowed settlements to move to less fertile areas or required less labour input.

Hypothesis 1: The change in settlement structure could impact the type of farming practised at the site. Therefore differences in agricultural practices will be seen between settlement types (e.g. flat horizontal settlements and tell sites).

2.3.2 Ritual

The changes in burial customs from the Late Neolithic through to the Late Bronze Age indicates changes in people's ideologies and in the way they viewed their landscape. Ritual behaviour also provides a route through which botanical remains may have been deposited, which ultimately affects interpretation. For example, the burning of houses at some of the Late Neolithic tells produced large quantities of plant remains that may not have been 'characteristic' of the local diet, but foods specially collected and deposited. Identifying a 'characteristic' diet at a settlement is difficult and only by comparing different contexts (e.g. houses versus rubbish pits), can possible ritual deposits be identified; however, the local belief system is likely to have been interwoven into agricultural practices and as such the archaeobotanical record may be viewed as more than a simple change in cultivation regimes.

Hypothesis 2: Ritual behaviour will have an impact on the interpretation of archaeobotanical material from the prehistoric sites.

2.3.3 Exchange systems

The importance of exchange systems in the movement of people and goods would have had a great influence on agriculture. The introduction of the wheel and the horse during the Early Bronze Age would have allowed people to move further faster, and the use of waterways, beside which many of the tell settlements were located, would have acted as a conduit through which new innovations and ideas could spread. The establishment of exchange networks would have allowed farmers to exchange surplus goods and would have facilitated crop specialisation, as well as encouraging the development of distribution centres.

Hypothesis 3: The increase in exchange systems during the Bronze Age encouraged changes in agricultural practices (e.g. the introduction of new species, new technologies and/or techniques).

2.3.4 Farming

2.3.4.1 Animal husbandry

Animal husbandry methods are closely linked with agricultural regimes and the two would have significantly impacted on each other. Current hypotheses suggest that during the Copper Age agricultural focus changes from mixed crop and animal farming to predominantly animal husbandry. The increase in cattle at this time could have provided traction, ultimately reducing the labour required to prepare a field for cultivation. The reduction in labour may also link back to the reduction in house and settlement size during the Copper Age, with animals supplementing the workforce. By the Bronze Age, the introduction of the plough would have permitted the application of an ‘extensive’ cultivation strategy (involving smaller inputs per unit area resulting in smaller area yields), radically reducing the time taken to prepare fields for sowing.

Hypothesis 4: The use of the plough will have an impact on the type of agriculture practised at a settlement (e.g. the introduction of extensive agricultural regimes).

2.3.4.2 Agriculture

To date archaeobotanical research identifying and linking changes in agricultural regimes has been limited in the Carpathian Basin during the study period. The crop package that predominated during the Neolithic included emmer, einkorn, barley, pea, lentil, grass pea, bitter vetch, and flax. By the Late Neolithic in the Carpathian Basin new crop species (e.g. bread, durum and club wheat, spelt and broomcorn millet) began to appear more frequently in the archaeological record, although still in small quantities, and it is not until the Bronze Age that they become more common in the region. The archaeobotanical evidence from the Copper Age is far more sporadic, with few rich samples to allow a clear interpretation of agriculture at this time. The lack of archaeobotanical finds from sites has been used to suggest a reduction in agricultural importance, supporting the view that animal husbandry took on a more active role in societies. By the Bronze Age a wider range of crops begin to be cultivated, as well as the introduction of a number of new species.

Hypothesis 5: Changes in agricultural practices and/or species diversity will be seen during the Copper Age in Croatia, following similar patterns in Hungary.

Hypothesis 6: Climatic changes seen ca. 3000 BC will impact on changes seen in agricultural practices and/or species diversity.

2.4 Conclusion

The key areas highlight many avenues of interpretation for the choices farmers made within the parameters of their socio-economic, technological and environmental setting. New archaeobotanical evidence from Croatia, a relatively unexplored area, will provide a fuller picture within which to explore these themes. The re-examination of archaeobotanical material recovered from Feudvar (Serbia) will also provide a better understanding of the crop husbandry regimes employed at the site and how the community may have shaped or been shaped by these methods. The following chapter will present the methodology employed, providing a basis from which the questions posed by this study may be answered.

Chapter three
Methodology

This chapter presents the methods of analysis employed to examine the study sites and to address the research questions posed. The chapter begins by detailing the sampling and recovery strategies (3.1), followed by the laboratory and identification procedures (3.2). The quantification methods applied to the assemblages are then discussed (3.3).

3.1 Sampling and recovery

The dataset presented in this study consists of carbonised plant material collected from 19 sites; 18 located in Croatia and one in Serbia, ranging in date from the Middle Neolithic to the Late Bronze Age (see Appendix I for site descriptions:246). The dataset is not an intentional sampling of a region, but the result of chance opportunities that arose from excavations conducted in the last decade within Croatia. In addition, with the kind permission of Prof Helmut Kroll (Universität Kiel, Germany), who recovered and examined the archaeobotanical remains, and the current site director Prof Frank Falkenstein (Universität Würzburg, Germany), the opportunity arose to work on a largely unpublished Late Bronze Age archaeobotanical dataset from the Bronze/Iron Age site of Feudvar (Serbia). Samples from the western trench, excavated during 1988, dating to the Late Bronze Age were selected for analysis as the area yielded a large and diverse number of plant remains.

3.1.1 Sampling

The quality of the dataset available depends on the sampling and recovery methods employed at an archaeological site. In many cases this will hinge on the project's aims and objectives. In order to reconstruct a reasonable and representative picture of agricultural and domestic activities on a site, samples need to be collected from a wide range of structures and features (Hillman 1981). In addition, multiple samples within structures and features should be sampled, in order to identify the full range of activities associated with that area (*ibid.*). Samples also need to be large enough to sufficiently represent the deposited plant remains in that feature (Jacomet and Brombacher 2005).

How representative an archaeobotanical dataset is to the site is an important factor to determine, especially when comparing different sites which have different sampling strategies. One way to determine this is to grade a site as to its ‘representativeness’ (Jacomet and Brombacher 2005), allowing sites to be assessed to their analytical and comparative potential. Based on the categories used by Jacomet and Brombacher (2005:74), the following classifications were applied to determine the representativeness of the study sites:

1. Very good systematic sampling, with samples taken from multiple features across the site, including several houses sampled. Judgement samples also taken and different building phases distinguished.
2. Good systematic sampling, with samples taken from multiple features across the site. Judgement samples also taken, but there is at least one methodological problem, such as building phases are not distinguished or small samples taken.
3. Few systematically collected samples or only judgement samples with at least one methodological problem.
4. Samples taken from only one type of feature, with at least one methodological problem.

Different settlement types were excavated including flat, or horizontal, settlements which have only a few layers of occupation, and tell sites which have multiple episodes of rebuilding within a relatively concentrated area. Each sampling method was determined and implemented by the director of the excavation in relation to their own aims and objectives and in isolation from this project. In a number of cases the author was able to provide some help and advice on sampling and recovery either during or after the excavation. Sampling procedures therefore differ between the sites resulting in differences in the volume of sediment collected and the number of features sampled (Table 3.1). All the samples were recovered from archaeological features relating to human activities e.g. settlement areas such as house floors, pits, and ditches. See Table 3.1. for a summary of the sampling, recovery and the representativeness of samples from each of the study site.

3.1.2 Recovery

Various procedures have been employed to extract archaeobotanical material from samples, such as by size, through sieving, or by density, through flotation. It is important to note that none of these methods are 100% efficient: loss, damage and contamination may occur at any stage of the recovery process. The efficiency of flotation machines has been examined by authors such as Wagner (1982) and Wright (2005), who have demonstrated variation within and between these different methods. The type of soil and size of samples to be processed is a factor in choosing a recovery system. Flotation is well suited to large samples and especially to sandy sediments with light carbonised macro-remains. Flotation is less appropriate for clay-rich soils, as the sample may not disperse easily, which can impede the release of the carbonised material (Wagner 1988). Bucket flotation is useful for small samples, and in some cases can shorten the processing time and decrease the amount of remains that are damaged and lost because of continued submergence and agitation.

In both sieving and flotation, recovery efficiency is based mainly on the size of the meshes used. For example, if the sieve used is 1mm in size, any plant material smaller than this will be lost. This will have a large impact on what species are recovered and will ultimately affect interpretation. It is generally accepted that a sieve of 300-500 µm is sufficient for the recovery of most archaeological plant material, even though this does not correspond with the smallest plant remains such as Juncacaeae and Ericaceae (De Moulins 1996; Hosch and Zibulski 2003; Keeley 1978; Pearsall 2000).

Machine flotation and bucket flotation were the two principle methods employed at the study sites (Table 3.1). In the case of Feudvar, bucket flotation occurred during the excavation next to the Tisza River (Kroll 1998). All the samples from the Croatian sites were largely processed by workers after the excavation season had been completed. At the sites of Čista Mala Velištak, Turska Peć, Sopot, Vinkovci, 14 Matije Gupca and Slavća, bucket flotation was initially demonstrated by the author and only Turska Peć and Vinkovci, 14 Matije Gupca were fully processed by the author. Due to time restraints, only half the volume of each sample was processed from Turska Peć during 2009. At these sites, as well as Ravnjaš, Orubica-

Veliki Šeš, Crišnjevi-Oštrov and Slavća, a flot sieve of 250 microns was used (Table 3.1). At Feudvar, a flot sieve size of 300 microns was used, while at the remaining sites, i.e. the motorway sites and Vučedol, a flot sieve size of 1mm was used. All heavy residues were collected using a 1mm mesh.

3.2 Laboratory sorting and identification

All the samples from Croatia were analysed using the same method and although a few mineralised remains were identified and recorded, for this study only the carbonised remains are presented. For Feudvar, sorting and identification was carried out by Prof Helmut Kroll using a low power (10-40x) binocular microscope (Kroll 1998). Identification of the plant taxa from Croatia was established by the author using a low power (7-40x) binocular microscope. For identification purposes, the modern reference collections at the Institute of Archaeology, UCL and the School of Archaeology & Ancient History, University of Leicester were used as well as seed manuals (Bojnanský and Fargaová 2007; Cappers *et al.* 2006). The nomenclature used in this thesis is that of Polunin (1980), *Flowers of Greece and the Balkans*, for indigenous species and Zohary and Hopf (2000), *Domestication of Plants in the Old World*, for cultivated species. The term 'seed' is used throughout to refer to all seeds, grains, and fruit remains.

All the sites, except Turska Peć, were 100% sorted. At Turska Peć, six samples contained large amounts of carbonised remains. By measuring the volume of carbonised remains subsamples were taken of 50%, 25% and 12.5% (See table 4.7). At the highway sites, it was noted that due to the heavy clay soil, the carbonised plant material was not floating sufficiently. To reduce recovery bias at these sites, it was decided that all the residues would also be examined for carbonised seed remains. Measurements were recorded for the volume of charcoal within a flot and the total flot volume.

3.2.1 Identification criteria: crops

The identification of cereal remains at the sites was particularly difficult in some instances due to poor preservation. Of particular note in the assemblages was the identification of 2-grained einkorn, and glume bases of the 'new' glume wheat, a type of tetraploid glume wheat resembling *Triticum* cf. *timopheevi* (*cf.* Jones *et al.*

2000b). The problem with two-grained einkorn is their similarity to emmer grains having a flat ventral surface, although they are usually smaller and narrower (Kroll 1992). They are also similar to one-grained einkorn as they have a distinctive ventral compression near the pointed apex. The identification of the new glume wheat glume bases was based on the observations made by Jones (2000) and Kohler-Schneider (Kohler-Schneider 2003). These included:

- A narrow and deep attachment scar, similar to emmer.
- A prominent primary keel, projecting vertically when viewed from the abaxial face, like einkorn.
- The secondary keel is also prominent, as in einkorn, but sharply angled, unlike einkorn where it is rounded, with a clearly defined vein running along the keel, unlike either emmer or einkorn.

These glume bases were particularly distinct from the emmer and einkorn glume bases as they were more robust. Many of the glume wheat glume bases were, however, poorly preserved with no diagnostic features allowing identification to species.

3.2.2 Identification criteria for: fruits and wild/weed seeds

Once again poor preservation made identification of fruit and wild/weed seeds to species difficult. A large number could only be identified to the generic or even family level. In a number of cases, the fruit remains contained particularly identifiable characteristics to allow identification to species, including, *Physalis alkengengi* (Fig 3.1) and *Sambucus ebulus*. The category of 'indet fruit' was used where fruit shell fragments had no diagnostic features to identify them to genus.

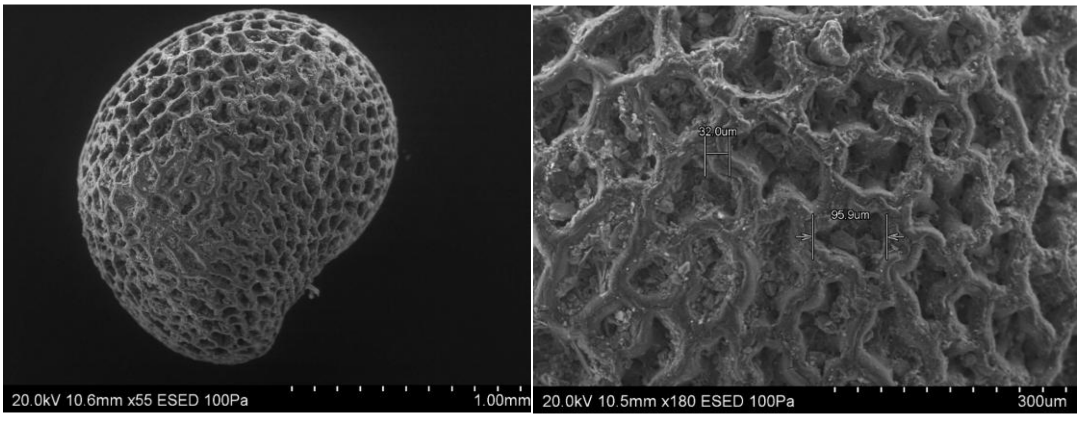

Fig 3.1. SEM photo of *Physalis alkengengi*, including close up of seed patterning, from sample SOP70 at the Late Neolithic site of Sopot. Photo taken by author

Grasses were particularly difficult to identify as many species have a degree of morphological overlap. Where possible, grasses were identified to genus; however, many could not be identified due to poor preservation. This resulted in two ‘Gramineae’ groups which contained ‘large’ seeds, similar to *Bromus*, and ‘small’ seeds, similar to *Poa* or *Phleum*. Unidentifiable millet grains, where the size and shape of the embryo and grain is distorted through charring, were grouped under ‘Panicaceae’. Similarly, a number of small and large legumes were recovered, but due to poor preservation could not be identified to either species or genus and as such were grouped into two classes. The ‘large seeded legumes’ are generally spherical seeds similar to *Vicia* which were often broken into the two cotyledons with the hilum broken off, while the ‘small seeded legumes’ are seeds similar in size to *Trifolium* and *Medicago*.

Rumex sp. and *Polygoum* sp. seeds were often broken or puffed by carbonisation and, with the exception of well preserved seeds of *Rumex acetosella* and *Polygonum aviculare*, no further attempt at identification was made. Cyperaceae seeds are also especially difficult to identify to species and only two types were identified to genus, *Carex* and *Scirpus*. The seeds of Chenopodiaceae were only identified to species level when the testa was well preserved, and although many seeds could be identified to *Chenopodium album*, the rest could not be identified beyond the generic or family level. Occasional mineralised remains were recovered, particularly from the family Chenopodiaceae and Caryophyllaceae.

3.3 Quantification

Quantification methods vary in the analysis of carbonised archaeobotanical samples, depending on the quality of the dataset available and the research questions being asked. Quantification can be seen as a means of numerical description, ranging from the tabulation of ‘raw’ data to the use of multivariate statistics, which permits interpretation in a variety of ways. The following sections outline the quantification methods applied to the current study.

3.3.1 Dataset

For the Croatian sites a standardised counting method was used, where each grain counts as one, fragments of grains being combined and estimated as to the number of complete grains they represent (whole grain equivalent (WGE)). Glume base fragments and oat floret bases were counted as one unless clearly representing part of another fragment, while whole spikelet folks were counted as two glume bases. The fruit and weed seeds were counted as one, even when only a fragment was found, except where large weed seeds were broken and clearly represented the same parts of the same seed. This was particularly applicable to the larger fruit seeds, such as *Cornus mas*, the large grasses and large legumes where the WGE was estimated. The WGE is used here as a consistent quantification of these partial seeds. These methods were also applied to the assemblage from Feudvar.

3.3.2 Database

In addition to the dataset collected from the study sites, published and unpublished archaeobotanical data from sites located within the Carpathian Basin (Middle Neolithic-Late Bronze Age) were also collected and compiled within Microsoft Office Access 2007. Only carbonised plant remains were recorded with the exception of impressions collected from Gornja Tuzla, Serbia (Hopf 1974). This allowed the easy handling of large amounts of archaeobotanical data. Each site was entered using a form and each entry represented one site, regardless of the number of publications, to prevent duplication. Each site received a six letter site code (based on the site name) and each phase within that site was defined by a number. For example, FEUDVA-1 represents the Early/Middle Bronze Age levels at Feudvar (Serbia). In addition, the type of preservation, sampling and recovery methods as well as species presence were recorded. Where available, further sample details were entered, including the number of taxa identified.

3.3.3 Univariate analysis

In the first instance, univariate analyses (where only one variable is examined at any one time) was applied to the datasets and analysed using Microsoft Excel 2007. Differences in sampling and recovery methods at the sites make direct comparisons difficult. As a result, a number of analyses were conducted in order to maximise the information available and provide a more accurate interpretation of the data.

3.3.3.1 Density

Density refers here to the number of identified seeds per litre of sediment floated, as well as the volume of charcoal per litre of soil. The density of the plant remains in an archaeological deposit is believed to be a direct reflection of the rate of deposition, where a low density of plant remains indicates slow accumulation, while high densities suggest rapid deposition (Jones 1991). Density is therefore widely used by archaeobotanists for assessing depositional patterns, preservation and recovery rates; however, this method is affected by preservation bias. Despite this, density is frequently used in combination with other indices, such as preservation, fragmentation measurements, or in the case of crop processing ratio analysis, in order to evaluate inter and intra-site differences relating to preservation and depositional histories. Densities were calculated per sample for all the study sites as well as the site mean and median, to allow comparison and make observations about depositional practices.

3.3.3.2 Proportional representation

This method displays the relative percentage of taxa. Here pie charts will be used to represent individual samples or sites as they are a useful tool for comparing species within a sample, between samples and between sites. All taxa must add up to 100% so identifying changes in composition may be difficult. This method is also easily biased by poor recovery techniques such as small sample volumes.

3.3.3.3 Ratios

Ratios display the relationship between two similar forms of data such as grains and chaff. Ratios are generally used to ‘even out unevenness in data’ (Pearsall 2000:196), and are used to identify the botanical composition of an assemblage. Ratios are applied to the Feudvar assemblage in concordance with the crop processing methodology outlined in chapter 6, where ratios of different plant components (i.e. grain, chaff, straw, weeds) are used to identify different crop processing stages (*cf.* Van der Veen and Jones 2006). Ratios are also affected by inconsistencies in processing and can only be used to compare plant remains that react in a similar way (Hosch and Zibulski 2003).

3.3.3.4 Frequency

Frequency displays the number of times a taxa is present in a sample per phase or site. Within this study, frequency is used to compare sites with different sampling and recovery strategies as a way of standardising the data between sites; however, inaccurate groupings of taxa, differential preservation and/or a low number of samples can still have an impact on the results.

3.3.3.5 Shannon diversity

The Shannon or Shannon-Wiener Diversity Index is used in ecology to measure the rarity and commonness of species in a community. This is calculated using:

$$H = \sum_{i=1}^{s} - (P_i * \ln P_i)$$

Where H is the Shannon diversity index, P_i the fraction of the entire population made up of species i, S is the numbers of species encountered and $\sum$ is the sum from species 1 to species S. Within this project, diversity will be calculated using CANOCO 4.5 to describe the relationship between the number of species and the number of seeds per sample (Chapter 7). This will allow samples with either high or low species diversity to be identified; however, this method is greatly influenced by preservation, the size of sample and the quantity of plant remains recovered, which can make it difficult to compare differences within or between sites.

3.3.3.6 Preservation indices

Preservation indices are used to indicate the state of preservation of a seed through the identification of certain characteristics such as the popping of endosperm or whether the seed's epidermis is intact (Alonso *et al.* 2008; Bouby and Billaud 2005; Braadbaart 2008; Hubbard and Azm 1990; Wilson 1984). As a result, it is widely understood that while charring in a lower temperature range can preserve seeds with their morphology retained, higher temperatures usually cause a loss of seed coats and glumes, severe shortening and swelling or complete disintegration (Boardman and Jones 1990; Braadbaart and Bergen 2005; Braadbaart 2008; Pearsall 2000; Wright 2003). Experimental studies have also linked the shiny surface on cereal caryopses to their having been soaked before combustion (Valamoti 2002), although other experiments also show a correlation between vitrinite reflectance of pulse seeds and the temperature to which they were heated (Braadbaart *et al.* 2004).

Although experimental studies have shown patterns that allow us to interpret the changes that the plant material undertakes during charring, it is not yet possible to analyse charring in a quantitative way. Therefore, preservation can only be analysed qualitatively, in combination with experimental results, to differentiate large fires, accidental burning or other processes that have resulted in the carbonisation of the remains. A preservation index was devised for the samples at the Croatian study sites based on the descriptive scale used by Hubbard and Azm (1990) to determine heat exposure. Each sample was assigned a preservation class based on the characteristics of >75% of the seeds within that sample. The following criteria determined which class that sample was assigned:

1. Perfect (>75% of the seeds showed no signs of distortion and the epidermis was completely intact)
2. Epidermis virtually intact with only slight puffing of the seeds
3. Epidermis incomplete and the seeds are clearly distorted
4. Fragments of epidermis remain with gross distortion
5. Identified by gross morphology only

3.3.4 Multivariate analysis

Multivariate analysis is used to simultaneously explore multiple variables within an assemblage and is applicable where datasets consist of a two-way matrix, e.g. samples and species (Gauch 1982). An advantage of multivariate analysis is that it can summarise large datasets, usually in the form of a plot, while keeping the separate identity of each unit of analysis. This allows differences and similarities to be observed between samples and species and can identify outliers. Multivariate analysis is susceptible to the presence of rare species which may or may not have been a part of the original community. These rare species are also known as background noise and in order to reduce their impact, species in less than 5-10% of an assemblage are usually excluded from the analyses (*cf.* Gauch 1982:214; Van der Veen 1992: Chapter 3).

A number of multivariate techniques have been used in archaeobotanical analysis such as principal components (PCA), correspondence (CA), discriminate (DA), and cluster analysis. For the present study, correspondence analysis has several features that distinguish it from other methods of data analysis. First, the multivariate treatment of the data through simultaneous consideration of multiple categorical variables. Second, the creation of a biplot, which allows structural relationships between the samples and species to be detected (*cf.* Gauch 1982). Third, correspondence analysis is easy to use as it only requires a rectangular data matrix with non-negative entries which it can transform into a graphical display in which each row and column is depicted as a point. In addition, unlike principle components analysis, correspondence analysis scales the data so that rows and columns are treated equivalently. Thus, this method does not require data to be normally distributed and works well with counts rather than percentages.

Correspondence analysis is, however, solely a pattern searching technique that does not use any information concerning the samples at the analytical stage. To interpret these patterns, additional information can be used to examine the plot, for example by coding either the samples or species in relation to ecological characteristics (e.g. Van der Veen 1992; Bogaard 2004). In addition, to illustrate possible variations within the archaeobotanical assemblage, pie-charts based on numbers of seeds or their presence per sample can also be used in correspondence analysis.

Correspondence analysis is used in this study to first explore further emerging patterns in relation to crop processing (Chapter 6) and second to examine variation in weed composition in order to determine crop husbandry regimes within the archaeobotanical dataset (Chapter 7). Correspondence analysis was carried out using CANOCO 4.5 and CANODRAW for Windows (Ter Braak and Smilauer 2002). All plots depict axis 1 (plotted horizontally) and axis 2 (plotted vertically) and the variance along each axis, while the position of each sample or species indicates the differences or similarities between them. Samples in the centre of the plot (0,0 coordinate) tend to indicate normal or average composition, while those that diverge from the centre indicate samples with positive or negative associations as well as their degree of divergence (Bogaard 2002b:102). See chapters 6 and 7 for further details.

Chapter four
Croatian site results

This chapter presents the results of the archaeobotanical data collected from the Croatian sites. The overall assemblage is first examined in order to explore general patterning within the data per period i.e. Late Neolithic, Copper Age and Bronze Age (4.1). This is followed by an examination of trends through time (4.2) drawing all the sites together to explore patterns in formation processes, the crops and the wild plant resources. Suggestions for future archaeobotanical research in Croatia are then discussed (4.3).

4.1 Assemblage characteristics

Eighteen sites were sampled from Croatia dating from the Mid/Late Neolithic to the Late Bronze Age (see Fig 4.1 and Table 4.1). A total of 565 samples were collected, representing 7,826 litres of sediment (Table 4.2). Overall, 487 samples contained identifiable plant remains totalling approximately 18,910 plant items as well as over 176,000 unidentifiable plant fragments. Fifteen different crop plants were recovered: einkorn (*Triticum monococcum*), emmer (*Triticum dicoccum*), spelt (*Triticum spelta*), bread/durum wheat (*Triticum aestivum/durum*), the 'new' glume wheat type (*Triticum* cf. *timopheevii*), barley (*Hordeum vulgare*), rye (*Secale cereale*), oat (*Avena sativa*), broomcorn millet (*Panicum miliaceum*), foxtail millet (*Setaria italica*), bitter vetch (*Vicia ervilia*), grass pea (*Lathyrus sativus*), lentil (*Lens culinaris*), pea (*Pisum sativum*) and flax (*Linum usitatissimum*). Chaff remains consisted largely of glume wheat glume bases, with only a couple of barley and free-threshing rachis recovered. The presence and absence of crop plants will be discussed further in section 4.4.2.

The mean seed density per litre is 2.4; however, the standard deviation for all the sites is reasonably high at 6.9, indicating variation among the samples. Therefore, the lower median density of 0.6 items per litre may be a more accurate calculation to use. In either case the mean and median are relatively low despite the large number of identified plant remains recovered. Figure 4.2 emphasises this further with 531 of the samples having a density (per litre) of between 0 – 5. The number of samples per density group subsequently drops to only 12 samples having a density of over 25.1 seeds per litre.

4.1.1 Mid/Late Neolithic

Seven sites yielded plant material from the Late Neolithic period and one site, Virovitica-Brekinja, from the middle Neolithic. In total, 352 samples were collected representing 5,240 litres of sediment and 14,052 identified plant remains (Table 4.3). Only 27 samples did not contain any plant material. Overall, 14 different crop plants five fruits and over 30 different wild/weed species were identified.

For all eight sites, the mean seed density per litre for the period is 3.1; however, the standard deviation is extremely high at 19, showing great variation among the samples. This great variation is largely due to the high seed density at Turska Peć, a cave site, of 21 seeds per litre, while the remaining seven sites have a density of less than 5 seeds per litre (Table 4.4). Turska Peć also has a relatively high mean charcoal density of 1.3 (cm^3 per litre) and an extremely high standard deviation of 74. This high standard deviation results from the extremely large numbers of carbonised *Chenopodium album* seeds found in samples TPEC01-03 located in zone 10 in Trench 2 (Table 4.7). Of particular note at the site is the contrast between Trench 2 which is dominated by wild/weed seeds and Trench 3 which is dominated by cereal remains, namely emmer, barley and einkorn, indicating different activity areas and thus formation processes within the cave. Both Slavča and Ravnjaš also have relatively high standard deviations indicating variation among the samples. At both sites this is largely the result of large numbers of glume wheat glume bases found in a number of samples such as RAVN42, SLAV30 and SLAV37 (Table 4.7). This is seen further in Table 4.5 which shows a relatively high median seed density per litre for chaff at both sites.

Čista Mala -Velištak and Sopot have a number of rich samples, including a high number of glume wheat glume bases in CISM12, a pit fill, and SOP052, a ditch fill (Table 4.7)., while the remaining sites have very low median seed densities (< 0.2 seeds per litre) and very low standard deviations (< 0.5). Overall the median density values correspond with the relative proportions of seeds per category (Fig 4.3), with Turska Peć being dominant in wild/weed seeds, Slavča in chaff, Sopot and Ravnjaš in grain and chaff and Virovitica-Brekinja and Ivandvor-Gaj in grain. Only Čista Mala -Velištak differs showing a dominance in chaff (glume wheat glume bases), due largely to sample CISM12, and not grain (Table 4.5 and Fig 4.3). Tomašanci-Palača is the only site with a median density for fruits per litre, but this is from the recovery of only one *Cornus mas* seed from one sample and is therefore not very representative (Table 4.5).

4.1.2 Copper Age

Nine sites yielded plant remains from the Copper Age in Croatia. In total, 155 samples were collected, representing 1,915 litres of sediment from which 4,385 seeds were identified, totalling 13 different crops, five fruits and 30 weed species (Table 4.3).

For all nine sites the mean seed density is 1.7 seeds per litre, almost half the mean density of the Late Neolithic sites (Table 4.3); however, the median value is the same as the previous period at 0.5 and the standard deviation is much lower at 4.6, indicating less variation among the samples and sites. Looking at the sites individually, Vinkovci/Matije Gupca 14 has a large median charcoal density of 2 (cm^3 per litre) and seed density per litre of 8, while the remaining eight sites have a median charcoal and seed density of less than one seed per litre (Table 4.8). Vučedol has the highest standard deviation of 9, which results from a number of house floor samples (e.g. VUCE09, VUCE10 and VUCE21) containing relatively large quantities of cereal grains (Table 4.10).

The median seed density per litre for each plant category i.e. cereal grain, fruits etc. per site is generally extremely low, especially at Jurjevac-Stara Vodenica, Pajtenica-Velike Livade, Tomašanci-Palača and Virovitica-Batelije which have < 0.2 seeds per litre (Table 4.6). These four sites also have extremely low standard deviations (< 0.5) indicating that there is little variation between the samples and thus a relatively homogeneous seed deposition across the sites. The highest median grain densities of two and one seeds per litre are seen from Vinkovci/Matije Gupca 14 and Potočani, respectively, while Slavča has the highest median chaff (glume wheat glume bases) density of 1.1 (Table 4.8). Vinkovci/Matije Gupca 14 also has an extremely high median density of wild/weed seeds per litre of 6 as well as the only site with median densities for oil plants (0.2) and fruits (0.03). The high wild/weed density is due to the large number of *Bromus* sp., *Chenopodium album* and large grasses recovered from VINM01-03 (Table 4.10). Potočani is the only site with a very low median density for pulses of 0.02 (Table 4.8). Vinkovci/Matije Gupca 14 and Potočani are, however, only represented by a few samples which may be over emphasising their results compared to the other sites.

Overall, the median density values correspond with the relative proportions of seeds per plant category (Fig 4.4), with Đakovo-Franjevac, Potočani, Jurjevac-Stara Vodenica, Pajtenica-Velike Livade and Vučedol being dominant in grain, Virovitica-Batelije and Slavča by chaff and Vinkovci/Matije Gupca 14 by wild/weed seeds. Only Tomašanci-Palača differs slightly with a high proportion of both grain and chaff. The higher chaff presence is due to sample TOMP19 which has a relatively large number of glume wheat glume bases (Table 4.10).

4.1.3 Bronze Age

Four sites yielded plant material from the Bronze Age in Croatia. In total, 58 samples were collected, representing 671 litres of sediment from which 472 seeds were identified, totalling ten different crops, two fruits and eight weed species (Table 4.3).

The four sites have a mean seed density per litre of 0.7 and a median seed density of 0.1, which is significantly lower than the Late Neolithic and Copper Age assemblages (Table 4.3). The standard deviation is also relatively low at 3, indicating very low variation among the samples. Looking at the sites individually, Mačkovac-Crišnjevi has the highest mean charcoal density of 0.9 (cm^3 per litre), a relatively high mean seed density of 1.5 and a high standard deviation of 5 (Table 4.9). The high standard deviation results from samples MACC09 and MACC13, from general occupation layers, which contain extremely large numbers of oat grains (Table 4.13). Overall, however, the median seed densities are less than 0.3 seeds per litre for each of the sites (Table 4.9 and 4.11). The relative proportion of seeds per category (Fig 4.5) shows that Mačkovac-Crišnjevi, Crišnjevi-Oštrov and

Tomašanci-Palača are all dominated by grain. Only Orubica-Veliki Šeš is dominated by wild/weed species; however, only 4 seeds were identified from the samples.

4.1.4 Summary

From the results above a number of key points can be made about the Croatian assemblage. First, the overall assemblage indicates low seed densities per litre of sediment. The highest densities are seen at Turska Peć, Slavča and Ravnjaš (Late Neolithic), Vinkovci/Matije Gupca 14 and Slavča (Copper Age) and Mačkovac-Crišnjevi (Bronze Age) which have median seed densities of between 1.5- 8 seeds per litre. The overall low densities and low number of items identified per sample recovered from the Croatian sites ultimately restricts the level of analysis that can be conducted. Multivariate techniques for instance, which have been widely used to explore crop husbandry regimes and crop processing stages, require a minimum number of identifications per sample (cf. Bogaard 2004; Jones 1987a; Valamoti 2004; Van der Veen 1992). Unfortunately, only a couple of samples from the Croatian sites contain over 50 identified plant items making this form of analysis redundant.

Second, up to 15 different crop species were identified from each period indicating a relatively diverse crop package. Third, the sites are largely dominated by grain, chaff and wild/weed species with fewer remains of pulses, fruits and oil plants. Fourth, the relatively high standard deviations for assemblages from Turska Peć, Vučedol and Mačkovac-Crišnjevi, which indicate variation between the samples, may denote differences in formation processes.

4.2 Distribution of species through time

This next section will examine two of the key points highlighted above: formation processes at the sites and the distribution of the crops and other plant remains through time; however, chronological changes will be discussed in more detail in Chapters 9 and 10.

In order to examine formation processes, seed preservation and density will be assessed per site and compared through time to determine whether any patterns can be seen between site or feature types. This will be followed by an examination of the presence/absence of certain crops and other plant species through time to determine whether any patterns can be seen between the sites and the periods.

4.2.1 Formation processes

To assess preservation at each study site, each sample was allocated a preservation class to describe the overall preservation of the taxa within that sample (see Chapter 3 for further discussion). Table 4.12 shows that up to 50% of the samples have a preservation of 5, indicating extremely poor preservation where the plant remains are only identifiable by their gross morphology. Perfect preservation (class 1) was only present in two samples: CISM26 which contained two perfectly preserved lentils and MACC13 which contained a large number of well preserved oat grains and floret bases (Table 4.7). The two main site types represented are ‘flat’ settlements and tell sites. Comparing these site types shows a slight increase in poorly preserved remains at the flat sites while tell (and cave) sites show an increase in well preserved samples (Table 4.14). This may suggest that formation processes at tell (and cave) sites facilitate better taxa preservation due to the multi layering of occupation levels than at ‘flat’ sites which are horizontally spread with thinner occupation levels. These observations have also been discussed by Valamoti (2004) examining differences between tell and flat sites in Northern Greece, Marinova (2006) in Bulgaria, as well as by Kruez *et al* (2005), who compared Early Neolithic flat Bandkeramic sites with Bulgarian tell sites.

The recovery method will also have an effect on the plant assemblage. For the Croatian sites, the main difference in the recovery method was the use of different sieve sizes. In bucket and machine flotation, recovery efficiency is based largely on the size of the mesh used to collect the flot. For example, if the sieve used is 1mm in size, any plant material smaller than this will be lost. This will have a large impact on what species are recovered and will ultimately affect interpretation. Looking at the differences between those sites with a 250µm and 1mm mesh, some differences may be seen. First, there is a slight decrease in chaff remains, although this may also result from the site types as those with a 1mm mesh are mostly horizontal settlements. Second, is the clear reduction in wild/weed seeds present at the sites with a 1mm mesh. The sites of Ivandvor-Gaj, Virovitica-Brekinja, Jurjevac-Stara

Vodenica and Virovitica-Batelije have no wild/weed species at all. There are exceptions to this pattern as the taxa recovered from Vučedol include a relatively high number of chaff and wild/weed remains suggesting that other formation processes may be at work.

Seven general feature types were identified from the 18 sites, including ditches, hearths, house floors and pits. The three most frequently sampled feature types were general occupation layers, house areas and pits (Table 4.15). Overall, over 90% of the samples collected from each feature type had a seed density per litre of between 0-5, while only general occupation layers, house areas and pits had samples with a density of > 25.1 seeds per litre (Table 4.15). Table 4.16 looks at these high density samples further. The three samples from Turska Peć are from general occupation layers from zone 10 area 2 and are dominated by wild/weed seeds with only a couple of crop species. In contrast, the three samples from Slavča recovered from pit features are dominated by chaff, with only a few other species present. Two samples from house floors at Vučedol are dominant in cereal grain. It is interesting to note that the five samples dominant in grain and wild/weed seeds were allocated higher preservation classes than the three chaff dominant samples. In addition, at both site types grains are consistently dominant within samples collected from hearth and house features, while pits and ditches have high chaff remains (Table 4.17). House samples also have a high percentage of fruit remains, while general occupation levels have a high percentage of wild/weed seeds.

Although a more detailed discussion of formation processes is presented in Chapter 6, generalisations about possible activities may be made for the Croatian sites. First, the high percentage of cereal grains within house and hearth features may suggest the preparation of cereals for human consumption. The collection of fruits to supplement the diet may also be indicated from the high proportion of remains found in house and hearth deposits (see also section 4.2.3). The high chaff content (mainly glume wheat glume bases) within pits and ditches may result from the deposition of crop processing waste. The high wild/weed content within the general occupation layers may result from a number of sources, including crop processing waste, the remains of collected foods (e.g. the high number of Chenopodium album seeds found at Turska Peć, see section 4.24) as well as the accidental burning of local flora.

4.2.2 Cereals

4.2.2.1 Einkorn and Emmer

Of the 15 different crops identified from the sites, grain and glume bases of einkorn and emmer are the most frequently recovered (Table 4.22). Only Copper Age Pajtenica-Velika Livade and Bronze Age Crišnjevi-Oštrov, Orubica-Veliki Šeš and Tomašanci-Palača do not have any remains of either species, although this may be a result of small sample sizes, recovery techniques and/or preservation (Table 4.21). During the Late Neolithic, einkorn and emmer remains are represented in roughly equal proportions (Table 4.18). By the Copper Age einkorn seems to increase in frequency, especially at Đakovo-Franjevac and Vučedol where einkorn grain and chaff dominate (Table 4.19 and 4.22). It is unclear how this pattern continues into the Bronze Age as only a couple of grains and glume bases were recovered from this period (Table 4.20). The relatively similar occurrence of both emmer and einkorn at the sites may point to the regular growing of a mixed or 'maslin' crop. This form of mixing crop species of a similar type (see chapter 7 for further details), is often suggested for emmer and einkorn in the LBK and the later Neolithic of Central Europe (Bakels 1978; Jones and Halstead 1995). Preservation at the sites made identification of einkorn and emmer glume bases particularly difficult, although they were easier to identify to genus than fragments of grain. Nevertheless, eleven of the sites produced identifiable einkorn and emmer glume bases, especially from the Copper Age levels at Slavča (Table 4.19 and 4.21). A small proportion of two-grained einkorn is also found at Late Neolithic Ravnjaš and Sopot, and Copper Age Tomašanci-Palača and Vučedol.

4.2.2.2 Barley

Barley is the third most common crop and is present at twelve of the sites (Table 4.21). Overall, naked barley (*Hordeum vulgare* var. *nudum*) is the dominant variety, although a small number of hulled barley grains were also recovered from the Late Neolithic and Copper Age sites of Sopot, Turska Peć, Vinkovci/Matije Gupca 14 and Vučedol (Tables 4.18-20). The benefits of naked barley over hulled varieties is that it is easier to process due to the grains being looser in the spikelets, while the grains of the hulled variety are fused with the palea and lemma which are not removed by threshing. Thus hulled barley requires an extra processing stage to remove the hull before consumption. The frequency of barley remains seem to decrease from the Late Neolithic to the Bronze Age (Table 4.22); however, these results are based on less than 100 grains found throughout the periods and is unlikely to provide a representative sample. Evidence of barley rachis was particularly rare, only being recovered from Late Neolithic Slavča and Sopot in low numbers (Table 4.18). As well as underrepresentation due to the carbonisation process, the method of crop processing may also cause barley rachis to be underrepresented at the sites as they are typically removed during the early crop processing stages which likely occur away from the site (cf. Dennell 1976; Hillman 1981; see Chapter 6 for further details).

4.2.2.3 Spelt and Bread/durum wheat

Small quantities of spelt were found at five of the Croatian sites, while bread/durum is present at nine (Table 4.21). Both species are present in only 2-4% of the samples between the Late Neolithic and the Copper Age but are represented by both grain and chaff (Table 4.22). No remains of either species were recovered from the Bronze Age. From the low frequency and small quantities recovered of both species, it is difficult to determine whether spelt and bread/durum wheat were grown separately, intercropped with other cereals or were simply weeds within the main crop.

4.2.2.4 ‘New’ glume wheat

The morphologically distinct tetraploid wheat commonly referred to as the ‘new’ glume wheat (*Triticum* cf. *timopheevii*), was recovered from four sites: Čista Mala - Velištak, Sopot, Slavča and Ravnjaš (Table 4.21). In these cases small quantities of the distinct glume bases have been identified, although in relatively low frequencies: 2% in the Mid/Late Neolithic and 1% in the Copper Age (Table 4.22). Since Jones *et al.* (2000b) identified a ‘new’ type of glume wheat from Neolithic and Bronze Age sites in northern Greece, several identifications have been made throughout Southeast and Central Europe during these periods (Jones *et al.* 2000b;

Kohler-Schneider 2003). This trend continues at the Croatian sites; however, with < 20 identified glume bases, assumptions about its cultivation are difficult.

4.2.2.5 Millets, Oat and Rye

Two types of millet were identified from the Croatian sites: broomcorn millet (*Panicum miliaceum*) (Fig 4.6) and foxtail millet (*Setaria italic*). Grains of both species are extremely rare in the Late Neolithic. Only one grain of broomcorn millet was recovered from Ravnjaš and only 4 grains of foxtail millet from Slavća (Table 4.7 and 4.18). By the Copper Age the frequencies of both increase slightly, although grain quantities are still extremely low per site (Table 4.10 and 4.19). The Bronze Age sees a sharp increase in frequency of broomcorn millet to 16%, which is far greater than the other cereals found during this period (Table 4.22). In addition, at Crišnjevi-Oštrov, 15 broomcorn millet grains were recovered, which is the largest number recovered so far from a single sample in this region (Table 4.13 and 4.20). By the Late Bronze Age, the increase in frequency and quantities may show an increase in the utilisation of these species as crops, especially in the case of broomcorn millet. During the earlier periods it is likely that these cereals represent admixtures or weeds within other crops.

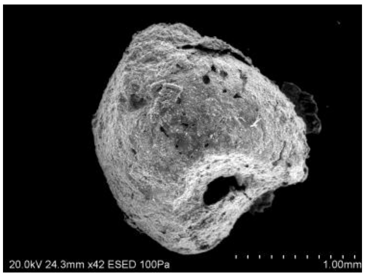

Fig 4.6. SEM of broomcorn millet (*Panicum miliaceum*) from Copper Age Đakovo-Franjevac (DAKF01). Photo taken by author

Fig 4.7. Photo of oat grains (*Avena sativa*) from Bronze Age Mačkovac-Crišnjevi (MACC13). Photo taken by author

Oat is not found within the Croatian assemblage until the Late Bronze Age and only at Mačkovac-Crišnjevi. Both grain and chaff were recovered with a relatively high frequency of 20% (Table 4.20). Oat is rarely found in Central and Southeast Europe until the 1st millennium BC, when it is suggested to be a secondary crop to wheat and barley (Zohary and Hopf 2000); however, the identification of >300 oat grains from general occupation levels at Mačkovac-Crišnjevi (Fig 4.7) and little evidence of any other cereal remains, may suggest that it was deliberately cultivated at the site.

Rye was recovered from three sites, Sopot, Potočani and Vinkovci/Matije Gupca 14, although only a couple of grains were found at each (Table 4.21). Frequency is therefore extremely low at 2% for the Late Neolithic and 1% for the Copper Age (Table 4.22). No rye grains were recovered from the Bronze Age. Rye is found from the Late Neolithic in Southeast Europe and is generally assumed to have been a weed in other cereal crops until the Bronze Age when it begins to be intentionally cultivated as a minor crop (Behre 1992). The few remains recovered from the Late Neolithic and Copper Age may support this view, representing a weed rather than an intentionally cultivated crop at these sites.

4.2.3 Pulses and oil plants

Four different pulses were identified from the Croatian sites: grass pea, bitter vetch, lentil and pea. The most commonly found was lentil, which is present at seven of the sites: Ivandvor-Gaj, Turska Peć, Sopot, Slavča, Ravnjaš, Đakovo-Franjevac and Mačkovac-Crišnjevi (Table 4.21). The frequency of lentil through the periods seems to decrease from the Late Neolithic (5%) to the Bronze Age (2%) (Table 4.22); however, as these results are based on less than 30 seeds it is unlikely to be a representative sample. Pea on the other hand seems to increase from 3% in the Late Neolithic to 6% in the Copper Age (Table 4.22). No remains of pea were recovered from the Bronze Age. Once again these results are from less than 50 seeds recovered from only three sites: Sopot, Ravnjaš and Đakovo-Franjevac (Table 4.21). Both grass pea and bitter vetch were also recovered from three sites: grass pea from Virovitica-Brekinja, Sopot and Đakovo-Franjevac and bitter vetch from Sopot, Ravnjaš and Đakovo-Franjevac, although, only in small quantities (Tables 4.21 and 4.22). Pulse preservation through carbonisation can be underrepresented in the archaeological record, but these four species are continuously found from the Early Neolithic onwards in Central and Southeast Europe (Zohary and Hopf 2000). Therefore, in Croatia it may be possible to suggest that lentil and pea, and to a lesser extent grass pea and bitter vetch, were continuously grown from the Late Neolithic to the Late Bronze Age.

Flax seeds were recovered from five of the Croatian sites: Sopot, Slavča, Đakovo-Franjevac, Vinkovci/Matije Gupca 14 and Vučedol (Table 4.21). Seed density is generally very low at these sites; however, Vinkovci/Matije Gupca 14 has the highest number of flax seeds recovered from all four of the samples (Table 4.10 and 4.19). As one of the founder crops, flax is found throughout Southeast and Central Europe from the Early Neolithic onwards and is traditionally used for its oil (linseed) and/or fibres (Zohary and Hopf 2000). In addition, the preservation of oil plants is also particularly underrepresented in the archaeological record as the high oil content makes the seeds particularly flammable. Overall, it is therefore likely that flax was cultivated as a crop at these sites.

4.2.4 Fruits

In total, seven fruit species were identified from the Croatian sites. The most frequent species were a range of edible fruits: chinese lantern (*Physalis alkekengi*) found at seven sites, cornelian cherry (*Cornus mas*) present at ten and dwarf elder (*Sambucus ebulus*) recovered from six sites. At Sopot, 23% of samples contained chinese lantern, especially sample SOP079, a house deposit, which contained over 100 seeds (Table 4.7 and 4.18). The location and quantity of remains are therefore likely to represent the deliberate gathering of wild fruits at the site. Similar patterns can be seen between the Late Neolithic and the Copper Age with a few finds of additional edible fruits such as blackberries (*Rubus fruticosus*). A few fragments of *Corylus* sp. identified at Tomašanci-Palača (Copper Age) and two sloe cherries (*Prunus spinosa*) from Jurjevac-Stara Vodenica (Copper Age) and Mačkovac-Crišnjevi (Bronze Age), may suggest the deliberate collection of fruits from local woodlands, although both species could also have been utilised for firewood. Only one grape pip was identified from the Bronze Age levels at Tomašanci-Palača (Table 4.13).

4.2.5 The wild/weed species

Over 35 different wild/weed species were identified from the three periods. The vast majority consist of those species commonly found in arable environments such as *Chenopodium album*, *Bromus* sp. and *Agrostemma githago*. These arable species are consistently present at sites such as Slavća, Sopot, Turska Peć, Đakovo-Franjevac, Vinkovci/Matije Gupca 14, Vučedol and Mačkovac-Crišnjevi from the

Late Neolithic to the Late Bronze Age. With the exception of Đakovo-Franjevac, the remaining sites are all multilevel settlements and the better preservation seen at these sites may account for the higher number of taxa recovered.

A number of the weeds recovered grow wet environments such as species of *Carex* sp. and *Scirpus* sp. Most of the sites with these water loving species, such as Vučedol, Vinkovci/Matije Gupca 14 and Mačkovac-Crišnjevi, are all located next to rivers where these species are still found today. In addition, some species could also have been utilised in a number of ways such as for building materials, medicine, dyes and food for either humans or animals. Edible species include the seeds of fat hen (*Chenopodium album*), the leaves of nettles (*Urtica dioca*), and the seeds of crabgrass (*Digitaria sanguinalis*), can also be sown into fields for grazing animals. Some species of *Teucrium* and self-heal (*Prunella vulgaris*) have culinary and medicinal qualities and vervain (*Verbena officinalis*) has been recorded as a medical herb from the Bronze Age in Greece (Beeston *et al.* 2006).

In addition, fodder can include small and large seeded legumes such as alfalfa (*Medicago sativa*) and a number of clovers (*Trifolium* sp.). This may be seen at Turska Peć where different activity areas may be identified at the cave site. For example, in Trench 3, cereals dominate the samples, while Trench 2 has a high number of wild/weed species, including a relatively large number of legumes.

The small number of seeds found of each species throughout many of the sites makes any further interpretation difficult. The process of carbonisation also hinders the level of interpretation as vegetative parts of the plants are rarely preserved under these conditions. Nonetheless, these species are likely to of contributed significantly to the spectrum of cultivated crops providing additional flavour and nutrition to the diet as well as fodder, medicine, dyes and/or building materials.

4.4 Conclusion

The general characteristics of the Croatian results indicate that although the dataset in the first instance seemed particularly large, subsequent examination highlighted a number of factors that hamper more complex statistical analyses. This was largely due to the samples containing low quantities of plant remains and, in most cases, very low densities. Nevertheless, general aspects can be drawn from the results:

- The variety of species present does not change between the Mid/Late Neolithic and Copper Age. Whether this pattern continues into the Bronze Age is unclear, as only a few sites, with low quantities of remains, were examined.
- Generally through both the Mid/Late Neolithic and Copper Age both emmer and einkorn are the most dominant crops, followed by barley.
- Oat (*Avena sativa*) is first seen at the Late Bronze Age site of Mačkovac-Crišnjevi.
- The type and density of plant remains recovered does show a slight association with feature type (e.g. grain and fruits with hearths and house deposit and chaff with pits). Thus, sampling strategies should include a wide range of feature types in order to maximise plant recovery.
- The low quantity and range of species identified is influenced by recovery methods. Although formation processes also affect the density of plant remains in any particular feature, it is clear that recovery methods will also affect the assemblage composition.

In order to explore further details about crop processing regimes during this period, the next chapter will introduce the results of the Late Bronze Age site of Feudvar. This site provides an extremely rich assemblage of plant remains previously identified by Prof Helmut Kroll. To date, the plant remains have only been partially published. Feudvar therefore provides a unique opportunity to explore in detail formation processes (e.g. crop processing) and crop husbandry regimes at a settlement within the same geographic region as the Croatian sites and add to the limited range of taxa identified from Bronze Age Croatia.

Chapter five
Results from Late Bronze Age Feudvar

This chapter presents the results of the plant remains from Late Bronze Age Feudvar (Serbia). The first section outlines the assemblage characteristics (5.1) in order to explore general patterns in the assemblage and provide comparative results to the Croatian assemblage. Formation processes at the site will then be explored (5.2), followed by a detailed discussion of the crops (5.3) and wild resources (5.4) found in the Late Bronze Age levels. The chapter concludes by comparing the Feudvar assemblage with the Croatian results in order to see if any further patterns can be seen through time (5.5).

5.1 Assemblage characteristics

Feudvar is a fortified Bronze and Iron Age settlement, situated on the northern rim of a loess plateau in Vojvodina, Serbia (Appendix I). The archaeobotanical assemblage, collected from the 1986 excavation, was previously identified by Prof. Helmut Kroll. The dataset selected for inclusion in this project consists of 524 samples collected from the western cut of the tell site dating to the Late Bronze Age. Each sample represented *ca.* 10 litres of sediment, a total of *ca.* 5,240 litres floated, from which 593,315 carbonised plant remains were recovered; however, within this assemblage 263,780 seeds were of *Chenopodium polyspermum*, recovered from FEU210. The large quantity of seeds recovered were a rare find within the assemblage and would have had a distinct effect on the following results. The *Chenopodium polyspermum* remains from FEU210 were subsequently removed. The sample is discussed further in section 5.4.2.

The mean seed density at Feudvar is high at 63 seeds per litre of sediment (Table 5.1). The standard deviation for the site is extremely high at 268, showing huge variation between the samples. The median density per litre is therefore slightly lower at 20 and may be a more realistic estimation for the assemblage; however, this is over 30 times greater than the median seed density from the overall Croatian assemblage (0.6 seeds per litre). Additionally, Figure 5.1, grouping the samples by seed density per litre, shows that the majority of the samples have a seed density of 10.1-25 (205 samples) and > 25.1 (209 samples). This is a complete contrast to the pattern seen in the Croatian samples, where the majority of samples contained < 5 seeds per litre. At Feudvar, only 39 samples have a seed density per litre of between 0 – 5.

The density of each plant group (i.e. grain, chaff, fruits) per litre (Table 5.2), as well as their relative proportions (Fig 5.2), show that grain, chaff and wild/weed seeds dominate the overall assemblage. The mean seed densities for these categories are extremely high, ranging from 133 for wild/weed seeds to 276 for chaff remains per litre; however, they also have extremely high standard deviations e.g. 1,924 for chaff (Table 5.2). As such, the median seed density per litre may be a more realistic assessment for each plant category. The median values therefore show that chaff remains have a density per litre of 45, followed by wild/weed seeds at 48 and then grain at 58. The relative proportions show that 44% of the assemblage consists of chaff, 31% grain and 21% wild/weed seeds (Fig. 5.2). Pulses, oil plants and fruits have median densities of < 5 seeds per litre and account for less than 5% of the overall assemblage.

5.2 Formation processes

Eight main feature types were identified from Feudvar, including house floors, pits, yard and hearth areas (Table 5.3). A vast majority of the samples, 257, were allocated as general deposits with no further contextual details. Context details were unclear for a couple of samples and some were from contexts that did not fit in with the main feature types (e.g. house, yard or street). Fourteen samples were therefore allocated as miscellaneous features. In contrast to the Croatian samples, where the vast majority of features were represented in the 0-5 density group, only six of the eight features are represented in the 0-5 density group at Feudvar (Table 5.3). The highest percentage of samples with a seed density of between 0-5 were recovered from the container fills (33%), while the remaining features increase in percentage towards the 25.1+ density group. For example, pit samples increase from 7% in the 0-5 seed density group to 49% in the 25.1 + category (Table 5.3). It is unclear, however, whether any correlation exists between certain feature types and seed density.

38 samples had a seed density per litre of over 100. Of these 12 are dominated by grain, 12 by chaff and 7 by wild/weed seeds (Table 5.4). Of the samples dominated by grain only FEU047, a general occupation layer, and FEU328, from a house level, indicate relatively clean grain deposits. FEU047 is dominated by barley grains (> 2,900 grains) and FEU328 has over 3,500 einkorn grains and no other crop species present. FEU217 has the highest density per litre of chaff (3,595) and was recovered from a house level. FEU485, from the floor of the northwest house, is the only sample with an extremely high wild/weed seed density of 927 per litre (Table 5.4). This sample, which also contained barley and einkorn grains, had over 30 different weed species present including high numbers of *Bromus* sp., *Lolium* sp., and *Setaria viridis*. Many of these species may be found as weeds in arable fields and may suggest the remains of crop processing by-products. Differences between feature types may also be seen from these rich samples where the vast majority of grain dominant samples are from house or hearth deposits, while the chaff and wild/weed rich samples are more likely to be found in general occupation layers (Table 5.3). This pattern was also identified in the Croatian assemblage (see Chapter 4, Table 4.16).

As well as the samples dominated by grain, chaff and wild/weed seeds, a couple of samples had relatively clean deposits of other food plants. For instance, the container fill, FEU079, had a distinctly high density of pulses, in particular pea, with > 2,700 seeds identified. Another sample of note is FEU342, a sample from the floor of the north-west house, which is dominated by 901 wild strawberry pips (*Fragaria vesca*).

To examine the distribution of the plant remains further within the western trench, the area has been divided into arbitrary 5 m^2 blocks/areas based on the grid pattern of the original excavation. The relative proportions of the main plant categories per block highlight differences in plant deposition across the trench (Figure 5.3). Blocks 1, 3 and 5 (northwest house and fish house) have a high percentage of wild/weed remains. Blocks 7 (north-west house), 9 (yard area) and 2 (the baker house) have extremely high percentages of chaff, while blocks 4 and 6 (the area of the baker house) show a high percentage of grain. Only block 3 (the fish and northwest house) shows a relatively high percentage of pulses, fruits and nuts. This is due to the large number of peas present in FEU079 and wild strawberries found in FEU 342.

The average seed density per litre across the trench shows an extremely high seed density in block 7, the fish and northwest house levels (Fig 5.4). This is likely the result of two particularly large deposits of glume bases recovered from FEU217 (house) and FEU350 (general occupation layer). Blocks 4 (baker house) and 12 (yard area) also have high seed densities of between 76-100 seeds per litre. Block 4 has particularly high numbers of grain in FEU206 and FEU207, while block 12 has large numbers of grain, chaff and wild/weed seeds. Blocks 8, baker house, 10 (baker house and yard) and 16 (general deposits) have the lowest seed density per litre. This section has therefore identified differences in formation processes with the western trench which may allow further differentiation between activity areas or between different households when examining crop processing and crop husbandry regimes at the site.

5.3 Crops

Fourteen different crop plants were recovered from Feudvar: both one-grained and two-grained einkorn (*Triticum monococcum*), emmer (*Triticum dicoccum*), spelt (*Triticum spelta*), bread/durum wheat (*Triticum aestivum/durum*), barley (*Hordeum vulgare*), broomcorn millet (*Panicum miliaceum*), broad bean (*Vicia broad*), bitter vetch (*Vicia ervilia*), grass pea (*Lathyrus sativus*), lentil (*Lens culinaris*), pea (*Pisum sativum*), flax (*Linum usitatissimum*), and gold-of-pleasure (*Camelina sativa*). Rye was also tentatively identified at the site (cf. *Secale cereale*). In total, over 104, 000 cereal grains and 144,000 chaff remains were recovered, as well as over 8,000 pulses and 800 oil plant seeds.

5.3.1 Einkorn

In terms of the quantity of remains recovered, one-grained einkorn is the most dominant crop found at Feudvar, with 69,586 grains and 136,228 glume bases recovered. Einkorn represents over 80% of the total crop assemblage and is present in 99% of the samples (Table 5.5). The richest deposit of einkorn grain was found in FEU207 (fish house) where 8,256 grains were recovered along with 4,234 einkorn glume bases. Barley, pulses and over 300 wild/weed seeds were also recovered from this sample. FEU217 (house deposit) had the richest einkorn glume bases, totalling 35,244, as well as 6,036 einkorn grains. This sample also contained rich deposits of 525 barley glume bases, 184 bread/durum wheat rachis, and 145 seeds of gold of pleasure.

Two-grained einkorn was also found, but only within 1% of the samples and in small quantities. The largest deposit of 124 grains was recovered from FEU128, a miscellaneous layer in block 5. This sample was described by Kroll (1992:181) as a relatively pure deposit of einkorn, still in their glumes and thus ready for dehusking, and were found scattered around a broken bowl that may have once carried the remains. Kroll (1992) also stressed the difficulties in distinguishing two-grained einkorn from emmer, unless the grains are well preserved, which may result in two-grained einkorn being under represented at Feudvar.

5.3.2 Barley

Barley is the second most common crop present at Feudvar, being found in 97% of the samples (Table 5.5). The richest deposit of barley grain was found in FEU047 (general occupation layer in block 3) where 2,942 grains were recovered. This deposit is relatively clean, with less than a hundred seed items identified from other species. Naked barley was also found, but in very small quantities and in only 4 samples (FEU019, FEU074, FEU296, FEU330). Barley rachis was recovered from only 22% of the samples and the richest deposit of 525 came from FEU217 (house layer in block 7). The disparity between the number of barley rachis internodes and grains recovered at the site could result from two factors. First, the chaff remains from free-threshing wheats are generally removed during the early stages of crop processing, which could occur away from the site and would therefore reduce their access to fire. Second, the carbonisation process itself may reduce the survival rate of free-threshing rachis, as they are more likely to be destroyed than glume wheat glume bases (Hillman 1981; Boardman and Jones 1990).

5.3.3 Emmer

Emmer is the third most common crop recovered from the site and is present in 73% of the samples (Table 5.5). In particular, a large number of emmer grains, 4,543, were found in FEU316 (yard context in block 12). Einkorn was also present in this sample, although in much smaller quantities, and a large deposit of 2,902 *Setaria veridis* seeds and small quantities of other wild/weed species. Emmer chaff is found in 61% of the samples (Table 5.5). A rich sample of emmer chaff was identified in FEU084 (house deposit in block 8) which contained 1,698 glume bases. This deposit contained only 108 wild/weed seeds and a small number of einkorn and emmer grains.

5.3.4 Spelt and bread/durum wheat

Both spelt and bread/durum wheat are present but in much smaller quantities. For spelt, only 14 grains were recovered from only 2% of the samples (Table 5.5). Spelt glume bases were slightly more prevalent being present in 9% of the samples. The largest number of glumes recovered in any one sample was 24 glume bases found in FEU034 (general occupation layer in block 9); however, the spelt glume bases were found among large numbers of einkorn and emmer glume bases.

Bread/durum wheat grains were found in 9% of the samples (Table 5.5). The richest deposit was of 198 grains found in FEU425 (general occupation layer in block 14). Bread/durum wheat rachis is found in only 5% of the samples and the richest deposit was FEU217 (a house deposit in block 7) which yielded 184 rachis remains; however, the rachis remains were recovered along with large numbers of einkorn, barley, cf. rye and gold of pleasure.

5.3.5 Millet, rye and oat

Positive identifications of rye (*Secale cereale*), oat (*Avena sativa*) and foxtail millet (*Setaria italica*) are absent at the site. The tentative identification of rye (cf. *Secale cereal*e) was found in only 63% of the samples, totalling nearly 3,000 grains within the assemblage. The largest quantity was recovered from FEU217 (house deposit in block 7) yielding 430 grains. Broomcorn millet (*Panicum miliaceum*) was found in 31% of the samples (Table 5.6) and totalled just over 2,500 grains. Two pit samples, FEU013 and FEU019 (both from block 14) contained the highest numbers of broomcorn millet, that of 552 and 534 grains respectively. Both samples contained other crop species, although in slightly lower quantities, such as einkorn, emmer and barley and FEU019 also contained 385 *Chenopodium* sp. seeds.

5.3.6 Pulses

At Feudvar, lentil is found in 64% of the samples, followed by bitter vetch which was found in 40% (Table 5.5). A large number of lentils were recovered from FEU182 (hearth deposit in the north house in block 3), which yielded a relatively clean assemblage of 614 lentils. The largest number of bitter vetch, 512 seeds, was found in FEU199 (baker house floor) which also contained 240 einkorn grains (Table 5.5).

Pea, on the other hand, was found in only 22% of the samples, but represented the largest number of items found for all the pulses. This is due to sample FEU079 (container deposit), which contained 2,760 peas. Pea numbers are extremely low within the rest of the samples at the site. A similar deposit was found at the Early Iron Age site of Hissar, southern Serbia, where 2,572 peas were recovered from one deposit suggesting that it was indeed a crop at the site (Medović and Horváth 2011).

Broad bean and grass pea were recovered from only 1% and 4% of the samples respectively (Table 5.5) and in extremely low numbers (< 2 seeds per sample). Broad bean is found in Near Eastern archaeological assemblages from the Neolithic (Tanno and Willcox 2006), but is not commonly found in temperate Europe until the 3rd millennium (Zohary and Hopf 2000). The presence of broad bean at Feudvar is particularly interesting as this species is absent from the Croatian assemblage.

5.3.7 Oil plants

Gold of pleasure is the most common oil plant found at the site and is present in 20% of the samples (Table 5.5). Its absence from the Croatian assemblage is not surprising as gold of pleasure is not commonly found until the Late Bronze Age in the region (Zohary and Hopf 2000:138). Both FEU350 (general occupation layer) and FEU217 (house context) from block 7, contained relatively large numbers of 143 and 145 camelina seeds, as well as a number of pod remains . Both assemblages are also dominated by einkorn grain and chaff. Flax seeds were found in only 4% of the samples in very small quantities (Table 5.5). The preservation of oil plants through carbonisation is, however, particularly problematic as the seeds tend to burn away due to their high oil content. See Chapter 9 for further discussion.

5.4 Wild resources

5.4.1 Fruits

Nine fruit species were identified at Feudvar: wild strawberry (*Fragaria vesca*), cornelian cherry (*Cornus mas*), chinese lantern (*Physalis alkengengi*), bird cherry (*Prunus padus*), sloe (*Prunus spinosa*), dewberry (*Rubus caesius*), blackberry (*Rubus fruticosus*), elderberry (*Sambucus ebulus*), elder (*Sambucus nigra*), and wild grape (*Vitis silvestris*). In addition, other plant items were identified to genus, such as pear (*Pyrus* sp.) and rosehip (*Rosa* sp.). In total 1,717 fruit seeds were recovered.

The most common fruit is elderberry (*Sambucus ebulus*) which is present in 20% of the samples. The largest deposit consists of 60 seeds found in FEU483 (north-west house). The remaining fruit species are found in < 15% of the samples and are generally represented by small quantities of remains. Fruit remains are found in all feature types, especially general deposits, house floors and pits. All of the fruit remains can be eaten, with the possible exception of the bird cherry which is extremely bitter, suggesting that they were collected from the local environment to supplement the diet. Their presence at the site therefore provides further evidence of the possible environment around Feudvar, especially as many of the fruits, such as *Prunus spinosa*, *Rubus fruticosus*, *Rosa* sp., *Fragaria vesca* and *Sambucus nigra*, are indicative of open woodland which usually grow in clearings and along wood edges.

Only one wild grape pip was found in the assemblage, from FEU164, a house floor deposit in block 3. Of particular note from this assemblage is the large deposit of wild strawberries from FEU342, a house floor deposit from the northwest house in block 3. Wild strawberry is present in 17% of the samples. Wild strawberry is found throughout Serbia today growing in forests and along hedges, particularly in areas rich in soil nitrates (Savic *et al.* 2007) and can be collected for consumption between May and August.

5.4.2 Wild/weed species

A total of 129 wild/weed species were identified from the Feudvar assemblage, totalling 69,780 seeds. The vast majority consist of those species commonly found in arable environments such as *Chenopodium album*, *Bromus* arvensis and

Agrostemma githago. Nine species are from wetland or aquatic environments, including sedges (*Carex* sp.) and water chestnut (*Trapa natans*), and four are seeds from trees, including lime (*Tilia* sp.) and oak (*Quercus* sp). Although the wild/weed seed remains from Feudvar will be examined further in the following Chapters in relation to crop processing and husbandry regimes, a number of other uses may also be attached to some of the species present, e.g. as food, medicine, fodder or building materials.

Kišgeci and Medović (2006) presented a case for the prehistoric use of medicinal and aromatic plants at Feudvar and a number of other Neolithic, Bronze and Iron Age sites in the region. They suggested that vervain (*Verbena officinalis*), high mallow (*Malva sylvestris*), black henbane (*Hyoscymus niger*), white mallow (*Althaea officinalis*), mint (*Mentha* sp.) and poppy (*Papaver somniferum*) could have been collected for herbal medicine. Many of these are found at Feudvar, although in relatively small quantities and are all present in relatively mixed deposits. Vervain is the most prevalent species, being found in 10% of the samples and totalling 196 seeds.

The concentrated find of 263,780 seeds from the many-seeded goosefoot (*Chenopodium polyspermum*) found in FEU210 (general occupation layer in block 3) would suggest the deliberate gathering of the plant. Behre (2008) also suggests that *Polygonum lapathifolium*, *Chenopodium album* and *Bromus secalinus* could have been deliberately collected and used for human consumption in prehistoric times. Only two samples at Feudvar contained *Chenopodium album* and all but one seed was recovered from FEU350 (house deposit in block 7), which contained 654 seeds. *Chenopodium* sp. is present in 94% of the samples and totals nearly 25,000 seeds, with the largest deposit of 1,325 seeds recovered from FEU485 (house deposit in block 4). Of the other two species, only 14 seeds of *Polygonum lapathifolium*, and 1 of *Bromus secalinus* were found in the assemblage .

Another plant which may have been utilised is that of *Lallemantia iberica*, which was suggested to have been grown and stored for oil in northern Greece in prehistoric times (Megaloudi 2006). *Lallemantia iberica* is found in 14% of the samples and totals 671 seeds, the largest concentration of 297 seeds being found in the house deposit FEU350. Other edible foods could also have been consumed at the site, such as wild parsnip (*Pastinaca sativa*), lettuce (*Lactuca* sp.), and carrot (*Daucus* sp.). In addition, the nature of preservation may also result in an underrepresentation of plants whose vegetative parts are usually picked and consumed.

Also of note is the presence of water chestnut (*Trapa natans*) at Feudvar, which has a high frequency of 22%, though no one sample has more than 2 seeds present. The importance of water chestnuts as a human food source for prehistoric farmers has been recently explored (Borojević 2006; Karg 2006). At Opovo, water chestnuts would have been collected from areas of shallow water around the settlement in late summer/early autumn (Borojevic 2006:140). The seed, which is comparable in starch (c. 50%) and protein (c. 10%) to cereals (Karg 2006), would then be extracted from the outer shell and either eaten raw, roasted, boiled or ground down into flour. During the Roman period, for example, it was noted that the Thracians made bread from the flour of water chestnuts (*ibid.*).

Taxa could also have been grown and/or collected as animal fodder; however, there is no evidence of large concentrations of wild/weed species that may suggest this practice occurred, especially as the number of small legumes and possible pasture species may also be classed as arable weeds. In addition, some species would have been used as building materials, whether in constructing a house or a basket. For example, reeds (*Phragmites australis*) are commonly used for thatching, especially in the UK (Haslam 1989), while bulrush (*Schoenoplectus lacustris*) can be used as a weaving material for mats or baskets (Beetle 1950). At Feudvar, imprints within burnt clay indicate that reeds were used in the construction of the houses (Hänsel and Medović 1998:73-4). The archaeological evidence indicates that bundles of reeds were bound with rope, made from reed fibres, within a wooden frame that was covered with clay, which contained elements of straw and other plant materials (*ibid.*). Thus, wild species would have continued to be an important resource to the Late Bronze Age inhabitants.

5.5 Distribution of species through time across all sites

The rich and diverse assemblage from Feudvar contrasts with the plant remains collected from the 18 Croatian sites. The plant remains from the Bronze Age sites in

Croatia are also particularly poor in plant remains, making observations about the distribution of species through time difficult. By combining all the results, from both Croatia and Feudvar, a number of patterns emerge in relation to the frequency of species through time (Table 5.6). First is the increase in frequency of both einkorn and barley from the Neolithic to the Bronze Age. Emmer is still present in a large number of samples during the Bronze Age, but in much smaller quantities (e.g. Feudvar assemblage). Second is the appearance of oat, broad bean and gold-of pleasure by the Bronze Age. Third is the large increase in the frequency of rye and broomcorn millet, which is rare in the Neolithic and Copper Age samples but is extremely well represented in the Bronze Age. This increase, along with the addition of new species, may suggest an increase in crop diversity by the Late Bronze Age (see chapter 9 for further discussion).

The new varieties of crops would have presented the farmer with a number of advantages and disadvantages to consider. Broomcorn millet, for example, has a comparatively low water requirement, with a relatively short growing season and can grow well in poor soils (Lu *et al.* 2009). This would have provided the farmer with a 'safety' crop which could be grown on land unsuitable for other cereals. When comparing glume wheats (emmer, einkorn and spelt), with free-threshing wheat (bread, durum and club wheat), glume wheats are usually seen as being better protected from bird, insect and fungal attack and adverse growing conditions due to the tight glume that surrounds and thus protects the grain (Dark and Gent 2001; Hillman 1981, 1984a). Free-threshing wheat, on the other hand, is relatively easy to grow, produces high yields and requires less crop processing as the grains thresh free from their glumes without the need for additional pounding (Hillman 1978; Zohary and Hopf 2000) (see chapter 9 for further discussion).

In addition to these differences, some species remain consistent through all three periods. For example, two-grained einkorn, spelt and bread/durum wheat all have a consistently low frequency throughout the periods, never rising above 8% of the samples (Table 5.6). Flax is also consistently low, especially in contrast to gold of pleasure, another oil plant, which appears in the Bronze Age. The frequency of pulses shows similar patterns in the dominance of pea and lentil throughout the periods, although there is also a clear increase in bitter vetch by the Bronze Age.

The addition of the Feudvar assemblage has therefore helped increase the Croatian dataset to allow patterns to be seen.

5.6 Conclusion

The previously identified Late Bronze Age assemblage from Feudvar was chosen for analysis within this project due to the high quantity and diversity of the plant remains recovered. The general assemblage characteristics support this view, showing a clear contrast with the Croatian assemblage which had an extremely low median seed density of 0.6, while at Feudvar there is a median value of 20 seeds per litre. An extremely high density of grain, chaff and wild/weed seeds within the Feudvar assemblage also highlighted the potential for more complex statistical analyses in relation to crop processing and crop husbandry regimes. In addition, differences in formation processes at the site, identified from the distribution of seed densities and plant groups, suggest that further differentiation between activity areas or between different households may be possible when examining crop processing and crop husbandry regimes at the site.

Overall, the plant assemblage recovered from the western cut at Feudvar contained a wide range of crops, fruits and wild/weed seeds. The site is dominated by einkorn grain and chaff, present in over 99% of the samples, closely followed by a high frequency of barley, then emmer. The site also yielded the first evidence of broad bean and gold of pleasure in the study area. The number of ‘clean’ deposits highlighted above may also point to food catches, supporting not only a case for the consumption of certain cereals but of other plant species such as *Chenopodium polyspermum*, as well as further collection and utilisation of wild/weed species at the site. The next chapter will explore in more detail the formation processes at Feudvar through the examination of crop processing within the samples.

Chapter six
Crop processing analysis at Feudvar

In this chapter, formation processes within the Feudvar assemblage are examined. The purpose of this is to investigate formation processes at the site and to determine which samples can be directly compared when examining crop husbandry regimes. This chapter begins with a brief discussion on formation processes in archaeobotany with a particular focus on crop processing and its effect on assemblage composition (6.1). The methods (6.2) and results of the crop processing analysis on the Feudvar dataset (6.3) will then be presented. In order to differentiate ambiguous samples identified from the ratio analysis, correspondence analysis is employed, which will group samples according to their composition (6.4). In addition, intra-site variability will be examined by exploring the distribution of crop processing within the trench (6.5), followed by a discussion on the crop processing activities identified at the site (6.6) and final conclusions (6.7).

6.1 Crop processing and other formation processes

6.1.1 Crop processing in archaeobotany

Archaeobotanical remains represent only a fraction of the original plant assemblage that, through a series of natural and/or anthropogenic processes, became deposited within the archaeological site. The most common form by which plant material is preserved on archaeological sites is through carbonisation or charring, which results when organic material is exposed to heat either accidentally or deliberately, such as cooking, burning rubbish or fuel. Experimental research suggests carbonisation occurs in the range of approximately 200–400°C, or to higher temperatures in the absence of oxygen, such as when the material is smothered in ash (Braadbaart 2008; Hillman 1981; Wright 2003). It is generally the harder, denser parts of the plants such as seeds, grains, wood and nutshells that are more likely to preserve (Boardman and Jones 1990; Hillman 1981, 1981), although in some instances soft organs such as dried grapes or tubers have been recovered in a carbonised form (Hather 1991; Valamoti 2007). Preservation in these instances will therefore be affected by the physical character of the plant material. For example, Boardman and Jones (1990) found that barley grain was more sensitive than glume wheat to the effects of charring. Similarly, since oil is flammable, the higher the oil content of the seed, the less likely it is to preserve under charring conditions. Carbonised plant remains will also be heavily biased towards items that come more frequently in contact with fire and subsequently survive the charring process (Boardman and Jones 1990; Dennell 1972; Hillman 1981; Jones 1985; Van der Veen 2007).

Knörzer (1971) first suggested that the general uniformity seen in the composition of carbonised seed assemblages from Neolithic settlements in the Lower Rhine, namely cereal grain, chaff and weeds, meant that these assemblages represented the remains of harvested cereals. In addition, Dennell (1972, 1974, 1976) noted that contexts within which carbonised remains are recovered are more likely to result from processes of food production than as a result of food consumption and therefore provide a record of the crop husbandry and processing methods employed. Although Dennell (1972) began to explore the sequence of crop processing and its effects on the composition of archaeobotanical assemblages, Hillman (1984a) and Jones (1984) were the first to develop more predictive models that could be applied to archaeobotanical remains. Through detailed ethnographic studies of traditional crop processing in Greece and Turkey, they determined that each stage of the processing sequence produced characteristically different compositions of cereal, chaff and weeds that could be calculated and identified within the archaeological assemblages.

Although ethnographic research is particularly useful in examining traditional methods first hand, it is important to note that direct comparisons with the past are problematic. Not only are modern environments and cultural traditions different than past societies but technology has also evolved which may affect agricultural methods. In spite of this, both Hillman (1981) and Jones (1984) argue that different methods of processing crops within a non-mechanised farm, regardless of the technology, would have been small, resulting in a limited number of ways to process them and so the effects on assemblage composition would remain the same. Ethnographic models on crop processing activities therefore allow the building of ‘cause and effect’ models for archaeological interpretation (Hillman 1984a; Jones

1984, 1987a); however, it is important to note this uniformitarian assumptions and be aware of possible changes in attitude to the purposes and mechanisms of crop processing, especially when making inferences about past communities.

The principle behind these studies is that a crop is processed through a number of stages before it is ready for consumption and each stage has a measurable effect on the composition of grain, chaff, straw and weeds. Each stage produces two assemblages: a crop product, which continues through each stage, and a crop by-product or residue, which is removed from the remaining processes. Simplified, the stages for processing free-threshing cereals (e.g. bread and durum wheat and barley) are as follows (after Hillman 1984a; Van der Veen 1992):

Processing stage	Rationale
Harvesting	to gather the mature crop from the field possibly by uprooting or cutting the grain-bearing part of the plant
Threshing	to release the grain from the chaff possibly by beating with a stick or trampling by cattle
Winnowing	to remove the light chaff and weeds from the grain possibly by wind or by shaking in a winnowing basket
Coarse sieving	to remove larger items such as weed heads, seeds, un-threshed ears and straw with large meshes
Fine sieving	to remove the small weed seeds from the grain with narrower meshed sieves

Glume wheats (e.g. einkorn, emmer and spelt) on the other hand require further processing stages to release the grain from the tight glumes. The additional processes involved in the dehusking of glume wheats are as follows (after Hillman 1984a; Van der Veen 1992):

Processing stage	Rationale
Parching	to dry the grain and render the glumes brittle
Pounding	to release the grain from the glumes possibly in a wooden mortar or quern
2nd Winnowing	to remove the light chaff and weeds from the grain
2nd Coarse sieving	to remove the remaining large items, such as un-threshed ears or chaff and remaining culm nodes and large weeds in heads
2nd Fine sieving	to remove the glume bases and remaining small weed seeds from the grain

The most effective way of dehusking glume wheats is debated (Nesbitt and Samuel 1996). Both Küster (1984) and Meurers-Balke and Lüning (1992), through experimental dehusking of glume wheats, found that the second winnowing stage alone was sufficient to separate the glume material from the grains after using either a quern or pounding the grain in a mortar. They suggest that the second coarse and fine sieving stages are superfluous as the arable weeds and straw would have been removed at the first winnowing and sieving stages. Therefore, only a second winnowing stage would be required to remove the remaining light chaff from the grain without any further need to sieve. The composition of the second winnowing stage would have a different composition from the first, with the winnowing by-products, prior to dehusking, containing more light weeds and little chaff, while the second winnowing stage by-products, after dehusking, would consist mostly of chaff with few weeds. Sample composition will also be dependent on the varying degrees of thoroughness used through the crop processing stages (Jones 1992), whether stages are missed (Jones 1984: 45) or whether stages are performed in different ways (Hillman 1984, 1985, Peña-Chocarro 1999).

Pulses, in particular vetches, peas, lentils and grass peas, have also been studied ethnographically by Jones (1984) and Butler (1992; *et al.* 1999). They found that *Vicia* and *Lathyrus* could be processed similarly to free-threshing cereals; however, ethnographic processing of *Vicia*/*Lathyrus* revealed that there was a spectrum of ‘threshability’, as many pods did not shatter during the first threshing and therefore needed multiple threshing stages (Butler *et al.* 1999). Millets, such as *Digitaria*, *Echinochloa*, *Panicum*, and *Setaria*, on the other hand, share similar processing stages with glume wheats, as millets also require dehusking (Harvey and Fuller 2005). Young (1999), exploring the traditional processing of finger millet (*Eleusine coracana*) in Uganda, identified a series of roasting, pounding and winnowing stages aimed at softening the grains and loosening the chaff before grinding into flour.

6.1.2 Other formation processes

Distinguishing routine activities and occasional accidental or deliberate burning episodes is particularly important not only to determine formation processes at a site but also when comparing different samples. Jones (1991a) and Van der Veen and

Jones (2006) advocate the need to differentiate between regular routine activities and rare accidental or deliberate events in order to restrict their contribution to the overall pattern on a site or to assist in the detection of repeated episodes of accidental or deliberate burning that may signify a specific practice. They also suggest that differentiation between the samples allows samples of the same crop processing stage, and thus the same relative composition, to be compared. This is particularly important when exploring weed ecology, as weeds with different physical characteristics (e.g. size or shape) are removed through each processing stage and would therefore bias the assemblage towards certain species. This will be explored further in Chapter 7.

Exploring the deposition of carbonised remains, Van der Veen (2007), referring back to Hillman (1981), highlighted five ‘routes of entry’ on archaeological sites, the most common being: plant remains used as fuel, both intentionally and through casual discard, and foods accidentally burnt during food preparation, such as through cooking or roasting. The least common routes include: accidental or deliberate destruction of food and fodder stores, the use of fire to clean out grain storage pits, and the destruction of diseased or infested crop seeds (Van der Veen 2007). Deposition of plant remains through ritual activities can also result in carbonised plant remains, such as from cremation burials or votive offerings (e.g. Megaloudi 2005). Ritual assemblages may contain special plant remains that are not typical foodstuffs at a site or have other ritual connotations which cannot be directly compared with plant remains resulting from general day to day activities.

Ethnographic models are particularly helpful in exploring types of activities that may result in the charring of crop processing products and by-products and their deposition into the archaeological record. Hillman (1984a) observed that the daily processing of stored glume wheat within households in Turkey allowed the by-products to be easily swept into the fire. This model of daily spikelet processing and the subsequent charring of residue in the hearth is often cited as the most common form by which charred plant remains (namely glume wheat glume bases) occur on Linearbandkeramik (LBK) and later sites in Central Europe (Gregg 1989; Meurers-Balke and Lüning 1992). It is also suggested that the roasting or parching stage within the processing of glume wheats and millets will also generate a number of discarded charred grains (Hillman 1985).

The use of dung as fuel has also been identified as a route by which plant material, especially glume wheat glume bases, becomes incorporated in the archaeobotanical assemblage (Charles 1998; Miller and Smart 1984a; Valamoti 2005b). Although research has largely focused on sites in the Near East and Asia (Anderson and Ertrug-Yaras 1998; Charles 1998; Miller and Smart 1984a), dung is slowly becoming recognised in European assemblages. Valamoti and Jones (2003) and Valamoti (2004), studying Late Neolithic and Early Bronze Age sites in northern Greece, were able to identify the use of dung fuel and a variety of animal feeding strategies from the characteristics of the wild plant species and the combination of cereal parts and fruits. This is particularly important in the interpretation of archaeobotanical assemblages, as samples derived from dung cannot automatically be used to reconstruct crop husbandry practices. Whether dung fuel would have been used in European contexts is still debated. Some propose that the likely abundance of wood in the landscape during the Neolithic and Bronze Age would negate the need to use dung as fuel (Van der Veen 1992: 104). On the other hand, some suggest that the use of dung is not reliant on the availability of wood but a distinct preference for that type of fuel (Anderson and Ertrug-Yaras 1998; Charles 1998).

6.1.3 Analytical approaches to crop processing

From the ethnographic work conducted by Hillman (1984a) and Jones (1984), two methods for analysing crop processing within archaeobotanical samples developed. These two methods were first implemented by Van der Veen (1992), and involved the use of ratios to classify samples based on their crop content, i.e. the crop type and plant part, and to categorise samples based on the physical properties of the weed seeds present. The first method involves the calculation of ratios of the straw, chaff, grain and weeds in each sample, using known proportions of plant parts in each whole species. For example, einkorn has two glume bases to one grain (2:1), while six-row barley has one rachis to three grains (1:3).

The second weed based method categorises weeds according to the degree to which the weed seeds either accompany the crop through processing or are removed, depending on their shape (aerodynamic properties), their ‘headedness’ (whether seeds come in capsules), size (‘sievability’) and density (‘winnowability’). Jones (1984) devised weed categories to group the weeds according to their characteristics and identified the stages at which they would be removed during the crop processing sequence. The weed categories used are big-heavy-headed (BHH), big-free-heavy (BFH), small-headed-heavy (SHH), small-free-heavy (SFH), and small-free-light (SFL) (Jones 1984). Thus weeds removed by winnowing tend to be small-free-light (SFL), weeds removed by coarse sieving are mostly headed weeds (SHL, SHH, BHH), while fine-sieving removes the small-free-heavy weeds. By examining the data through discriminant analysis, Jones (1984) was able to separate samples indicative of by-products from early (winnowing and coarse sieving) and late (fine sieving) crop processing stages, as well as final crop products.

The criteria to determine the weed categories are not clear cut, however, resulting in variation between authors and where species are grouped. Van der Veen (1992:84) investigated whether small grasses should be categorised as light or heavy but found, when tested, that there were no discernible differences in the results. Stevens (2003) also compared the weed seeds from his British Iron Age samples, where large seeds were grain sized or larger (> 2.5mm) and small seeds were < 2.5mm. This led to some differences between the classifications determined by Stevens (2003) and Van der Veen (1992). For example, *Polygonum aviculare* was classified as large and heavy by Stevens (Stevens 2003) but as small-free-heavy by Van der Veen (1992:207, Table 7.4). In contrast, Bogaard (2002b) suggested that seeds are big if they are ≥ 1.5 mm diameter and small if they are < 1.5 mm in diameter. These differences in criteria may have been determined by the assemblages each author was studying; for example, Van der Veen (1992) examined mainly spelt and barley assemblages, Stevens (2003) mainly barley crops, while Bogaard (2002b, 2004) analysed mainly emmer and einkorn. Further work is needed to look at whether disparities exist between the different size categories on the interpretation of crop processing stages.

The two methods proposed by Hillman (1984a) and Jones (1984) were first implemented and compared by Van der Veen (1992), who examined crop processing as part of her study on agriculture in Iron Age and Roman northern England. Three ratios were first calculated from the data, glume:grain, rachis:grain and weed:grain, followed by a discriminant analysis of the weed seeds, using Jones's aerodynamic properties of the weeds (after Jones 1984). When comparing the results of each method, Van der Veen (1992:86) found that there was little difference, suggesting that one method would be enough to address crop processing at a site.

The three ratios used by Van der Veen (1992:82) were later revised by Van der Veen and Jones (2006), who presented a further three ratios: ratio 1, 5 and 6 (Table 6.1). Previously, Van der Veen (1992: chapter 7) used discriminant analysis to explore the aerodynamic properties of the weeds (*cf*. Jones 1984); however, Van der Veen and Jones (2006) reduced this method to a simple ratio that could be used in conjunction with the other ratios. The calculation of seed density per litre (ratio 6) also allows samples to be broadly assessed as to their rate of deposition and thus the possible nature of the deposit (i.e. primary, secondary or tertiary context).

Subsequent work by Van der Veen (2007:987) proposed a further two ratios: the number of germinated to non-germinated grains and the number of diseased/insect damaged to 'normal' grains. These ratios were proposed in order to help determine the presence of accidental grain spoilage, deliberate burning of storage pits, malting residue or spoiled grain. Van der Veen (2007:25) also highlighted here that these ratios should only be calculated where adequate numbers of plant items are available. Previously Van der Veen (1992:25) used a cut off of point of 50 identified items per sample as an adequate figure to analyse crop processing within samples. Other authors have also implemented this strategy; for example Bogaard (2004:Chapter 2) analysing crop husbandry regimes in Neolithic Central Europe only examined samples with over 50 cereal grains and 30 weed seeds.

In summary, crop processing stages successively alter the composition of the crop assemblage, creating at each step a product and a by-product. It is important to determine which processing stage samples represent in order to compare like with like when analysing the assemblage for crop husbandry regimes. The following sections will present the methodology and results of the crop processing analysis applied to the plant assemblage from Feudvar. The results will be used to determine which samples will be selected for analysis in Chapter 7.

6.2 Methodology

The methodology applied here is based on the ratios presented by Van der Veen (1992) and Van der Veen and Jones (2006). In addition, the weed seeds will be categorised according to their aerodynamic properties but only primarily as a tool to determine whether a weed seed is categorised as big or small for the calculation of ratio 5 (Jones 1984). The methods applied to the Feudvar dataset are detailed in the following section.

6.2.1 Standardisation of the data

In order to carry out the analysis, the data needed to be standardised and simplified to allow an accurate interpretation of the assemblage. Non-cereal crops, such as pulses and oil-rich seeds, fruits and other non-cereal wild/weed seeds, such as *Crataegus* sp. and *Tilia* sp., were excluded from the analysis. Weed seeds here where determined through the examination of similar studies where weed seeds were identified (e.g. Bogaard 2004; Van der veen 1992; Marinova 2006). To allow for poor preservation, species identified to cf., such as *Triticum* cf. *spelta*, were amalgamated with the identified species, e.g. *Triticum spelta*, if the species was present in the sample. In addition, to reduce the number of calculations, both hulled and naked barley were combined as they are both free-threshing varieties. All glume bases are counted as one and spikelets were counted as two (i.e. two glume bases). In order to determine more accurately the numbers of grains present in the samples, grains categorised as Cerealia indet. were reallocated to the cereal species present in that sample, with the exception of *Panicum miliaceum*. This was achieved by calculating, $\sum = s + (c \times \frac{s}{t})$ for each species in each sample, where s is the number of items per species, c the total number of cereal indet, and t the total number of identified cereal items (not including cereal indet). Only weeds identified to species or genus were included in the calculations, as those identified to family generally contained species with different size and aerodynamic characteristics. In accordance with the criteria applied by Van der Veen (1992: Chapter 7), samples with less than

50 identified items were removed. This reduced the number of Feudvar samples from 524 to 484.

6.2.2 Weed seed categorisation

Weed species are defined here as those plants that can grow within a cereal crop. In order to determine the small:large weed ratio as well as determining the stage at which the species may have been removed during crop processing, each weed species was categorised according to their aerodynamic properties. Initially, the length and width of each species was recorded (Table 6.2). The measurements were obtained from two sources; the online Digital Seed Atlas (Cappers *et al.* 2006) and from the University of Leicester seed collection. To establish the size of seeds identified to genus, species measurements recorded in the Digital Seed Atlas were averaged. In addition, the length and width of each cereal species was also recorded (Table 6.3). The purpose of this was to help identify possible differences in grain size between the different cereals, as this may ultimately affect the size of the sieves used to process them, and will help to determine the cut off point at which a weed seed is large or small. Jones (1996) also suggests that for sieves where the grain passes vertically, the maximum width of the grain is the most important dimension.

The average width per species can be sorted into two groups: those that have a width > 3 mm, i.e. barley, bread/durum wheat and rye (Group A), and those with a width between 2 - 3mm, i.e. emmer, einkorn, spelt, oat and broomcorn millet (Group B). This may suggest that different sieve sizes could have been used for different crops. To explore this further it was decided that two categories, A and B, would be employed to determine which category, either big or small, a weed species belonged. The criteria are as follows:

- Group A – Weeds are defined as 'small' if they are < 2.5mm and 'big' if they are > 3mm. Species falling in the range of 2.5-3mm are defined as IBT (in between).
- Group B – Weeds are defined as 'small' if they are < 2mm and 'big' if they are > 2.5mm. Species falling in the range of 2-2.5mm are defined as IBT (in between).

Of the 120 different weeds identified from the Feudvar assemblage, group A contained 10 weeds categorised as IBT, 62 as small and 48 as big, while group B contained 11 categorised as IBT, 50 as small and 59 as big. To determine ratio 5, small:large weeds, and to account for the potential differences in sieve size for each species group, four ratios were calculated. Two of these ratios represent group A and B with the IBT weeds categorised as small and two with the IBT weeds as big. In this way, all the weed species were included in the analysis and differences in the categories could be observed in relation to the composition of each sample.

In addition to categorising weeds by size, further attributes were assigned to each species based on their aerodynamic properties (*cf.* Jones 1984). To help determine these properties, previous identifications were compiled from Jones (1984), Van der Veen (1992), Peña-Chocarro (1999) and Bogaard (2002b) (Table 6.2). Where the classification was not recorded by the authors, the weeds were examined first to see whether the seeds grew within a seed head or capsule and if so whether the seeds would be released after threshing, during the winnowing process. This was primarily determined by the properties of the capsule, such as wall thickness and whether the capsule is tightly closed or open. Weeds identified as light were those that were extremely small or small seeds that had wings, making them more aerodynamic.

6.3 Results

Three main crop processing groups were identified: namely those of spikelets, fine-sieving by-products and products (see Table 6.5 for the calculation of ratios 2-6 per sample). Two further subdivisions were also recognised for each group; these included sieved and unsieved spikelets, sieved and unsieved fine sieving by-products and sieved and unsieved products. Each group is explained further in the following sections.

6.3.1 Spikelets

6.3.1.1 Sieved

Samples identified as sieved spikelets contained large numbers of grain and glume bases with a ratio indicating the complete ear of the crop and few weed seeds present. 21 samples were identified as containing sieved einkorn spikelet remains. These samples were characterised by einkorn glume bases:grains, having a value of between 1.6 and 2.1 and a low weed seed:cereal grain value.

To account for differential preservation of the chaff remains (i.e. glume bases and rachis), which are less likely to preserve compared to the denser grains and seeds, it was decided that samples with a low einkorn glume bases:grains ratio, of between 0.6 and 1.5 could also indicate sieved einkorn spikelets. As a result, an additional 64 samples were categorised as possible sieved einkorn spikelets.

6.3.1.2 Unsieved

Samples identified as unsieved spikelets contained large numbers of grain and glume bases with a ratio indicating the complete ear of the crop as well as large numbers of weed seeds. 22 samples were identified as containing unsieved einkorn spikelets. These samples were characterised by einkorn glume bases:grains, having a value of between 1.6 and 2.1 and a high weed seed:cereal grain value, indicating that there are more weeds compared to the number of grains. In addition, a further 30 samples were identified as indicating possible unsieved einkorn spikelets, where the glume bases are under-represented. Two samples, FEU095 and FEU439, were also identified as possible unsieved spikelets; however, they both have < 55 items which makes their interpretation difficult. The composition of these samples will be looked at further in section 6.5.

6.3.2 Fine sieve by-products

6.3.2.1 Sieved

Samples identified as sieved fine sieve by-products contained large quantities of glume wheat glume bases and only a few weed seeds. This means that the glume wheat spikelets had been previously sieved before dehusking, resulting in fewer weed seeds in the second fine sieving by-products. 79 samples were identified as being previously sieved einkorn fine sieving residue. These samples were characterised by einkorn glume bases:grains ratio, having a value of ≥ 2.2, and a low weed seed:cereal grain value. Three samples, FEU009, 065 and 084, were identified as being previously sieved emmer fine sieving by-products. The samples here were dominated by emmer remains with a high ratio 2 value of ≥ 1.5 as well as a low value for weed seed:cereal grain.

6.3.2.2 Unsieved

Samples identified as fine sieving by-products that may not have been previously sieved contained large quantities of glume wheat glume bases but with far more weeds. This may suggest that the glume wheat spikelets had not been previously sieved before dehusking, resulting in more weed seeds in the second fine sieving by-products. 87 samples were identified as being einkorn fine sieving residue that had not been previously sieved. These samples were characterised by einkorn glume bases:grains, having a value of > 2.2 and a high weed seed:cereal grain value. Three samples, FEU37, 257 and 262, were identified as possible einkorn fine sieving by-products that had not been previously sieved; however, the similar weed seed to cereal grain ratio and the small number of items recovered per sample made interpretation difficult. These samples will be addressed further in section 6.5.

6.3.3 Products

6.3.3.1 Sieved

Samples identified as a sieved product contained large quantities of 'clean' grain i.e. grain with little to no chaff and few weed species present as a result of systematic sieving. One hundred and three samples were identified as deriving from sieved einkorn products. These samples were characterised by a value of ≤ 0.4 for einkorn glume bases:grains, and a low weed seed:cereal grain value. In addition, four samples were tentatively identified as sieved einkorn products, due to the low number of einkorn grains (< 25 items). Whether these samples should be allocated here can be explored further in section 6.5.

Two samples, FEU083 and 316, were identified as emmer products. They were characterised by emmer glume bases:grains, having a ratio of 0.001 and a low weed seed:cereal grain value. Twelve further samples were identified as originating from sieved barley products and were characterised by a value of ≤ 0.2 for barley rachis:grains, and a low weed seed:cereal grain value. FEU029, 030, and 079 were identified as containing equal proportions of einkorn and barley sieved products, an additional five were tentatively identified as einkorn and barley products, and

FEU18 was interpreted as containing both barley and broomcorn millet sieved products.

FEU013 and 402 contained sieved broomcorn millet (*Panicum miliaceum*) products. No broomcorn millet spikelets were identified at the site, possibly due to differential preservation, and therefore the identification of broomcorn millet products is more speculative. In sample FEU049, two possible remains were identified: broomcorn millet products and einkorn fine sieving residue. The presence of einkorn fine sieving residue in the sample may, however, suggest that broomcorn millet represents a weed instead of a crop. The sample may then indicate unsieved einkorn fine sieving residue. FEU021 was identified as sieved rye products; however, rye is only tentatively identified at Feudvar and no rye rachis was recovered at the site. The composition of FEU021 contains a relatively high number of large weeds and barley grain, which may suggest that the rye grains represent a weed instead of a crop. Both samples will be examined further in the following section.

6.3.3.2 Unsieved

Samples identified as unsieved products contained large quantities of ‘clean’ grain i.e. grain with little to no chaff and lots of small weed seeds. Unlike the sieved products, these samples represent products that may not have been thoroughly sieved, possibly missing stages of the later processing sequence; however the large quantity of weeds may result from the mixing of products with fine sieving by-products. This will be assessed in the following section. 26 samples were allocated as unsieved einkorn products, characterised by a value of ≤ 0.4 for einkorn glume bases:grains, and a high weed seed:cereal grain value. In addition, samples FEU203, 346, 446 and 478 have been tentatively identified as unsieved einkorn products as they have approximately equal numbers of weeds compared to the number of grains.

FEU353 and 485 were identified as unsieved barley products due to the low barley rachis:grain value, and although the value for weed seed:cereal grain was *ca.*1, it was decided that the large numbers of seeds present would more likely represent an unsieved deposit. FEU068 was also tentatively identified as containing unsieved barley products due to the approximately equal value of weed seed:cereal grain. A further three samples, FEU017, 019, and 050, were tentatively identified as unsieved broomcorn millet products due to the dominance of millet grains; however, FEU017 and 050 have less than 100 broomcorn millet grains between them and may indicate a mixture of millet products and by-products. All three samples also have relatively large numbers of small weed species which may suggest that the millet grains may have arrived at the site as a weed instead of a crop. The large number of broomcorn millet grains in FEU19 may, however, contradict this theory. This sample in particular is the most likely broomcorn millet product. The only other ambiguity is whether the sample can be classed as sieved or unsieved due to the large number of small weeds present; however, a sieve specifically designed for broomcorn millet is likely to collect a number of small weeds of the same size during the sieving stages. FEU483 was also identified as containing unsieved rye products due to the high quantity of rye grains in the sample. These samples will be looked at further in section 6.5.

6.3.4 Summary

The analysis of crop processing at Feudvar, through the application of ratios 2-6 (after Van der Veen 1992; Van der Veen and Jones 2006), has identified six different processing stages: sieved and unsieved spikelets, sieved and unsieved fine sieving residue and sieved and unsieved products. Of the 484 samples analysed, a total of 445 were identified as resulting from einkorn remains, fourteen from barley, six from broomcorn millet (*Panicum miliaceum*), five from emmer, two possibly from rye and twelve from two or more crop mixtures (Table 6.6 summarises the results). Only einkorn spikelets were identified and only einkorn and emmer fine sieving by-products. Two samples represented a mixture of einkorn fine sieving by products and the possible remains of earlier crop processing stages of barley and bread/durum wheat, identified from the large number of rachis remains. The majority of the products resulted from einkorn remains; however, a much wider variety of crops was identified including barley, broomcorn millet and rye products. Only 36 samples were identified as unsieved products, with the majority having been systematically sieved. The possibility of mixed samples, makes it difficult to accurately calculate the relative proportions of grain, chaff and weeds to a crop processing stage, as it is impossible to determine which weed seeds belonged to which crop. Jones (1990) suggests that the best way to overcome this problem is to adopt a multivariate approach. As the ratio analysis showed clear differences in the groups of samples identified to different crop processing groups, it was decided that no further tests were required; however, with the use of correspondence analysis the samples will be examined further to aid in the classification of ambiguous identifications and possible mixing within the samples.

6.4 Correspondence analysis

Correspondence analysis is used here to examine the results of the crop processing analysis in order to explore whether the tentative identifications are associated with their groupings. This multivariate technique is particularly useful as it allows each sample to be plotted along two axes depending on their similarities and differences in species composition (see Chapter 3). The following section will present the methodology applied to the dataset and the results of the analysis.

6.4.1 Standardisation of the data

Before correspondence analysis could be applied to the dataset certain samples and species were excluded from the analysis. All 484 samples used in the crop processing analysis were included here, as they represent samples with over 50 cereal and weed items. This cut off point was applied by Van der Veen (1992:25) in the application of multivariate techniques (i.e. principle components, cluster and discriminant analysis) in order to reduce the level of unreliability caused by such small samples. The presence of rare species within the samples is also problematic as they may not be associated with the crop but result from other activities or come from the local environment; however, variation exists as to how authors address this. Some advocate the exclusion of weed species found in either < 5% or < 10% of samples (*cf.* Bogaard 2004). Van der Veen (1992) found that a 10% cut off point was more than adequate to account for rare species in the dataset. It was therefore decided that weed species in < 10% of the samples would be excluded. This reduced the weed species from 122 down to 28 (see Appendix 6, Table 6.7 for species codes). With the exclusion of these species, two samples, FEU91 and 43, fell below the 50 items cut off point; however, both samples were only a few seeds below this point, 46 and 45 items respectively, and were therefore included in the analysis. The dataset was then entered into CANOCO 4.5. and CANODRAW where each sample was coded to their identified crop processing stage.

6.4.2 Results

All of the samples classified to a crop processing stage through the ratio analysis were first examined through correspondence analysis to identify whether each stage did form a distinct group. Each sample was coded to their basic crop processing stage (i.e. all samples identified as sieved or unsieved spikelets were combined) regardless of cereal type and all tentative identifications were included within their possible groups. Initial analyses identified a separate cluster of seven samples near broomcorn millet (*Panicum miliaceum*) along axis 2. These samples, FEU13, 17-19, 49, 50 and 402, had been previously identified as containing broomcorn millet products. Once removed, *Chenopodium* sp. had a distinct effect on the dataset, pulling a number of samples along axis 2. To reduce the effects, it was decided to down weight this species. Lastly, sample FEU425 separated from the main group of samples due to the high number of bread/durum wheat grains. This sample was subsequently removed. Figure 6.1 presents the results plotted along axes 1 and 2.

All of the cereal categories, except rye and barley rachis, are located on the negative end of axis one, while the majority of the weeds are located on the positive end. Along axis 2 the glume bases are located at the negative end while the cereal grains are found along the positive end. This distribution therefore resulted in the fine sieving by-products clustering to the bottom left, near the glume bases, the spikelets in the middle of the glume bases and the grains, and the products at the top near the cereal grains. Clustered with the products are a few samples identified as fine sieving by-products. These samples contain little chaff, a few grains but lots of small weeds (SFH), which would suggest that they are indeed fine sieving by-products and not products. The clear clustering of different crop processing stages would suggest that the ratio cut off points were acceptable, especially in the case of the spikelet remains. The dispersal of samples towards the positive end of axis 1 may result from unsieved crop processing stages, as the majority of the weed species are located in this area. These will be explored further in the following sections, as each crop processing stage is analysed separately.

Discrete clusters of species can also be seen and although weed ecology will be considered in chapter 7, these associations are interesting to note (Fig 6.1). First, a large group consisting of Compositae, *Chenopodium* sp., *Echinochloa crus-galli*, *Solanum nigrum*, *Digitaria* sp., Labiatae, and *Teucrium* sp. cluster together near the centre of the plot (see Appendix 6, Table 6.7 for species codes). Second, *Bupleurum rotundifolium*, Gramineae, *Bromus* sp., *Bromus arvensis*, *Plantago lanceolata*, *Polygonum persicaria*, *Polygonum convolvulus*, *Trifolium* sp., and *Verbena officinalis* cluster near rye to the right of the plot (Fig 6.1). The third group includes *Lolium* sp., Polygonaceae and *Polygonum aviculare* clustering near barley rachis to the far right of the plot (Fig 6.1).

6.4.2.1 Spikelets - sieved/unsieved

A correspondence analysis was run on the samples categorised as einkorn spikelets. A large number of *Galium spurium* seeds in FEU138 and *Agrostemma githago* seeds in FEU92 made these samples outliers and prevented the rest of the samples from being clearly seen. As a result they were removed from the analysis.

The clear separation of the sieved and unsieved spikelets supports the results from the ratio analysis (Fig 6.2). The sieved samples cluster in the bottom left of the plot, with all the cereals, suggesting little variation between the samples. The spread of the unsieved samples along the positive ends of axes 1 and 2 and their proximity to the wild/weed species, including broomcorn millet and rye, suggests greater variation between the samples. The location of broomcorn millet and rye may suggest that in these samples they represent weeds within the main einkorn crop. There is also a distinct cluster of samples near *Chenopodium* sp, at the positive end of axis 1. This results from the large numbers of *Chenopodium* seeds in the samples. Whether these samples represent unsieved remains or the collection of *Chenopodium* as a food is unclear, especially as the remains were not identified to species and the genus is commonly found growing as weeds in crops.

Only FEU128, classified as sieved, is distinctly separate from the main cluster, towards the top of axis 2. The sample has very few weed remains compared to the quantity of grain and glume bases present, so it is unlikely to be unsieved. The low glume:grain einkorn glume bases:grains, of 0.9 may suggest unsieved einkorn products rather than spikelets with underrepresented glume bases; however, the sample is particularly dominant in one weed species which may explain why it is plotted near *Echinochloa crus-galli*. The samples along the border of sieved and unsieved are largely characterised by an approximately equal value for weed seed:cereal grain, making it difficult to determine their classification. Re-examining FEU497, 133 and 86, which are located furthest away from the main cluster of sieved spikelets, it may be possible to change these to unsieved spikelets as the number of weeds are slightly higher than the einkorn remains. These 'uncertain' samples will need to be explored with caution when examining weed ecology in the following chapter.

6.4.2.2 Fine sieve by-products - sieved/unsieved

A correspondence analysis was run on the samples categorised as fine sieve by-products. Both samples FEU79 and 425 were removed as they contained large numbers of *Vicia* sp. and bread/durum wheat, respectively, making them outliers in the analysis. FEU425 in particular was identified as emmer and einkorn sieved fine sieving residue; however, the relatively large number of bread/durum wheat and barley grains in the sample prevented any clear interpretation and may suggest that the assemblage is the result of mixing of different crop processing stages during deposition.

FEU56 and 57, identified as sieved remains from the ratio analysis, are located in the unsieved area along the positive end of axis 2 (Fig 6.3). The value of the weed seed:cereal grain ratio implies sieved remains, but if the broomcorn millet grains are interpreted as a weed then the samples may suggest unsieved remains. As a result, these samples have been re-identified as unsieved samples based on the correspondence analysis. Two further samples, FEU217 and 219, located along the positive end of axis 1, were identified as sieved einkorn by-products with possible remains of free-threshing early crop processing by-products. Both have low values for weed seed:cereal grain but due to the high number of bread/durum wheat and barley rachis they have separated from the rest of the sieved remains. This would suggest that the samples likely represent a mix of glume wheat fine sieving by-products and free-threshing early crop processing waste.

The samples along the border of sieved and unsieved are largely characterised by an approximately equal value for weed seed:cereal grain, making it difficult to determine their classification. A re-examination of FEU327 and 435, identified as unsieved remains, are located within the cluster of samples identified as sieved and may suggest that they actually represent sieved fine sieving residue, especially as the number of weeds are lower than the number of einkorn glume bases; however, these ‘uncertain’ samples will need to be explored with caution when examining weed ecology in the following chapter.

6.4.2.3 Products - sieved/unsieved

A correspondence analysis was run on the samples categorised as products. Initial analysis identified a distinct cluster of seven samples, FEU 402, 13, 19, 49, 50, 18 and 17, which were all identified as containing broomcorn millet products. FEU18 was identified as containing both barley and broomcorn millet products and although the correspondence analysis may suggest that it is mainly broomcorn millet products, the similar number of barley and millet grains support the original interpretation. In addition, FEU483 was an outlier in the analysis as a result of the large number of Cruciferae seeds recovered (402 seeds). From the ratio analyses, this sample was identified as an unsieved rye product. These samples were subsequently removed to allow further analysis of the remaining products.

Correspondence analysis was first run on the sieved and unsieved products regardless of the species of the product in order to determine whether differences could be seen between the samples (Fig. 6.4). The sieved samples generally cluster in the bottom left of the plot, while the unsieved samples are spread along the right. The tentatively identified sieved and unsieved products were also plotted. From Fig. 6.4, it is difficult to determine whether the possible sieved or unsieved are correct identifications as they are located among both types of samples. As a result, the samples have been left to the classifications determined from the ratio analysis. Similar to the previous crop processing groups a number of samples also cluster near *Chenopodium* sp.

A second correspondence analysis was run to determine whether the different crops identified as products clustered together. Due to the effects of *Chenopodium* sp. on sample composition, it was decided that it would be removed from this analysis. The most distinct group of samples are those identified as sieved barley products (Fig 6.5). Of the 12 samples, 11 are found clustered at the positive end of axis 2. The last sample, FEU47, is located on the positive end of axis 1 near rye and barley rachis; however, looking at the ratios it is clear that this sample represents a sieved barley product. The second distinct group is the two samples identified as unsieved barley which are located at the positive end of axis 1. It is also interesting to note that a number of grasses (e.g. *Lolium* sp.) and knotgrasses (e.g. *Polygonum aviculare*) also cluster here.

FEU29 and 30 are located between einkorn and barley, supporting their identification as a mixed crop or deposit of einkorn and barley products. The composition of FEU83 is clearly that of an emmer product, so the location of the sample may result from the composition of the few weed seeds present in the sample. Finally FEU21, identified as a sieved rye product, is located near the rye but is also near samples identified as unsieved einkorn products. The sample also includes a number of barley and einkorn remains which could possibly suggest that either the rye is a weed in another crop, especially as there are a lot of large weed seeds present, or the sample may contain a mix of different crop products. It is also important to note that cultivated rye was only tentatively identified within the assemblage (i.e. cf. *Secale cereale*), making it difficult to determine whether it was a product at the site.

6.4.3 Summary

As the ratio analysis showed clear differences in the groups of samples identified to different crop processing groups, it was decided that no further tests were required (e.g. discriminate analysis); however, with the use of correspondence analysis the samples could be examined further to aid in the classification of ambiguous identifications. This proved successful as the samples identified to different crop processing groups clustered together and tentative identifications were reinforced by the analysis. Correspondence analysis was also useful in highlighting certain samples that did not conform to the clusters and therefore required reassessing.

Table 6.8 presents a summary of the number of samples identified to each crop processing stage before and after the correspondence analysis. Only three samples previously identified as sieved spikelets were re-examined and changed to unsieved spikelets. For the fine sieving residue, samples FEU056 and 057, previously identified as sieved were changed to unsieved. In addition, FEU327 and 435, previously identified as unsieved fine sieving residue were changed to sieved.

A number of issues were also brought to light. The first involved the dominance and effect of *Chenopodium* sp. on many of the samples in the assemblage. Two samples identified as unsieved fine sieving by-products have >90% *Chenopodium*, while a further 16 samples identified as unsieved spikelets, fine sieving by-products and products contain >70% *Chenopodium* (Table 6.9). These samples may therefore suggest that within these samples *Chenopodium* sp. represents food collection rather than a crop weed. Species within the *Chenopodium* family can, however, be found as a weed in crops and each individual plant can produce large numbers of seeds. For example, Williams (1969: 837) observed that *Chenopodium* plants in nitrogen-poor soils produced < 20 seeds per plant, although those on nitrogen-rich soils can produce > 200,000 seeds per plant. It is therefore difficult to determine its significance within the samples and will need to be explored further when examining weed ecology in the samples.

Second, is the role of broomcorn millet and rye at the site. The lack of rachis remains does not necessarily mean that they were not grown at the site and its absence may result from differential preservation (especially for millet), small harvests or its arrival at the site as a clean product; however, both species are found as a small component of many of the samples which may support the idea that they were weeds within the main crop. The identifications of broomcorn millet as a product from the ratio and correspondence analysis will remain, although it is important to note the issues that surround these identifications.

6.5 Intra-site variability

6.5.1 General trends

The location of each sample identified to a crop processing stage within the western trench at Feudvar is presented below. The aim is to see whether certain crop processing remains are found within particular features or areas within the trench. The trench is divided into 5x5m areas to help determine any differences in spatial deposition. This will contribute to the overall depositional history of the samples.

The samples identified to crop processing stages were first examined as to their percentage presence within each feature type (Table 6.10). The majority of samples were recovered from general deposits, houses and pits, although the percentage of samples identified to each crop processing stage varies. General deposits along with container fills, hearths and miscellaneous deposits have a higher percentage of samples identified as fine sieving by-products. Pit, street and yard deposits have a higher percentage of products, while the house deposits contain an approximately equal percentage of spikelets, fine sieving by-products and products. The street deposits are the only feature that contains mainly products, while the yard samples contain mainly products and spikelets and the container fills have more samples identified as fine sieving residue and spikelets. However, these features are represented by a small number of samples, so it is difficult to determine how accurate these trends are.

Looking at the distribution of samples across the site seen in Figure 6.6, some distinctions may be identified. First, a high percentage of spikelets can be seen in area 1 and 3. The samples here come from mainly general deposits, houses and pits (Table 6.11). Second, the majority of samples containing fine sieving by-products are located in areas 2, 7, 12, 15 and 16 from a wide range of features, although mainly general, house and pit deposits. Areas 7 and 12 also have extremely high plant seed densities per litre of soil (Fig 5.3). Third, areas 4-6, 8 and 14 have slightly higher percentages of samples identified as products which are mainly from general deposits, pits and house areas with only a few being found in street and yard deposits (Table 6.11). In addition, the distribution of sieved and unsieved samples (Fig 6.7), shows that areas 6, 9 and 15 have a high percentage of sieved remains (> 85% of samples) while areas 3, 13, 14 and 16 have over 50% of the samples identified as unsieved. The later areas were generally identified as containing high percentages of spikelets and fine sieving residue, while the former contained products and fine sieving residue.

6.5.2 Cereal distribution

In order to determine whether these areas show any consistency in distribution that may suggest differences in household activities or crop preference, the distribution of crop remains were also examined. The majority of the crop processing remains have been identified as einkorn crops and as such are found in all the feature types sampled at the site (Table 6.12). General, house and pit deposits have the greatest variety of samples identified to a certain crop, however, no further patterns can be distinguished. Looking at the percentage presence of each crop as well as the weeds per feature for all the samples a number of patterns can be seen (Table 6.13). Overall general occupation layers and house floors contain the highest percentage of remains from most of the cereals and weeds. Only broomcorn millet and emmer deviate from this trend, the millet remains being found in pits and 48% of emmer grain found from hearth features; however, 33% of emmer glume bases are found from house floors along with einkorn glume bases and barley rachis. Another interesting observation is the fact that broomcorn millet remains are high within pits but low in house floors, while rye has a high percentage of grains within house deposits and only a small percentage in pits (Table 6.13).

The differences seen between house deposits and pits was examined further in relation to the percentage of cereal and weed remains per areas within the trench for each crop processing stage i.e. spikelets, fine sieving residue and products (Tables 6.14-16).

6.5.2.1 Spikelets

House levels which contain spikelets occur in areas 1-9, 13 and 14, while pits containing spikelets are found in blocks 1-4, 6-9 and 12-14 (Table 6.14). Although the areas are largely dominated by einkorn spikelets, a number of observations can be made between the two feature types and areas. Area 14 has a high number of barley grains and weeds in the house levels. Both area 14 and 3 contain a high percentage of weeds for both house and pit features, while areas 6 and 12 have an extremely low percentage of weeds. Area 7 shows a high percentage of broomcorn millet grains and a low percentage of weeds within the pits, while a high percentage of rye grains are located in area 9 within the house deposits along with a high percentage of weeds.

6.5.2.2 Fine sieving by-products

House levels which contain fine sieving by-products occur in areas 1-8, 11 and 13-16, while pits containing fine sieving by-products are found in blocks 2-4, 6, and 8-15 (Table 6.14). Although the areas are largely dominated by einkorn spikelets, a number of observations can be made between the two feature types and areas. Area 14 has a high number of barley grains and weeds in the house levels. Areas 3-4 and

13- 14 contain a high percentage of weeds for both house and pit features, while generally areas 6-9 have a lower percentage of weeds. Broomcorn millet is largely absent from the house levels; however, rye is present in small quantities in both house and pit features, especially in the southern half of the trench. A large percentage (77%) of emmer glume bases are present in area 8 of the house level; however, this results from FEU084, which was identified as sieved emmer fine sieving by-products.

6.5.2.3 Products

House levels which contain products occur in areas 3-8, 10-11 and 13-14, while pits containing products are found in blocks 1-2, 4-6, 8-11, 14 and 16 (Table 6.14). Although the areas are largely dominated by einkorn spikelets a number of observations can be made between the two feature types and areas. Area 14 has a high number of barley grains and weeds in the house levels. Areas 3, 11 and 13 have a high percentage of weeds within the house levels, while areas 4 and 7 have the lowest. Area 11 shows a high percentage of broomcorn millet grains within the pits, while a high percentage of rye grains are located in area 5 within the house deposits along with a relatively high percentage of weeds.

6.5.3 Correspondence analysis

Each crop processing group was re-examined in relation to the distribution of feature types and areas with the trench in correspondence analysis. This was conducted in order to determine whether the distribution of samples may also be linked with feature type of area, especially as a number of patterns have been identified above.

6.5.3.1 Spikelets

A correspondence analysis was run on the samples identified as spikelets. Each sample was first coded as to their feature type and second to the area within which they were recovered within the trench. Figure 6.8 shows that pit features are located to the bottom of the plot near the wheats, broomcorn millet and *Chenopodium* sp. In addition, samples recovered from the southern areas of the trench (blocks 13-16) are also located along the bottom of the plot (Fig 6.9). Hearth deposits are located in the bottom left of the plot, while the remaining features have no clear associations (Fig

6.8). There are also no further associations with area, although there is a small cluster of samples from blocks 7-12 located near rye at the top of the plot (Fig 6.9).

6.5.3.2 Fine sieving by-products

A correspondence analysis was run on the samples identified as spikelets. Each sample was first coded as to their feature type and second to the area within which they were recovered within the trench. Figure 6.10 shows that pit features are located to the left of the plot near the wheats, broomcorn millet and *Chenopodium* sp. In addition, samples recovered from the southern areas of the trench (blocks 13-16) are also located along the left of the plot (Fig 6.11). Hearth deposits are more dispersed but are mainly found along the left of the plot, while the remaining features have no clear associations (Fig 6.10). There are also no further associations within the areas (Fig 6.11).

6.5.3.3 Products

A correspondence analysis was run on the samples identified as spikelets. Each sample was first coded as to their feature type and second to the area within which they were recovered within the trench. Figure 6.12 shows that pit features are located to the left of the plot near the wheats, broomcorn millet and *Chenopodium* sp. In addition, samples recovered from the southern areas of the trench (blocks 13-16) are also located along the left of the plot (Fig 6.13). Hearth deposits are located in the middle left, street deposits in the bottom left and yard deposits are also located to the left. Only general and house deposits seem to be associated with barley and rye to the left of the plot (Fig 6.12). There are also no further associations within the areas (Fig 6.13).

6.5.4 Summary

The general trends of crop processing distribution at Feudvar suggests that products are more commonly associated with pit, street and yard deposits, fine sieving remains with general deposits, containers and hearths, while the house deposits have all three crop processing stages. In addition, samples tend to be unsieved in areas 3 and 14 within the trench which correspond with the ‘fish’ house to the northeast of the trench and the southern house possibly indicating crop processing areas within the house. Block 14 also has a consistently high percentage of barley grain which may suggest a greater preference for barley within the household or may indicate an area within which animals are kept. This may also be supported by the increase in fine sieving remains found in pits near the southern end of the trench and the reduction in presence of samples identified as spikelets and products in this area. However, from the correspondence analysis there also seems to be a strong association with broomcorn millet and *Chenopodium* sp. within the southern area of the trench. Unfortunately no further archaeological details are unavailable at present making it difficult to interpret.

In contrast, sieved samples seem to occur more regularly in the centre of the trench especially in the bottom half of the 'fish' house. From the correspondence analysis the north and central parts of the trench seem to have the greatest variance and are unassociated with any particular crop or weed. Further patterns can be seen where rye grains correspond with house floors and broomcorn millet has a greater association with pits. From the correspondence analysis the location of broomcorn millet, near the crops, and rye, located near the weeds, may suggest that rye is a weed. This may explain why rye is regularly found in house deposits, which contain all three crop processing stages, while broomcorn millet is found within pits, which have a greater association with products and few weeds, suggesting it may be an admixture or crop in its own right.

6.6 After the harvest: crop processing at Feudvar

The growing of crops involves a yearly cycle of activities such as preparing the soil, sowing, harvesting and crop processing. Each activity relies on variables such as labour, technology, the environment and society. By analysing the crop processing stages at Feudvar the activities conducted by the community are brought to light. The main crop grown was einkorn with potential minor crops of emmer, barley, bread/durum wheat and possibly broomcorn millet and rye. The identification of sieved and unsieved spikelets, sieved and unsieved fine sieving residue and sieved and unsieved products shows a clear separation in the activities performed at the site. The following sections will discuss further the different crop processing stages identified from the Feudvar assemblage, what activities they may represent and how this impacted on social organisation.

6.6.1 Early stages of crop processing

As outlined above, early stages of crop processing, i.e. threshing and winnowing, are performed to break the ears of the cereals into either spikelets for the glume wheats or to separate the grain from the chaff in the case of free-threshing cereals. Ethnographic evidence from Greece, Turkey and Spain shows that stone threshing floors are used as well as numerous methods to thresh the crops (Halstead and Jones 1989; Hillman 1981; Peña-Chocarro 1999). For example, for the threshing of spelt in different regions of Asturias farmers employ human trampling, wooden mallets and flailing to release the spikelets from the straw (Peña-Chocarro 1999:34-5). Areas known as threshing floors are usually built just outside the settlement in an open space where the wind is able to aid the winnowing process (Peña-Chocarro 1999:34). In Karpathos, teams of animals were used to trample the cereals and in rare cases a threshing sledge was employed (Halstead and Jones 1989:44). The cereals also needed to be dry before threshing and in Karpathos threshing would typically take place in the heat of the midday sun (*ibid.*). The level of dryness would therefore impact on the time it would take to process the cereals at this stage.

Once the crop has been broken apart the next stage is to winnow the remains to separate the grain from the light chaff, straw and weeds. In the region of Asturias this is done by using a winnowing drum to either pour the remains from a height allowing the wind to blow away the light remains or they can be thrown into the air (Peña-Chocarro 1999:41). A steady breeze seems to be required for the efficient winnowing of cereals. In Armogos branches from local bushes, such as Juniper, were placed at the edges to catch fragments of chaff and straw and prevent it from being blown away (Halstead and Jones 1989:44).

Evidence of early crop processing by-products will therefore largely include straw fragments, culm nodes and bases, awn fragments and, in the case of free-threshing cereals, rachis internodes. At Feudvar there is no evidence of straw, culm nodes or awn fragments. As the area excavated includes a number of houses and streets it is likely that the threshing and winnowing would have occurred away from this area, possibly on the outskirts of the settlement. Thus, the likelihood of the remains becoming charred and deposited within these features is doubtful. Evidence of rachis remains from barley and bread/durum wheat at the site may suggest the remains of early crop processing waste but as they are incorporated within a deposit of einkorn fine sieving waste they may also represent the by-products of sieving.

6.6.1.1 Building material

Evidence from the excavations at Feudvar has shown that the house walls were built of reeds and clay strengthened with other plant parts (Hänsel and Medović 1991). This would suggest that although no evidence can be found from the archaeobotanical remains the by-products from crop processing were regularly utilised in the construction of housing at the site.

6.6.2 Spikelets

6.6.2.1 Human consumption

After threshing and winnowing the remaining products for glume wheats would include the spikelets some chaff and weeds, while the free-threshing cereals would include the grain, some chaff remains and weeds. At this point the grain/spikelets can be stored semi-clean or processed further, e.g. coarse and fine sieved. In regards to glume wheats, whether the spikelets are sieved prior to dehusking may depend on a number of factors such as what the intended product is, climate, labour availability as well as possibly being a cultural preference. In Morocco ethnographic observations showed that when einkorn was used for human consumption the grain was not sieved until after dehusking on a smaller scale within the house on a day-to-day basis before the grain was milled for flour (Peña-Chocarro *et al.* 2009). Similarly, in regions of Asturias spelt is stored semi-cleaned but is later dehusked en masse at a local mill, where it is sieved and the clean grain is stored again to be used on a piecemeal basis (Peña-Chocarro 1999:42). The remains of fine sieving by-products at Feudvar suggest that a certain proportion of the cereals were intended for human consumption as dehusking glume wheats is time consuming and is unlikely to be performed for animal feed (Hillman 1984a, 1984b; Meurers-Balke and Lüning 1992; Nesbitt and Samuel 1996; Peña-Chocarro 1999).

6.6.2.2 Animal fodder

It is also important to consider that semi-cleaned spikelets/grain may represent animal fodder. Ethnographic studies on traditional einkorn crop processing in Spain identified that einkorn spikelets were not thoroughly sieved as the final product was intended to feed animals (Peña-Chocarro 1999:36). Einkorn spikelets, either on their own or mixed with barley, were then fed to mules, donkeys, goats and chickens. However, einkorn is grown as a minor crop at these sites. In addition, Peña-Chocarro (1999:44) also points out that emmer and spelt are not commonly used for animal feed unless absolutely necessary. Ethnographic observations in Romania, however, found that minor crops of einkorn and emmer intended for animals were also usually grown in distant plots that had become overgrown with weeds (Hajnalová and Dreslerová 2010). As a result the crop remains had a high weed content. The high weed content found in a number of the spikelet samples at Feudvar could also be intended for animal fodder.

6.6.2.3 Seed corn

Another important consideration is the processing of grain for seed corn that will be used to plant the fields the following year. In the region of Asturias, einkorn, emmer and spelt are always sown by broadcasting the spikelets. This is also observed for the cultivation of einkorn in Morocco (Peña-Chocarro *et al.* 2009), as well as the sowing of emmer spikelets in south-central Tigrai, Ethiopia (D'Andrea and Mitiku 2002). The ethnographic study by D'Andrea and Mitiku (2002:189) in south-central Tigrai also noted that an area of 1/8 hectares was sown with 46 litres of emmer spikelets, while in the region of Asturias farmers roughly pick out the largest spikelets for next year's sowing, approximately 250kg per hectare (Peña-Chocarro 1999:39). Thus, a proportion of the einkorn spikelet remains found at Feudvar are likely to have been intended for sowing.

6.6.2.4 Storage

Unfortunately details of the excavation are not available at present for Feudvar, so there is no confirmation of the presence of insitu burning, preventing further analysis of the location or size of possible storage facilities; however, many of the pits excavated within the houses were interpreted by the excavators as storage pits as they usually contained concentrations of cereal remains (Hänsel and Medović 1998). In addition, the identification of different crop processing stages, which may have allowed further spatial interpretation, have revealed little to suggest differences in storage areas within the trench. Only area 6, the baker house, in the western trench seems to contain a much higher number of pits containing sieved einkorn spikelets, products and by-products. No other discernible differences can be seen within the trench to suggest, for example, any particular areas for the storage of sieved or unsieved products (See Chapter 9 for further discussion).

From the analyses there was also a high association of broomcorn millet with pit features which may simply result from storage of this crop but could also be associated with methods of storage. For example, the adding of broomcorn millet grains to wheat has been observed in France to increase the preservation of the crop by reducing voids that can be penetrated by weevils (Marinval 1992). By sieving the mixture the broomcorn millet can then be easily removed from the main wheat crop when needed.

6.6.3 Fine sieving by-products

As already mentioned evidence of fine sieving by-products at Feudvar suggests that a certain proportion of the cereals remains were intended for human consumption. The majority of the remains found throughout the trenches are therefore likely to represent the discard of day-to-day dehusking where the fine sieving by-products are thrown into the fire. The fine sieving by-products can also have an additional value such as for the feeding of animals, as a building material or intentionally collected for fuel. For example, 64% of the samples collected from containers at Feudvar were identified as fine sieving by-products. As these were recovered in the area of houses it suggests that the by-products were deliberately collected; however, it is unclear whether this was for fuel, fodder or temper.

6.6.3.1 Animal fodder

The use of chaff remains for the feeding of cattle has been recorded ethnographically from a number of areas. For example, in central Anatolia households were noted as using a common fodder type *(zavar)* which contained a mixture of wheat, barley, rye, oats, vetch, beet and clover, mixed with cereal bran and crop processing residues from cereals and legumes (Anderson and Ertrug-Yaras 1998). Archaeobotanical work on distinguishing animal dung remains in Europe and the Near East have also highlighted that animals were regularly fed a combination of cereal components as well as wild species. This practice is also suggested at a number of Late Neolithic sites in Greece where glume wheat chaff and fig seeds were identified from 'dung' samples (Valamoti and Jones 2003; Valamoti 2004).

6.6.3.2 Temper

Fine sieving by-products are used for temper within the clay bricks of the houses at Feudvar. A number of miscellaneous deposits from wall slumps have been identified as fine sieving by-products, which may suggest they result from inclusion into the clay walls of the houses before it was burnt.

6.6.3.3 Fuel

The charring of glume wheat glume bases has been regularly cited as resulting from their use as a fuel (Charles 1998; Hillman 1981; Van der Veen 2007). The use of fine sieving by-products as fuel, whether intentionally or accidentally, may be seen at Feudvar as 50% of the hearth remains are fine sieving by-products. At the Late Neolithic sites of Galini, Makriyalos and Apsalos, Greece, glume wheat processing by-products were encountered around hearths, ovens and inside pits and were interpreted as remains of spent fuel (Valamoti 2005a).

6.6.4 Products

Einkorn products dominate this category of samples although there is evidence of products of barley, broomcorn millet (*Panicum miliaceum*) and possibly rye (cf. *Secale cereale*). Two types of products were identified from Feudvar those that had been sieved and those that were unsieved, which contained large numbers of weed seeds.

6.6.4.1 Human consumption

Of the samples identified as products from Feudvar, 63% are sieved einkorn products. These remains most likely represent products intended for human consumption. Ethnographic observations from Morocco identified that einkorn was sieved again just before the grains were milled for human consumption to remove any remaining weed species (Peña-Chocarro *et al.* 2009). This last sieving may also suggest that einkorn products intended for human consumption were not thoroughly cleaned prior to this stage. The samples which were identified as unsieved product may therefore be remains of unsieved einkorn grain prior to this final sieving and milling.

Twelve samples were identified as originating from sieved barley products which would suggest that these were intended for human consumption. On the Greek islands of Amorgos and Karpathos Halstead and Jones (1989), observing the local barley and bread/durum wheat harvest, found that fine sieving usually occurred piecemeal throughout the year as part of food preparation and that fodder crops were not usually fine sieved.

6.6.4.2 Animal fodder

Numerous ethnographic studies show that barley is an important fodder crop (e.g. Halstead and Jones 1989; Miller 1984b; Palmer 1996). For example, Jones and Halstead (1995), studying traditional farming practices on the Greek island of Amorgos, found that a deliberate wheat (free-threshing)-barley maslin crop was commonly grown. After harvest the crops were sometimes sorted by sieving into wheat rich and barley rich remains. The wheat rich remains were subsequently used for human consumption while the barley rich remains were used for animal fodder (*ibid.*). Eight samples were identified as einkorn and barley products and although these may represent depositional mixing they may suggest that a small proportion of the einkorn crop was grown with barley. In addition, the presence of sieved barley products may also result from the processing of a mixed crop which would separate out the wheat and barley and result in fewer weed species. The barley may then be used for animal fodder instead of for human consumption.

From previous analyses by Borojević (1991) on the Early Bronze Age plant remains from Feudvar, the immature size of emmer grains recovered and the high proportion of small seeds (e.g. *Setaria viridis*) suggested that they were intended for cattle feed. From the current analysis, no unsieved emmer remains were identified; however, the unsieved nature of some of the einkorn remains, which may also contain a certain amount of emmer, could suggest that these were used as an animal supplement.

6.6.4.3 Broomcorn millet and rye

Three samples have been identified as sieved broomcorn millet products and three as unsieved. Ethnographic work on the crop processing of millets has shown that only winnowing and raking are likely to have been used to remove the weed species (Harvey and Fuller 2005). If this is the case then the unsieved remains may simply be those crops that had not been processed as thoroughly. Four of the six samples were also recovered from pits within house areas which may support the theory that broomcorn millet was grown for human consumption.

Only two samples were identified as containing rye products, one of which was from a house deposit. Little is known about the prehistoric cultivation of rye and little ethnographic work exists. As rye is only tentatively identified at Feudvar and it is unclear whether rye actually represents a crop or a weed, it is difficult to further say whether it was grown for human or animal consumption. Rye cultivation at Feudvar will be discussed further in the next two chapters.

6.7 Conclusion

The purpose of this chapter was to examine formation processes within the Feudvar assemblage and determine variation between the samples before further weed analysis in Chapter 7. Crop processing analysis was applied to the samples in order to determine whether groups of samples could have originated from this activity, contributing to formation processes at Feudvar. Ratio analysis (after Van der Veen and Jones 2006) was used to identify each sample to a crop processing stage and correspondence analysis was then used to examine and clarify these identifications further. Three crop processing groups were clearly identified: spikelets, fine sieving by-products and products, and two sub-groups: sieved and unsieved. Further observations included: the influence of *Chenopodium* sp. on sample composition during correspondence analysis, which could impact interpretation of weed ecology, and the presence of ambiguous samples, which may represent mixed crop processing stages. As a result these samples will need to be monitored in order to reduce bias within the assemblage. The impact of crop processing on the reconstruction of crop husbandry regimes will be explored further in the following chapter.

The identification of crop processing at Feudvar has also provided evidence of human behaviour. Whether a crop is sieved or not may result from factors including climate, time, and labour availabilities as well as the intended purpose of the crop. For example, more time is spent on crops intended for human consumption, so samples identified as unsieved products may be intended as animal fodder. The distribution of samples between features and areas were also seen from the crop processing remains. First, the southern area of the trench was identified as containing a high percentage of barley remains as well as fine sieving residue compared to the rest of the trench and may indicate an area where a household is choosing to include barley in their diet or may possibly be an area for animals. Unfortunately no further archaeological details are unavailable at present. Second, broomcorn millet showed a close association with pits, while rye had a high association with house deposits. This may suggest that rye is indeed a weed within the crops while broomcorn millet, which was also closely associated with the wheats, represents a crop at the site. Third, crop processing areas seem to occur within the centre of each house, where there is a higher incidence of unsieved remains and a greater variance in weed species present; however, no clear differences could be seen in the presence of crop species to distinguish between the two northern houses. Variation between features and areas will be examined further in the following chapter to determine whether differences can be seen between crop processing regimes and different houses within the trench. Ultimately, the presence of all three crop processing stages from house floors confirms that crop processing not only occurred at the site, but within certain areas of the house.

Chapter seven
Weed Ecology at Feudvar

This chapter presents the analysis of weed ecology within the Feudvar assemblage. The purpose of this is to investigate crop husbandry regimes from the ecological characteristics of the weed species that accompany the cereal crop. This chapter begins with a discussion on the approaches used to examine weed ecology and their application in archaeobotany (7.1). This is followed by the methods (7.2) employed to analyse weed ecology within the Feudvar dataset and the results of the analysis (7.3). Intra-site variability will then be examined in order to explore further patterns in the data (7.4). This chapter concludes with a discussion of crop husbandry regimes during the Late Bronze Age at Feudvar, exploring the possible relationships between the farmers and the crops grown (7.5).

7.1 Approaches to weed ecology

Weed ecology is the study of how individual plants interact with their biotic and abiotic environment (Booth *et al.* 2003). Biotic components are living organisms, such as plants and animals, which make up an ecosystem. The abiotic environment incorporates non-living factors such as climate, including light and temperature, and edaphic properties such as nitrogen, pH and moisture. The impact of anthropogenic activities, such as tilling and manuring, will also affect biotic and abiotic factors within an environment. By studying the weed species present in archaeobotanical assemblages, information about these environmental factors can be obtained and used to infer possible anthropogenic activities resulting from certain crop husbandry regimes.

The link between archaeological weed species and the environment in which they grew can only be provided by modern weed ecology data. As such the need for an appropriate source of such data and appropriate interpretative methods has often been emphasised (Hillman 1991; Küster 1991; Van der Veen 1992). Within the study of archaeobotanical weed ecology three main analytical methods have been used to infer agricultural practices, namely phytosociology, which studies biotic interactions between organisms (e.g. vegetation communities), autecology, which studies single organisms and their interactions with their environment and other species, and more recently Functional Interpretation of Botanical Surveys (FIBS), which classify species into a ‘functional type’. These methods are assessed below.

7.1.1 Phytosociology approach

Developed in Central Europe, phytosociology (or Braun-Blanquet system) is a subdiscipline of plant ecology that describes the co-occurrence, or compositional patterns, of plant species in communities, or ‘syntaxa’ (Braun-Blanquet 1964). Within this method, the fundamental unit of vegetation is the Association, which is defined entirely by floristic composition, and not by habitat. Each Association comprises characteristics of the community based on the fidelity, presence, constancy and dominance of a certain species within any stand of an Association (Poore 1955). This results in ‘character species’, of narrow ecological range, becoming restricted or central to particular syntaxa; ‘differential species’ or species which distinguish closely related syntaxa by their presence; and ‘constant companions’ that are species not restricted to a given syntaxon but help characterise it (Dierschke 1994). By exploring the presence and absence of these characteristics within a given stand, Associations are constructed and placed within the hierarchical classification system of Alliances, Orders and Classes.

The categorisation of species is, however, largely subjective and some have highlighted the lack of consistent criteria for distinguishing or classifying vegetation units, as well as lacking clear distinctions between the groups, which can obscure the successional series (Becking 1968; Pignatti *et al.* 1995; Poore 1955). The focus on the group rather than the individual may also obscure distinct species characteristics; for example, individual species may be characterised within their community as moisture loving when in fact they only tolerate wet environments. In addition, some have suggested that little account is taken of ecotypic differentiation and change of tolerance species within their range, making comparisons outside the observation zone (Holzner 1978; Westhoff and Van der Maarel 1973), and through time, problematic (Becking 1968; Poore 1955).

The application of phytosociology to archaeobotanical assemblages is largely based on the occurrence of character species to determine the habitat conditions under which the group as a whole occurs (Jones 1992). As a result, archaeobotanists have commonly used phytosociology, and in some cases additional ecological information, to infer habitat conditions and crop husbandry practices (Jacomet *et al.* 1989; Karg 1995; Van Zeist 1974; Wasylikowa 1978, 1981; Willerding 1983). Two fundamental problems occur with this method in relation to archaeobotanical material. First, temporal and geographic changes in the ecological co-occurrence of species make comparisons with modern and past plant communities difficult (Behre and Jacomet 1991; Holzner 1978). Some authors have also identified the occurrence of past associations that are absent today, for example, the Bromo-Lapsanetum praehistoricum association (Knörzer 1971). Second, the nature of the archaeobotanical material itself represents only a fraction of the original community, which has been successively altered by formation processes such as crop processing (see Chapter 6), as well as potentially originating from a number of different sources. Although these factors will affect all types of interpretation it is particularly detrimental for phytosociological interpretation as it relies on intact communities (Jones 2002). The application of the phytosociological approach on archaeobotanical data is therefore inappropriate (Van der Veen 1992:108).

7.1.2 Autecological approach (Ellenberg numbers)

In contrast to phytosociology, autecology or Ellenberg numbers offers an approach that examines the ecology of individual plant species rather than the plant community as a whole. Ellenberg numbers refer to a relative scale of six major environmental factors linked to climatic variables: light regime (L), temperature (T) and continentality of climate (K), and edaphic conditions; moisture of soils (F), reaction or pH (R) and nitrogen availability (N) (Ellenberg 1950, 1979, *et al.* 1992). Based on modern field observations an ordinal scale of between 1 and 9 (F ranges between 1 and 12) is used to denote each environmental factor per species based on its optimal ecological requirements when in competition with other species (*ibid.*). For example, L1 is a full-shadow species while L9 is a full light plant. In addition, indifferent behaviour to environmental factors is indicated with an X. Other factors associated with morphological and anatomical adaptations are also noted; these include salt tolerance (sonst.), persistence of leaves (B), anatomical structure (Anat.)

and phytosociological behaviour; however, Ellenberg (1979:107) does stress that the indicator values do not denote the preference of a species but reflects the conditions it can tolerate compared to other species. *Lazula luzuliodes*, for example, has an indicator value of R3, suggesting a preference for acidic soils; however, when grown without competition from other species, its optimal productivity is around pH 6.5, which is only slightly acidic (Ellenberg 1979).

Nevertheless, field observations only address where a species is found and not why it is there, thus ignoring other ecological factors that may determine its presence at a certain location (Charles *et al.* 1997). Methods of data collection, genetic variation within populations, the relative constancy of habitat requirements needed, and differences between ecological and physiological behaviour can also affect interpretation (Kowarik and Seidling 1989). The use of indicator values and their extrapolation to other regions can be problematic, as species behaviour will vary widely from one region to another, especially as the Ellenberg indices are not related to ecological optimum of a species but to its synecological optimum (Gégout and Krizova 2003; Pignatti *et al.* 2001). Despite this, Ellenberg's system has been successfully applied to other regions in Europe (Diekmann and Dupré 1997; Koerner *et al.* 1997; Persson 1981; Ter Braak and Gremmen 1987; Van der Maarel 1993), and new regional databases are providing important extensions to the original Ellenberg system e.g. Britain (Hill *et al.* 1999), Hungary (Borhidi 1995) and Italy (Böhling 2002; Pignatti *et al.* 2001).

Ellenberg numbers have been used in archaeobotany on their own and in conjunction with phytosociological classifications (Jacomet *et al.* 1989; Van der Veen 1992; Wasylikowa 1978, 1981; Willerding 1978, 1980, 1983). The main advantage of using Ellenberg numbers in archaeobotany is that the environmental values identified are precisely the types of information required to infer soil fertility, moisture, disturbance etc, in relation to different crop husbandry practices (Van der Veen 1992:108). The use of Ellenberg numbers is also well suited to archaeobotanical assemblages as the absence of species causes fewer problems (Jones 2002). In addition, all the species present can be examined, making it more reliable, rather than character species or differential species of a particular syntaxon, which can be particularly rare thus restricting the archaeobotanical database (Van der Veen 1992:108). Issues of temporal change, seen particularly with the phytosociological approach, are still relevant here. Nevertheless, Ellenberg numbers focus mainly on the plant's behaviour which is genetically determined and is less likely to change or will change less rapidly than the co-occurrence of species (*ibid.*:109). In addition, even if changes exist in the ecological behaviour of certain species, by examining all the species together these changes are largely mitigated (Jones 1992). The autecology approach is therefore more applicable to archaeobotanical analysis.

7.1.3 Functional Interpretation of Botanical Surveys (FIBS)

The Functional Interpretation of Botanical Surveys or FIBS, as described by Charles *et al.* (1997), is a floristic analysis for the investigation of ecological processes on species distribution in a range of habitats. FIBS classifies species by relating the modern behaviour of the individuals to specific ecological characteristics and thus a distinct 'functional type' (*ibid.*), rather than basing analyses on the floristic identity and coexistence of communities as in phytosociology. Only attributes that can be rapidly measured and validated against experimental or distributional data are used. Functional attributes measure the potential rather than the performance of species which is particularly suited to archaeobotanical analysis (Jones 2002). Through the application of FIBS, modern studies have revealed causal relationships between crop husbandry practices, such as irrigation, and certain suites of attributes identifying characteristic weed species (Bogaard *et al.* 2001; Charles *et al.* 1997; Charles *et al.* 2003; Jones *et al.* 2000a, 2010).

The archaeobotanical application of FIBS has worked particularly well in identifying past crop husbandry practices such as crop rotation (Bogaard *et al.* 1999), cultivation intensity (Jones *et al.* 2000a), crop sowing times (Bogaard *et al.* 2001), and irrigation (Charles *et al.* 2003). In these instances, functional attributes were specifically selected to address each type of analysis such as drought tolerance or avoidance in relation to irrigation; however, while it is possible to identify one suite of functional attributes as indicative of a certain husbandry regime, that regime may have more than one functional type or may have the same range of functional attributes as that of another regime (Jones 2005). In addition, only the extreme values for an attribute will indicate a husbandry regime while moderate values are generally seen as of little diagnostic importance (*ibid.*). Therefore, the application of FIBS to archaeobotanical data are only appropriate where meaningful contrasts exists within the archaeological dataset. This is because FIBS can only identify whole husbandry regimes (based on a suite of functional attributes) with limited abilities to disentangle individual husbandry practices (Jones *et al.* 2010). Despite this, the FIBS approach is able to deal with fragmentary and mixed records of past plant communities better than phytosociology (Hodgson *et al.* 1999). It is also particularly well suited to identify husbandry regimes at a regional scale or to identify changes through time, as FIBS focuses on functional characteristics rather than individual taxa which is less vulnerable to biogeographical changes in the species (Jones *et al.* 2010). Temporal changes in the functional attributes of suites of species is also far less likely than changes in individual species or changes in the composition of phytosociological groupings (Charles *et al.* 1997). Although this method is particularly suited to the analysis of archaeobotanical material, much of the information is as yet not publically available.

7.1.4 Conclusion

The phytosociological approach is only appropriate for analysing archaeobotanical samples at the general level as it relies heavily on character species to determine ecological groups. It ignores the fragmentary nature of past assemblages, which it compares to complete modern plant communities. In addition, past vegetation communities may not exist in modern analogues, making comparisons unreliable. The FIBS approach uses functional traits of species which may be less susceptible to temporal and geographic changes, as well as being able to cope with archaeobotanical material. Nevertheless, this method only works when variation exists within the dataset. At Feudvar, only one main crop type is identified and as a consequence may not exhibit extreme values. In addition, this approach is also restricted in its application, as at present species data are not publicly available. The autecological approach is therefore the most appropriate method to apply to the Feudvar dataset as it allows all the weed species to be analysed individually, making the results more reliable. In addition, Borhidi (1995) provides data on over 2,500 species within Hungary that are more directly relevant to the region under study.

7.2 Methodology

7.2.1 Dataset

From the crop processing analysis of the Feudvar assemblage (Chapter 6), six different groups of samples were identified to a particular crop processing stage (Table 7.1). At each stage crop processing has an effect on the types of weed seeds present in the sample, only 'like' samples can be examined and only those with adequate numbers of weed remains per sample (*cf.* Jones 1991). In order to assess whether each dataset had sufficient numbers of weed seeds per sample to allow further weed analyses, each sample was initially standardised. First, to reduce potential environmental 'noise', caused by rare species in the samples, species present in < 10% of the samples were removed (*cf.* Van der Veen 1992: Chapter 3). Seeds identified to the family level were also excluded, resulting in the removal of up to 80% of the species (Table 7.1).

Second, the number of weed seeds present per sample was calculated and those with <25 weed seeds were removed (Table 7.1). For the three unsieved groups, this resulted in only a few samples being removed (up to 8% of the samples); however, for the sieved remains, up to 40% of the samples were removed. In addition, the number of samples with > 100 weed seeds was significantly lower in the sieved samples. For example, only 6% of samples in the sieved spikelet group had over 100 seeds, while the unsieved spikelets had over 100 seeds in 41% of samples. Therefore, in order to maximise the amount of information that can be gained through the analysis of the weed species at Feudvar, it was decided that only the three unsieved groups of samples would be analysed, as they contained the highest number of species and samples with adequate numbers of weed seeds.

Of note from the crop processing analysis were the large numbers of *Chenopodium* sp. seeds within some of the samples, which may suggest collected food deposits rather than crop weeds. To assess the extent to which *Chenopodium* sp. affects the three datasets, a correspondence analysis plotting the Shannon diversity for each sample was created for each group using Canodraw (Fig 7.1-3). This is illustrated by the size of the pie, which gets bigger as the diversity increases. Each plot confirms that a number of samples from each group contain a high proportion of *Chenopodium* sp. seeds, as well as having an extremely low species diversity.

Although species of *Chenopodium* can produce large numbers of seeds per plant, the low species diversity may suggest that these samples do indeed represent collected food remains rather than weeds. In addition, Bogaard (2004:64) classified samples as deriving from one crop type if the sample contained at least 70% of one crop. Thus, to reduce ambiguity caused by these rich *Chenopodium* samples, those with a content of >70% *Chenopodium* sp. were removed from the subsequent analyses (Table 7.2).

7.2.2 Analysis

Correspondence analysis was conducted using CANOCO 4.5 and Canodraw (Ter Braak and Smilauer 2002). In order to examine weed ecology within the three datasets, the six main indicator values were recorded for each weed species, following the autecology approach (Table 7.3). Where seeds are identified only to genus, an average indicator value was calculated where the indicator values do not range too greatly. These will be treated with caution. Indicator values published by Borhidi (1995) and Ellenberg (1979) were recorded in order to see whether any significant differences can be seen between the indicator values assigned for the Hungarian flora and those in Central Europe (Table 7.3). Generally, similarities exist between the two authors; however, different values are assigned for species such as *Agrostemma githago, Polygonum aviculare and Polygonum convolvulus*. In these cases, Ellenberg identifies these species as indifferent to temperature, moisture, pH (reaction) and nitrogen, while Borhidi assigns particular indicator values. Although some variations exist between the two authors, Borhidi’s (1995) indicator values are used in the following analyses as they are more geographically relevant to the study area.

Correspondence analysis will be used to establish whether there are distinct associations between certain crops and certain weeds and certain ecological conditions. Each ecological factor will be grouped into high, medium and low values to allow clearer interpretation of the plots. For example, where 9 ecological factors occur, values 1-3 are low, 4-6 are medium and 7-9 are high. For moisture, which ranges from 1 to 12, values 1-4 are low, 5-8 are medium and 9-12 are high.

In addition to environmental factors, anthropogenic, or human actions will also have a significant impact on the formation of arable weed communities, as well as influencing which seeds are ultimately found in the archaeobotanical assemblage. The three main factors explored here are harvesting methods, soil disturbance and sowing time. The maximum height a weed attains provides an indicator of the possible height at which the crop was cut. For example, if low-growing weeds are recovered then this may suggest the crop was cut low to the ground, therefore simultaneously collecting both the straw and ears (*cf*. Hillman 1981). The maximum growing height of each species was therefore recorded (Table 7.4). The average height of each taxa identified to genus was also calculated.

To explore soil disturbance, which relates to possible tillage and weeding practices, the regenerative properties and the life cycle of the weed species were recorded. Previous research suggests that tillage significantly reduces the number of perennials (Hillman 1981; Van der Veen 1992; Zimdahl 2007) and only those with extensive networks of rhizomes, stolons and roots can regenerate (Bogaard 2002b:78). Therefore, to explore the level of disturbance within the Feudvar assemblage, the weed species were identified as either an annual, biennial or perennial, with or without rhizomes and its regenerative properties (Table 7.4). Only those taxa that were identified to genus and contain both annuals and perennials were excluded in order to reduce potential bias in the analysis.

Finally, the germination time of species, which has been shown to correspond with the sowing time of crops (e.g. Groenman-Van Waateringe 1980; Kreuz and Schäfer 2011), were recorded. Although Bogaard *et al.* (2001) showed that germination information gained from flowing data is more useful, the availability of flowing data is limited, restricting the level of analysis within this study. In the past some authors have also assessed cereal sowing times by applying phytosociological Classes, e.g. the proportion of Chenopodietea (summer annuals) verses Secalinetea (winter annuals), to an archaeobotanical assemblage (see 7.1.1). Although this approach is deemed inappropriate for archaeobotanical analysis (above) authors still use these Classes to indicate groups of species or to use as a comparative approach with other ecological methods (Ernst and Jacomet 2006; Jones 1992; Karg 1995; Van der Veen 1992). In order to compare the two methods, the phytosociological class of each species was also recorded (Table 7.5). Germination times based on these Classes alone are, however, problematic. For example, *Galium spurium*, a species of the Chenopodietea Class, has been identified as both a spring and autumn germinator within studies in Central Europe (Karg 1995; Kreuz and Schäfer 2011; see also Royo-Esnal *et al.* 2010). In addition, not all the species are found under Chenopodietea and Secalinetea.

In summary, three groups of samples, namely unsieved spikelets, unsieved fine sieving by-products and unsieved products (identified in Chapter 6), will be analysed. Each group will be examined separately in relation to the six main ecological factors, i.e. light, temperature, continentality, moisture, reaction and nitrogen, according to Borhidi (1995). In addition, three further analyses will be conducted on each dataset examining the height, life cycle and germination times of each species. As such, the nine analyses are repeated for each of the three sample groups. The results are presented in the following section.

7.3 Results

7.3.1 Spikelets: unsieved

7.3.1.1 Introduction: Crop and weed associations

A correspondence analysis was carried out on the unsieved spikelet group (54 samples). This group is dominated by einkorn spikelets (see 6.5.2.1for details). Five outlying samples were removed from the analysis (FEU138, FEU184, FEU211, FEU373, FEU409). Species were initially coded as either a crop, a possible crop or a weed (Fig 7.4). From Figure 7.4, einkorn (TRITMOT/G) grain and chaff are closely associated at the bottom of the plot, emmer (TRITDIC/G) is to the left of the plot, while barley (HORDSAS/RS) and rye (SECACEG) are towards the top of the plot. Broomcorn millet (PANIMIL) is clearly separate from the other cereals to the top left of the plot. Close crop and weed associations include: einkorn, *Portulaca oleracea* (PORTOLE) and *Atriplex patula* (ATRIPAT); emmer, *Sherardia arvensis* (SHERARV), *Glaucium corniculatum* (GLAUCOR), *Setaria viridis* (SETAVIR) and *Vicia* sp. VICISPE; barley, Polygonum persicaria (POLYPER) and *Echinochloa crus-galli* (ECHICRG); rye and *Teucrium* sp. (TEUCSPE).

The cereal composition of each sample shows that einkorn is the dominant cereal in all samples except one to the top left, which has a higher barley content (Fig 7.5). In addition, five samples in the top right of the plot contain rye and one sample to the left contains broomcorn millet. Samples to the right of the plot also have a greater association with pits and blocks 13-16, i.e. the southern end of the trench (Fig 7.6-7). A divide is therefore seen between the left of the plot (einkorn, emmer and broomcorn millet) and the top right of the plot (barley and rye). Possible differences in depositional patterns will be examined further in section 7.4.

7.3.1.2 Ecological indicator values

Light

Each species was coded to its light indicator value (after Borhidi 1995), which is based on the occurrence of plants in relation to relative light intensity during the summer. All the species have a high light indicator value except *Polygonum persicaria* (POLYPER) and *Sherardia arvensis* (SHERARV), which have a slightly lower light indicator value of L6 (Fig 7.8).

Temperature

Each species was coded to its temperature indicator value (after Borhidi 1995), which reflects the heat, vegetation zone and altitudinal belt of the habitat where the species occur. Weed species characterised by moderate and high temperatures are associated with einkorn and barley (Fig 7.9). Overall, the samples are largely dominated by weed species characteristic of moderate temperatures (Fig 7.10).

Continentality

Each species was coded to its continentality indicator value (after Borhidi 1995), which indicates the general continentality of the general climate. The majority of the indicator values for the weed species ranged from low to medium and only *Chenopodium* sp. (CHENSPE) and *Chenopodium hybridum* (CHENHYB) had high continentality values of K7 (Fig 7.11). Einkorn, emmer and barley are associated with species characteristic of low and medium continentality. Sample composition shows that there is a divide in those samples dominated by species characteristic of medium continentality to the right of the plot and those dominated by species characteristic of high climate continentality to the left (Fig 7.12); however, this is due to the large number of *Chenopodium* seeds within the samples. Once removed, the samples are dominated by weed species characteristic of medium continentality, although there is a slight increase in low values to the right of the plot (Fig 7.13).

Moisture

Each species was coded according to its moisture indicator value (after Borhidi 1995), which relates to soil moisture or the water table. The majority of the indicator values for the weed species ranged from low to medium and only *Euphorbia palustris* (EUPHPAL) had a high moisture value of F9. Einkorn, emmer and barley are associated with species characteristic of low and medium soil moisture levels (Fig 7.14). Sample composition shows that there is a divide in those samples dominated by species of dry soils to the right of the plot and species of wetter soil to the left (Fig 7.15). This is largely due to *Chenopodium* sp. and once removed, the plot shows a dominance in species characteristic of low moisture levels in all but one sample to the left of the plot (Fig 7.16).

pH (Reaction)

Each species was coded according to its reaction indicator value (after Borhidi 1995), which reflects plant occurrence in relation to soil reaction or pH. The majority of weed species are characterised by high indicator values, typical of alkaline soils (Fig 7.17). Sample composition corroborates this, with the majority of samples containing a high proportion of weeds characteristic of alkaline soils (Fig 7.18).

Nitrogen

Each species was coded according to its nitrogen indicator value (after Borhidi 1995), which is related to the availability of ammonia and nitrate in the habitat. The majority of the weed species indicate medium to high nitrogen availability and only *Trifolium* sp. (TRIFSPE), *Teucrium* sp. (TEUCSPE) and *Polygonum convolvulus* (POLYCON) have low nitrogen values (Fig 7.19). Sample composition shows a divide in those samples dominated by weed species characteristic of high nitrogen availability to the left of the plot and species characteristic of medium nitrogen availability to the right (Fig 7.20). This is largely due to *Chenopodium* sp. and once removed, the plot shows an overall dominance in species characteristic of medium nitrogen availability (Fig 7.21).

7.3.1.3 Anthropogenic factors

Harvesting height

A correspondence analysis was run to show the maximum flowering height of the weed species (Table 7.4). The height of the weed species ranged from low to high with no particular associations with any of the cereals (Fig 7.22). Sample composition shows a divide in those samples with a dominance of tall weeds to the right of the plot and those with a dominance of medium height weeds to the left (Fig 7.23); however, with the removal of *Chenopodium* sp. it is clear that the vast majority of samples contain low-growing weeds (Fig 7.24).

Soil disturbance

A correspondence analysis was run to examine the relative proportion of annuals, perennials and perennials with rhizomes within each sample. Of all the species present, only *Euphorbia palustris* (EUPHPAL) is a perennial and only *Polygonum convolvulus* (PLANLAN) is a perennial with rhizomes; the rest are all annuals (Fig 7.25). This is also visible in the pie charts, where sample composition highlights the predominance of annuals (Fig 7.26).

Sowing time

A correspondence analysis was run to examine the relative proportion of winter and summer annuals within the samples. Only five species, *Agrostemma githago* (AGROGIT), *Bromus arvensis* (BROMARV), *Bromus* sp. (BROMSPE), *Bupleurum rotundifolium* (BUPLROT) and *Sherardia arvensis* (SHERARV), are winter annuals and are mostly located to right of the plot (Fig 7.27). Looking at sample composition there is a clear divide between those samples dominated with summer annuals to the left and winter annuals to the right of the plot (Fig 7.28). Once *Chenopodium* sp. is removed, however, the majority of samples have an approximately equal proportion of summer and winter annuals, with no clear crop associations (Fig 7.29).

7.3.1.4 Exploring differences between barley and einkorn cultivation

The results from the unsieved spikelets show a similar trend in ecological and anthropogenic factors throughout all the samples. The samples are primarily dominated by einkorn which may suggest that the spikelets are from an einkorn crop with admixtures of barley, emmer, broomcorn millet and rye. The divide between broomcorn millet and rye within the plots and the large influence of *Chenopodium* sp. may, however, mask any patterns seen between barley and einkorn. Thus, to explore any further patterns that might emerge, a correspondence analysis was run on the dataset removing rye, broomcorn millet and *Chenopodium* sp. Samples containing >70% of these species were also excluded as they may contain the remains of a crop product.

The weed and cereal associations do not change significantly from the previous correspondence analyses (Fig 7.30). Barley grain is clearly separate from the other cereals at the top of the plot; however, barley rachis has a high association with einkorn in the middle of the plot. At present, it is unclear why barley rachis is closely associated with einkorn. Of the nine ecological and anthropogenic factors analysed, only the distribution of nitrogen values and summer/winter annuals produced clearer patterns.

Nitrogen

The weed species were coded according to its nitrogen indicator values. Two groups of species are distinguished in the plot (Fig 7.31). First, species characteristic of high nitrogen soils, einkorn and emmer to the bottom left of the plot and second, species characteristic of low and medium nitrogen soils and barley to the top and right.

Sowing time

The species were coded according to its sowing time. Although weak, two groups of species may be distinguished in the plot (Fig 7.32). First, summer annuals, einkorn and emmer to the bottom left of the plot and second, winter annuals and barley to the top and right.

7.3.1.5 Summary

Correspondence analysis of nine different ecological and anthropogenic factors were conducted on 54 samples identified as unsieved spikelets i.e. samples dominant in einkorn spikelets with admixtures of emmer, barley, broomcorn millet and rye as well as high numbers of weed seeds. From these analyses the following observations were noted (with the removal of *Chenopodium* sp.):

- There is a strong division between emmer and einkorn, and barley and rye.
- Einkorn and emmer have a stronger association with weeds with high nitrogen values and summer annuals.
- Broomcorn millet plots away from the other cereals, but has a high association with pit features and the southern area of the western trench (blocks 13-16).
- The ecological indicator values suggest that overall the species had plenty of light and grew in a mild climate (not too hot or cold) on well drained, slightly alkaline soil and a medium nitrogen value.
- The anthropogenic factors suggest that the crops grew on disturbed ground, sown in autumn, with possible weeding activities, and were harvested low to the ground so that both the straw and grain could be collected.

7.3.2 Fine sieving by-products: unsieved

7.3.2.1 Introduction: Crop and weed associations

A correspondence analysis was carried out on the unsieved fine sieving by-product group (83 samples). This group is dominated by einkorn glume bases (see 6.5.2.2 for details). Eight outlying samples were removed from the analysis (FEU046, FEU056, FEU057, FEU344, FEU350, FEU329, FEU407, FEU085). Species were initially coded as either a crop, a possible crop or a weed (Fig 7.33). From Figure 7.33, einkorn (TRITMOT/G) and emmer (TRITDIC/G) grain and chaff are closely associated in the top centre of the plot, spelt (TRITSPL/TRISPLG), bread/durum wheat (TRITAED) and broomcorn millet (PANIMIL) to the left of the plot, while barley (HORDSAS/RS) is in the centre right of the plot. Rye is clearly separate from the other cereals in the bottom right of the plot. Close crop and weed associations include: einkorn, emmer and *Silene* sp. (SILESPE); barley, *Solanum nigrum* (SOLANIG) and *Polygonum persicaria* (POLYPER); bread/durum wheat, broomcorn millet and *Chenopodium* sp. (CHENSPE). In addition, there seems to be a greater number of weed species associated with barley to the right of the plot than with the wheats (i.e. einkorn, emmer, spelt and bread/durum wheat) in the left of the plot.

The cereal composition of each sample shows that einkorn is the dominant cereal in all samples except a number of samples to the bottom of the plot which contain higher proportions of emmer and barley (Fig 7.34). In addition, eight samples in the top right of the plot contain rye and three samples to the left contain broomcorn millet. Samples to the top left of the plot also have a greater association with pits and hearths as well as with blocks 13-16 in the southern end of the trench (Fig 7.35-6). A divide is therefore seen between the top left of the plot (einkorn, emmer, spelt, bread/durum wheat and broomcorn millet) and the bottom right of the plot (barley and rye). Possible differences in depositional patterns will be examined further in section 7.4.

7.3.2.2 Ecological indicator values

Light

Each species was coded to its light indicator value (after Borhidi 1995). All the species have a high light indicator value except *Polygonum persicaria* (POLYPER) and *Sherardia arvensis* (SHERARV), which have a slightly lower light indicator value of L6 (Fig 7.37).

Temperature

Each species was coded to its temperature indicator value (after Borhidi 1995). Weed species characterised by moderate and high temperatures are associated with einkorn and barley (Fig 7.38). Overall, the samples are largely dominated by weed species characteristic of moderate temperatures (Fig 7.39).

Continentality

Each species was coded to its continentality indicator value (after Borhidi 1995). The majority of the indicator values for the weed species ranged from low to medium and only *Chenopodium* sp. (CHENSPE) and *Chenopodium hybridum* (CHENHYB) have high continentality values of K7 (Fig 7.40). Einkorn, emmer and barley are associated with species characteristic of low and medium continentality. With the removal of *Chenopodium* sp., which has a distinct effect on sample composition in the bottom left of the plot, the samples are dominated by weed species characteristic of medium continentality (Fig 7.41).

Moisture

Each species was coded to its moisture indicator value (after Borhidi 1995). The majority of the weed indicator values ranged from low to medium and only

Euphorbia palustris (EUPHPAL) has a high moisture value of F9. Einkorn, emmer and barley are associated with species characteristic of low and medium soil moisture levels (Fig 7.42). With the removal of *Chenopodium* sp., dominance in species characteristic of low moisture levels is seen (Fig 7.43).

pH (Reaction)

Each species was coded to its reaction indicator value (after Borhidi 1995). The majority of weed species are characterised by high indicator values, typical of alkaline soils (Fig 7.44). Sample composition corroborates this, with the majority of samples containing a high proportion of weeds characteristic of alkaline soils (Fig 7.45).

Nitrogen

Each species was coded to its nitrogen indicator value (after Borhidi 1995). The majority of the weed species indicate medium to high nitrogen availability and only *Silene* sp. (SILSPE), *Plantago lanceolata* (PLANLAN) and *Polygonum convolvulus* (POLYCON) have low nitrogen values (Fig 7.46). With the removal of *Chenopodium* sp., the samples show dominance in species characteristic of medium nitrogen availability (Fig 7.47).

7.3.2.3 Anthropogenic factors

Due to the influence of *Chenopodium* sp. on the assemblage, this species was removed from the analysis of anthropogenic factors.

Harvesting height

A correspondence analysis was run to show the maximum flowering height of the weed species (Table 7.4). The height of the weed species ranged from low to high (Fig 7.48). The majority of the low-growing weed species are associated with barley in the bottom right of the plot. The majority of samples are dominated by medium height species, although the vast majority also contain low-growing species (Fig 7.49).

Soil disturbance

A correspondence analysis was run to examine the relative proportion of annuals, perennials and perennials with rhizomes within each sample. Of all the species present, only *Rumex crispus* (RUMECRI) and *Verbena officinalis* (VERBOFF) are perennials and only *Plantago lanceolata* (PLANLAN) is a perennial with rhizomes; the rest are all annuals (Fig 7.50). This is also visible in the pie charts, where sample composition highlights the predominance of annuals (Fig 7.51).

Sowing time

A correspondence analysis was run to examine the relative proportion of winter and summer annuals within the samples. Only four species, *Bromus arvensis* (BROMARV), *Bromus* sp. (BROMSPE), *Bupleurum rotundifolium* (BUPLROT) and *Sherardia arvensis* (SHERARV), are winter annuals and are largely associated with barley in the bottom right of the plot (Fig 7.52). Einkorn has a greater association with summer annuals. From the pie charts, the majority of samples contain approximately equal proportions of summer and winter annuals (Fig 7.53).

7.3.2.4 Exploring differences between barley and einkorn cultivation

The results from the unsieved fine sieving by-products show a similar trend in ecological and anthropogenic factors throughout all the samples. The samples are primarily dominated by einkorn which may suggest that the fine sieving by-products are from an einkorn crop with admixtures of barley, emmer, spelt, bread/durum wheat, broomcorn millet and rye. The divide between broomcorn millet and rye within the plots and the large influence of *Chenopodium* sp. may be masking any patterns seen between barley and einkorn. Thus, to explore any further patterns that might emerge, a correspondence analysis was run on the dataset removing spelt, bread/wheat, rye, broomcorn millet and *Chenopodium* sp. Samples containing >70% of these species were also excluded as they may contain the remains of a crop product.

The weed and cereal associations do not change significantly from the previous correspondence analyses (Fig 7.54). Barley grain and rachis is clearly separate from the other cereals at the top and right of the plot, and could be associated with differences in crop processing stages. Sample composition shows a divide between those dominated by einkorn to the left of the plot and those with a greater proportion of barley to the right (Fig 7.55). In addition, there is a clear divide between samples recovered from pits and hearths to the left of the plot and those from house levels to the right (Fig 7.56). Of the nine ecological and anthropogenic factors analysed, only the distribution of nitrogen values and summer/winter annuals produced clearer patterns.

Nitrogen

The weed species were coded to their nitrogen indicator values. Although weak, two groups of species may be distinguished from the plot (Fig 7.57): first, species characteristic of high nitrogen soils, einkorn and emmer to the left of the plot, and second, species characteristic of low and medium nitrogen soils and barley to the bottom right.

Sowing time

The species were coded to their sowing time. Two groups of species are distinguished in the plot (Fig 7.58). First, summer annuals, einkorn and emmer to the left of the plot and second, winter annuals and barley to the bottom right.

7.3.2.5 Summary

Correspondence analysis of nine different ecological and anthropogenic factors were conducted on 83 samples identified as unsieved fine sieving by-product i.e. samples dominant in einkorn glume bases with admixtures of emmer, barley, broomcorn millet and rye, as well as high numbers of weed seeds. From these analyses the following observations were noted (with the removal of *Chenopodium* sp.):

- There is a strong division between emmer and einkorn, and barley and rye.
- Einkorn and emmer have a strong association with weeds with high nitrogen values and summer annuals.
- The ecological indicator values suggest that overall the species had plenty of light and grew in a mild climate (not too hot or cold) on well drained, slightly alkaline soil and a medium nitrogen value.
- The anthropogenic factors suggest that the crops grew on disturbed ground, sown in autumn, with possible weeding activities, and were harvested low to the ground so that both the straw and grain could be collected.

7.3.3 Products: Unsieved

7.3.3.1 Introduction: Crop and weed associations

A correspondence analysis was carried out on the unsieved products group (35 samples). This group is dominated by einkorn grains (see 6.5.2.3 for details). No outlying samples were removed from the analysis. Species were initially coded as either a crop, a possible crop or a weed (Fig 7.59). Here a clear separation is seen between rye (SECACEG) and barley (HORDSAS/RS) in the centre- left of the plot, broomcorn millet (PANIMIL) in the bottom right, and emmer (TRITDIC/G) and einkorn (TRITMOT/G) at the top of the plot. A large number of species are associated with rye and barley including close associations with *Bromus arvensis* (BROMARV), *Plantago lanceolata* (PLANLAN) and *Bupleurum rotundifolium* (BUPLROT). Einkorn is closely associated with *Hyoscyamus niger* (HYOSNIG), *Digitaria* sp. (DIGISPE) and *Polygonum persicaria* (POLYPER).

The cereal composition of each sample shows that einkorn is the dominant cereal in all samples except six. Three samples to the bottom right have a high proportion of broomcorn millet, two to the bottom left of barley and one sample in the centre left has a high proportion of rye (Fig 7.60). Samples to the top and right of the plot also have a greater association with pits and blocks 13-16 in the southern end of the trench (Fig 7.61-2). A divide is therefore seen between the top and right of the plot (einkorn, emmer, bread/durum wheat and broomcorn millet) and the bottom left of the plot (barley and rye). Possible differences in depositional patterns will be examined further in section 7.4.

7.3.3.2 Ecological indicator values

Light

Each species was coded to its light indicator value (after Borhidi 1995). All the species have a high light indicator value except *Polygonum persicaria* (POLYPER) and *Sherardia arvensis* (SHERARV), which have a slightly lower light indicator value of L6 (Fig 7.63).

Temperature

Each species was coded to its temperature indicator value (after Borhidi 1995). Weed species characterised by moderate and high temperatures are associated with einkorn and barley (Fig 7.64). Overall, the samples are largely dominated by weed species characteristic of moderate temperatures (Fig 7.65).

Continentality

Each species was coded to its continentality indicator value (after Borhidi 1995). The majority of the indicator values for the weed species ranged from low to medium and only *Chenopodium* sp. (CHENSPE) and *Chenopodium hybridum* (CHENHYB) have high continentality values of K7 (Fig 7.66). Einkorn, emmer and barley are associated with species characteristic of low and medium continentality. With the removal of *Chenopodium* sp., which has a distinct effect on sample composition in the top right of the plot, the samples are dominated by weed species characteristic of medium continentality (Fig 7.67).

Moisture

Each species was coded to its moisture indicator value (after Borhidi 1995). The majority of the weed indicator values ranged from low to medium (Fig 7.68). With the removal of *Chenopodium* sp., dominance in species characteristic of low moisture levels is seen (Fig 7.69); however, there is a slight association with species characteristic of medium moisture levels, emmer and broomcorn millet at the top of the plot.

pH (Reaction)

Each species was coded to its reaction indicator value (after Borhidi 1995). The majority of weeds species are characterised by high indicator values, typical of alkaline soils (Fig 7.70). Sample composition corroborates this, with the majority of samples containing a high proportion of weeds characteristic of alkaline soils (Fig 7.71).

Nitrogen

Each species was coded to its nitrogen indicator value (after Borhidi 1995). The majority of the weed species indicate medium to high nitrogen availability and only *Silene* sp. (SILSPE), *Teucrium* sp. (TEUCSPE) and *Polygonum convolvulus*

(POLYCON) have low nitrogen values (Fig 7.72). Einkorn, emmer and broomcorn millet have a greater association with species typical of a high nitrogen environment. With the removal of *Chenopodium* sp., the samples show dominance in species characteristic of medium nitrogen availability (Fig 7.73).

7.3.3.3 Anthropogenic factors

Due to the influence of *Chenopodium* sp. on the assemblage, this species was removed from the analysis of anthropogenic factors.

Harvesting height

A correspondence analysis was run to show the maximum flowering height of the weed species (Table 7.4). The height of the weed species ranged from low to high, with no particular associations with any of the cereals (Fig 7.74). The majority of samples are dominated by medium height species although the vast majority also contain low-growing species (Fig 7.75).

Soil disturbance

A correspondence analysis was run to examine the relative proportion of annuals, perennials and perennials with rhizomes within each sample. Of all the species present, only *Malva* sp. (MALVSPE) and *Allium* sp. (ALLISPE) are perennials and only *Plantago lanceolata* (PLANLAN) is a perennial with rhizomes; the rest are all annuals (Fig 7.76). This is also visible in the pie charts, where sample composition highlights the predominance of annuals (Fig 7.77).

Sowing time

A correspondence analysis was run to examine the relative proportion of winter and summer annuals within the samples. Six species, *Agrostemma githago* (AGROGIT), *Bromus arvensis* (BROMARV), *Bromus* sp. (BROMSPE), *Bupleurum rotundifolium* (BUPLROT), *Conringia orientalis* (CONRORI) and *Sherardia arvensis* (SHERARV), are winter annuals and are largely associated with barley and rye in the bottom left of the plot (Fig 7.78). Einkorn has a greater association with summer annuals. The majority of samples have approximately equal proportions of summer and winter annuals (Fig 7.79).

7.3.3.4 Exploring differences between barley and einkorn cultivation

The results from the unsieved products provide an opportunity to examine in more detail einkorn, emmer and barley cultivation at the site. The results show similarities in the ecological and anthropogenic factors e.g. temperature, reaction and disturbance; however, there may be slight patterning in moisture, nitrogen and sowing times highlighting possible differences between einkorn and barley cultivation. The impact of broomcorn millet, rye and *Chenopodium* sp. may be masking any patterns seen between barley and einkorn. Thus, to explore any further patterns that might emerge a correspondence analysis was run on the dataset removing bread/wheat, rye, broomcorn millet and *Chenopodium* sp. Samples containing >70% of these species were also excluded as they may contain the remains of a crop product.

The weed and cereal associations do not change significantly from the previous correspondence analyses (Fig 7.80). Barley grain and rachis is clearly separate from the other cereals to the left of the plot. Sample composition shows a divide between those dominated by einkorn to the right of the plot and those dominated by barley to the left (Fig 7.81). In addition, there is a clear divide between samples recovered from pits to the bottom right of the plot and those from house levels to the top (Fig 7.82). Of the nine ecological and anthropogenic factors analysed, only the distribution of moisture, nitrogen values and summer/winter annuals produced clearer patterns.

Moisture

The species were coded to their moisture indicator values. Species characteristic of wetter soils are associated with emmer in the bottom right of the plot (Fig 7.83-4). Einkorn and barley are associated with species typical of dry, well drained soils.

Nitrogen

The weed species were coded to their nitrogen indicator values. Two groups of species are distinguished in the plot (Fig 7.85): First, species characteristic of high nitrogen soils, einkorn and emmer to the right of the plot and second, species characteristic of low and medium nitrogen soils and barley to the left.

Sowing time

The species were coded to their sowing time. Two groups of species are distinguished in the plot (Fig 7.86). First, summer annuals, einkorn and emmer to the right of the plot and second, barley and summer and winter annuals to the left.

7.3.3.5 Summary

Correspondence analysis of nine different ecological and anthropogenic factors were conducted on 35 samples identified as unsieved products i.e. samples dominant in einkorn grain with admixtures of emmer, barley, broomcorn millet and rye, as well as high numbers of weed seeds. From these analyses the following observations were noted (with *Chenopodium* sp. removed):

- There is a strong division between emmer and einkorn, and barley and rye.
- Einkorn and emmer have a strong association with weeds with high nitrogen values and summer annuals.
- The ecological indicator values suggest that overall the species had plenty of light and grew in a mild climate (not too hot or cold) on well drained, slightly alkaline soil and a medium nitrogen value.
- The anthropogenic factors suggest that the crops grew on disturbed ground, sown in autumn, with possible weeding activities, and were harvested low to the ground so that both the straw and grain could be collected.

7.3.4 Conclusions

Weed species within the three groups of samples identified as unsieved spikelets, unsieved fine sieving by-products and unsieved products were examined in relation to nine ecological and anthropogenic factors. It is important to note that the reliability of the results is dependent on the reliability of the crop processing analysis; however, the results showed similarities in the ecological and anthropogenic characteristics of the three groups of samples identified to three different crop processing stages. Thus, the overall picture presented by the weed species indicates that the environment within which the crops grew had plenty of light, grew in a mild climate (not too hot or cold) on well drained, slightly alkaline soil with an overall medium nitrogen value. The anthropogenic factors analysed suggest that the crops grew on disturbed ground, sown in autumn, with possible weeding activities, and were harvested low to the ground so that both the straw and grain could be collected.

The correspondence analysis also revealed a separation between two groups of crops. Group A, which includes barley and rye, is characterised by species indicative of low levels of nitrogen and by winter annuals. Group B, on the other hand, includes einkorn, emmer, spelt, bread/durum wheat and broomcorn millet and is characterised by species indicative of high levels of nitrogen and by summer annuals. With all three groups of samples presenting the same results, it is likely that the differences seen between group A and B represent two different crop husbandry regimes at Feudvar.

7.4 Intra-site variability

From Chapter 6, a number of patterns were identified in the distribution of certain crop processing samples throughout the western trench at Feudvar. This section will examine these trends further in order to determine whether different cultivation methods can be associated with a particular group of inhabitants or household. As already observed from the previous analyses, barley and rye are generally associated with house deposits, while the wheats (einkorn, emmer, spelt, bread/durum wheat) and broomcorn millet are more associated with pits. Broomcorn millet is also closely associated with pits, especially within the southern end of the trench. The association of broomcorn millet with wheat and with pits may therefore support the theory that broomcorn millet may have been added to the wheat crop to aid in crop preservation in storage pits (section 6.6.2.4).

Two factors, nitrogen availability and germination time, distinguished differences in cultivation methods of group A crops (barley and rye) and group B crops (einkorn, emmer and broomcorn millet). In order to explore possible differences in cultivation methods applied by different households, the distribution of species characteristic of low, medium and high nitrogen environments were plotted across the western trench for each of the three unsieved crop processing stages. Species indicative of high nitrogen availability are found predominantly in areas 4 and 8 for all three groups (Fig 7.87). This corresponds with floor deposits from the ‘fish’ house. From Chapter 6, these areas were seen as being dominant in einkorn and emmer remains.

The remaining areas are all dominant in species characteristic of medium nitrogen levels. Looking at the proportion of summer and winter annuals and perennials/annuals across the trench, some slight patterning may also be seen (Fig 7.88). First, blocks 4 and 8 are higher in summer annuals. Second, blocks 5, 7 and, to a lesser extent, blocks 13-16 at the south end of the trench are higher in winter annuals. Nevertheless, dominance does vary depending on the crop processing stage being examined.

Thus, from the analysis of spatial distribution of samples within the trench, it may be possible to see a slight increase in species indicative of higher nitrogen levels and summer annuals within the 'fish' house which may correspond with possible differences seen in the cultivation regimes of einkorn and emmer. Correspondence analyses on the datasets has been a helpful tool in making a distinction between house and pit features which provides further evidence of depositional practices at the site. Unfortunately, at present, detailed chronological and archaeological information is unavailable so it is difficult to determine whether any chronological changes occurred at the site in relation to crop processing regimes during the Late Bronze Age.

7.5 Identification of crop husbandry practices at Feudvar

7.5.1 The arable environment (climate, temperature, water and soil pH)

From the ecological indicator values, the weed species suggest that during the Late Bronze Age at Feudvar the temperature was typical of a submontane broad leaved forest belt (T6). In northeast Serbia today, submontane and montane beech forests can be found (Koprivica *et al.* 2008). In terms of continentality, the weeds typically characterised suboceanic (K4) species, with slight oceanic (K3) and subcontinental (K5) tendencies, mainly of Central Europe although extending to the east. Plant reaction indicated basifrequent plants (R7) found on slightly calcareous soils. This corresponds with the pH of chernozem soils today which are neutral to slightly alkaline, although hydromorphic soils also have a neutral pH in the Balkans (Mitkova and Mitrikeski 2005).

The moisture value for the species generally indicates a semidry habitat (F4). As the chernozem soils are well drained soils, while the surrounding hyromorphic soils are particularly waterlogged, this would suggest that the majority of the species were growing on chernozem soil. The presence of *Phragmites australis, Trapa natans* and *Schoenoplectus lacustris* from the whole Feudvar assemblage, which have high moisture values (F10-F11), indicates plants of frequently flooded soils. Along the Danube today, especially in areas of Croatia and Serbia, *Phragmites australis, Trapa natans* and to a lesser extent *Schoenoplectus lacustris* are regularly found (Ozimec at al. 2010). Therefore, during the Late Bronze Age these species are likely to have grown on the alluvial soils which are prone to flooding and run to the south and east of the Titel plateau.

7.5.2 Cultivation methods

The different cultivation methods employed by a farmer will ultimately determine the crop's productivity, its sustainability (e.g. long term cultivation) and labour requirements. Two groups of species were identified from the correspondence analysis: group A, which includes barley and rye and is characterised by species indicative of low levels of nitrogen and by winter annuals, and group B, which includes einkorn, emmer, spelt, bread/durum wheat and broomcorn millet and is characterised by species indicative of high levels of nitrogen and by summer annuals. It was concluded that these differences indicated two different cultivation methods. These issues will be discussed in more detail, focusing on four main cultivation activities: preparing the ground (e.g. tillage methods), sowing the seeds of the crop, tending the crop (e.g. weeding, manuring) and harvesting.

7.5.2.1 Tillage methods

Tillage refers to the preparation of soil for the growing of crops. The extent of soil disturbance will be determined by the type of method employed and the amount of energy applied to the activity. This is ultimately linked to the type of crop grown and the scale and intensity of the cultivation regime employed. By examining the 33 weed species recovered from Feudvar, only five species are perennials and one, *Plantago lanceolata*, is a perennial with rhizomes (making it less susceptible to disturbance). The remaining 27 species are all annuals. Previous research suggests that annuals increase with the rise of disturbance, especially in relation to tillage activities (e.g. Ellenberg 1988; Hillman 1981; Van der Veen 1992; Zimdahl

2007:284). Thus, at Feudvar, the dominance of annuals over perennials suggests that the agricultural fields were heavily tilled before the crops were sown.

Soil organic matter availability and distribution of nutrients to crop plants are often influenced by the type and degree of soil tillage. Tillage practices have been shown to increase nitrogen availability by aerating the soil and mobilising microorganisms (Doran *et al.* 1998). The loss of soil organic matter is, however, greatest within ploughed fields (Salinas-Garcia *et al.*1997). Soils tilled in the autumn also have a greater risk of nitrogen leaching due to high precipitation during the autumn and winter (Stenberg *et al.* 1997). On the other hand, intensive tillage practices are typically associated with manuring and are therefore more likely to maintain soil nitrogen levels compared to extensive plough cultivation (*cf.* Van der Veen 1992:139). Tillage intensity also has an effect on weed density, where fields with minimal tillage have greater quantities of weeds (Blackshaw *et al.* 2001). In addition, species-rich fields have been shown to correlate with marginal environmental conditions, rather than fertile soils, as well as with extensive mixed-cropping-breeding systems that depend on both animal and crop production (Fried *et al.* 2008).

Although no tillage equipment (e.g. ploughs, hoes or digging sticks) has been recovered from the excavations at Feudvar, tillage practices may be inferred from the archaeobotanical remains. The high nitrogen levels associated with einkorn, emmer and broomcorn millet (group B) and the low number of weed species associated with the crops, may suggest that intensive tillage methods were practised. Barley (group A), on the other hand, had a greater association with species indicative of low nitrogen environments, which may suggest a more extensive regime and the use of an ard plough. Autumn tilling of barley (group A), may also be inferred from the presence of winter annuals and species indicative of low nitrogen levels.

In conclusion, the cultivated fields at Feudvar were tilled before the crops were sown. Two different forms of tillage were also inferred from the archaeobotanical remains. For barley (group A), extensive ard cultivation was most likely performed. For the cultivation of einkorn, emmer and broomcorn millet (group B), a more intensive tillage method was performed, either through repeated use of an ard or the use of hoes.

7.5.2.2 Sowing strategies

Autumn versus spring sowing

The time at which a crop is sown provides information about the yearly activities at the site. The sowing time of a crop may also indicate productivity: as winter sown crops have a longer growth period they may have potentially higher yields. From the germination time of the weed species found within the crops, it is possible to infer the season the crop was sown. The basic principle suggests that if a crop contains predominantly spring germinating weeds, then the cereal was sown in spring, while a dominance in winter annuals indicate autumn sowing (Groenman-Van Waateringe 1980; Jones 1981; Wasylikowa 1981).

At Feudvar, the correspondence analyses showed that winter annuals had a greater association with barley and rye (group A), while summer annuals had a greater association with einkorn, emmer and broomcorn millet (group B). This could suggest that barley and rye were sown in the autumn, while einkorn, emmer and broomcorn millet were sown in the spring. However, studies have shown that summer annuals will outcompete winter annuals in nitrogen rich fields (Carson and Barrett 1988; Van der Veen 1992:131-3). In addition, studies have shown that weeding in spring reduces the number of winter annuals and encourages the growth of short-lived summer annuals (Van Elsen 2000). Thus, autumn-sown crops that are subjected to intensive practices (e.g. weeding and manuring) have been shown to have a weed flora rich in summer annuals (Jones *et al.* 1999; Bogaard *et al.* 2001). The high association of summer annuals with group B (einkorn, emmer and broomcorn millet) may therefore result from more intensive practices being applied to autumn-sown crops.

The identification of spring sown broomcorn millet has also been traditionally identified by the presence of Chenopodietea within the samples (Kroll 1979; Wasylikowa 1978). More recently, this method has allowed the identification of a spring sown broomcorn millet crop at the Bronze Age site of Ganglegg (southern Italy) (Schmidl and Oeggl 2005). Today, broomcorn millet (*Panicum miliaceum*) is commonly planted as a summer crop, due to its sensitivity to frost, its ability to withstand intense heat, poor soils, drought and its relatively short growing period compared to the other cereals (Nesbitt and Summers 1988; Schmidl *et al.* 2005). It may therefore be prudent to reconsider the identification of autumn-sown broomcorn millet at Feudvar. Previous work by Kroll (1997), suggests that broomcorn millet was indeed sown in spring at Feudvar and may have been an effective method to reduce weed infestation in winter fields as its cultivation would prevent re-establishing weeds from growing abundant seeds. Therefore, if broomcorn millet was indeed grown as a minor crop at Feudvar it may have been sown in spring rather than autumn.

Maslins and monocrops

Another aspect to consider is the practice of intercropping, where two or more species are sown together in a field to increase yield and/or reduce complete crop failure. In traditional farming communities in Ethiopia, intercropping of emmer and barley is commonly practised in order to add variety to the diet and reduce risk of economic loss from pests or adverse weather conditions (D'Andrea *et al.* 1999; D'Andrea and Mitiku 2002; Kislev 1989). The inclusion of barley in a wheat crop is also believed to increase the wheat yield and protect it against fungal attack (D'Andrea *et al.* 1999). Two features have been commonly used to determine the presence of a maslin crop in archaeobotanical samples: first, through the presence of two or more cereals in one sample and second, from similar proportions of the crops (Van der Veen 1995).

The presence of two or more crop species within a sample may, however, result from a number of activities unrelated to intercropping. For example, mixing of cereals after harvest (e.g. as a result of crop processing or depositional activities) (Jones and Halstead 1995), from crop rotation (Dennell 1978; Willerding 1988) or from accidental contamination (Jones and Halstead 1995). The examination of proportions is also problematic as the point of a maslin crop is to allow one crop to outperform another depending on the environmental conditions (Jones and Halstead 1995; Van der Veen 1995). In this sense, the proportions within a sample are not a reliable indication of intercropping. A solution to these problems was proposed by Van der Veen (1995) who suggested that multivariate analyses can be used to identify intercropping through the close associations seen between crops and suites of weeds.

At Feudvar, the correspondence analysis shows a close association with einkorn and emmer and their associated weeds. This may suggest that einkorn and emmer were grown as a maslin crop, but the environmental conditions were more suited to einkorn, resulting in the dominance of einkorn within the majority of the samples. Alternatively the close association between emmer and einkorn indicates similarities in crop processing techniques, and thus a similar sample composition. The correspondence analyses also identified a close association between einkorn and barley rachis within samples identified as unsieved spikelets. Although the intercropping of einkorn and barley may explain this close association, the overall results of the correspondence analyses consistently showed the separation of barley and einkorn within the plots and a separation between their associated weeds. From these results, it is therefore unlikely that the intercropping of einkorn and barley occurred at Feudvar.

Sowing method

In the previous chapter it was determined that a certain proportion of the cereal remains would likely represent seed corn. A number of methods can be employed to sow the cereals including broadcasting or dribbling into channels. The area of land that needs to be sown will have an effect on the method employed, as large areas will need a more rapid method of sowing. Thus, extensive ard cultivation tends to be associated with broadcast sowing (e.g. low labour input/low area yield), while smaller scale cultivation tends to involve dribbling or planting (e.g. high labour input/high area yields) (Halstead 1995b; Halstead and Jones 1989). Therefore, broadcasting is faster but more wasteful, while dribbling in rows is slower but less wasteful and allows weeding.

In conclusion, the high proportion of winter annuals associated with barley (group A) would suggest that this crop was sown in autumn by broadcasting, which requires less labour input per area. Einkorn, emmer and broomcorn millet (group B), were also likely sown in autumn by dribbling or planting, but due to more intensive practices (e.g. weeding and manuring) the weed flora is dominated by summer annuals. In addition, the strategy of intercropping may have also been practised at Feudvar through the mixing of einkorn and emmer.

7.5.2.3 Intensive practices

Weeding

The application of intensive practices has already been highlighted above in relation to tillage practices and sowing strategies, but what is meant by intensive practices? Intensive agricultural activities involve the high input of resources, e.g. labour, manure, irrigation, into a given area of land, resulting in high area yields (see section 9.3). Weeding or hoeing crops is classed as an intensive action that takes time and labour. This strategy prevents weeds from reaching maturity and outcompeting the crop plants, which ultimately affects the productivity and yield of the crop. Studies have shown that weeding encourages the growth of annuals, due to the high levels of soil disturbance (see 7.5.2.1). The level and intensity of weeding will have an impact on the weed species present in the field. For example, if autumn crops are weeded in the spring then the majority of winter annuals will be removed. The freshly hoed ground is then more susceptible to the growth of quick growing summer annuals.

Identifying weeding in archaeobotanical material can be problematic. For example, Bogaard (2004:142) suggests that hand tillage using a hoe could have a similar effect on the overall weed composition as small-scale ard ploughing followed by weeding. In addition, if crops are grown in spring on freshly tilled earth, then it is very difficult to distinguish between the disturbance seen from the tillage methods and any further weeding activities. At Feudvar, weed species associated with both groups are indicative of high soil disturbance, whether from tillage or tillage and weeding; however, if einkorn and emmer (group B) were sown in autumn, their strong association with summer annuals would suggest weeding of the crops in spring.

Manuring

Another intensive practice is manuring, which involves enriching the agricultural soil to increase crop productivity. As nitrogen is responsible for the protein quality within the grain’s, the lack of nitrogen will severely affect yield and the grains nutritional quality (Gregg 1988:64). Manuring as part of an intensive regime would therefore allow families to produce relatively high yields from small areas of land. The only problem with this method is the availability of manure and subsequently the number of livestock available. At Feudvar, the availability of manure is likely as zooarchaeological remains indicate the rearing of cattle, sheep/goat and pigs at the site (Hänsel and Medović 1998), although the quantity needed to provide enough manure is difficult to estimate. In addition, manure could have been applied directly, by allowing the livestock to graze on the land between cultivation periods, or indirectly, by collecting and spreading the manure manually. Rubbish disposal at a settlement would also inevitably lead to midden heaps occurring in and around the site (Bogaard 2012). These nutrient rich rubbish heaps would provide additional compost material for cultivated fields, as well as providing areas that could be directly cultivated (Guttman 2005).

The strong association between weed species characteristic of high nitrogen environments and einkorn, emmer and broomcorn millet (group B), may suggest that these crops were manured. In contrast, the strong association between species indicative of medium to low levels of nitrogen in the soil and barley (group A) would suggest that no soil enrichment occurred for this crop. The lower levels of nitrogen indicative of barley cultivation at Feudvar may, however, not necessarily indicate poor crop yields, as nitrogen availability is also impacted by the type of soil (e.g. whether well aerated or compacted) and its ability to retain nutrients.

Within the landscape of Feudvar, the main soil type is chernozem. Chernozem soil has been shown to have a naturally high fertility that has allowed cultivation of cereals without the addition of manure (Gerasimov and Glazovskaya 1965). Chernozem soils are also particularly rich in potassium and calcium (Dent *et al.* 2011:58). Crop rotation and fallowing are strategies that have also been implemented to increase nitrogen, prevent soil exhaustion and therefore increase crop yields; however, experimental evidence has shown that prolonged cultivation need not necessarily result in low yields (Rowley-Conwy 1981; Reynolds 1992). In addition, Rösch (1996) suggests that non-demanding cereals like spelt, broomcorn millet and barley can reach sufficient yields without fertilisation and that soil fertility could be conserved by a rotation system.

The identification of crop rotation in archaeobotanical material has generally occurred from the identification of two or more species within a sample (e.g. Dennell 1978:148; Willerding 1988:36). Alternatively, the identification of perennial meadow and footpath plants in crop weeds have been used to infer short fallow phases in Bronze Age contexts (Rösch 1996). At Feudvar, the high number of annuals makes it unlikely that the fields were left fallow; however, it is difficult to determine whether another form of crop rotation occurred, as the majority of samples contain more than one cereal species. The intercropping of nitrogen fixing legumes or crop rotation (legume-cereal) is another method of maintaining soil fertility during cultivation. From the correspondence analysis, *Vicia* sp. is regularly associated with einkorn and may support the use of legumes in the husbandry regime to increase soil nitrogen. Intensive practices will be discussed further in 9.3.

In conclusion, intensive practices e.g. manuring and weeding, are likely to have been practised for einkorn, emmer and broomcorn millet (group B) due to their strong association with summer annuals and species indicative of high nitrogen levels. Barley (group A), on the other hand, had a strong association with winter annuals and species indicative of medium-low nitrogen availability suggesting that manuring and weeding was not practised on a regular basis on the crop.

7.5.2.4 Field location

The choice of cultivation scale and intensity will also depend on the location of the settlement in relation to the fields. For example, research has shown that the most intensively cultivated plots are usually those located closest to the village (within 500m), while extensive cultivation is performed further afield (Bogaard *et al.* 2011; Jones *et al.* 1999). In addition, manure is heavy to transport and would be spread within a limited distance from the settlement or stalling area (Bogaard 2012). At Feudvar, the location of the settlement would have allowed both intensive and extensive regimes to be practised on the plateau. This is supported by previous analysis of sample 3063W which identified a deposit of underdeveloped emmer grains from the Early Bronze Age levels at Feudvar. It was suggested that although this may represent the early harvest of emmer (for some unknown reason), it may also indicate the impact of summer droughts, which is unlikely to occur on the surrounding floodplains, but could have impacted crops grown on the plateau

(Borojević 1991). It is therefore likely that the more intensively cultivated crops, such as einkorn, emmer and broomcorn millet, were cultivated closer to the settlement on the plateau, while barley could have been cultivated at greater distances from the site (whether further along the plateau or to the west of the site).

7.5.2.5 Harvesting

The arable weeds also give information about harvesting methods. For example, the proportion of seeds from tall and short weeds in the harvested crop will vary according to the height at which the sickle cuts the straw or if the preferred harvesting method involves plucking the ears singly (Hillman 1981). Typically, the presence of low-growing species in cereals is used to infer harvesting low down on the culm, while the presence of seeds of free-standing, non-twining species indicates sickle harvesting (Stevens 2003). Ethnographic work by Ibáñez *et al*. (2009) suggest that in areas with long dry summers harvesting was able to be conducted at a slower pace, so alternative methods of harvesting such as ear plucking or uprooting could be conducted. The use of the sickle was therefore suggested as a means to allow the development of a quick system of crop collecting (*ibid.*).

At Feudvar, low-growing species such as *Sherardia arvensis*, *Trifolium* sp. and *Bupleurum rotundifolium* were found in the majority of samples suggesting that the cereals were cut low on the culm. This would mean that the straw, as well as the cereal grains, were collected at the site. Ethnographic research in Spain has identified that einkorn straw is used mainly for crafts and thatching, while emmer straw is mainly used for animal bedding (Peña-Chocarro 1999:44). Straw could also be used for fodder but only if there was no other food source (*ibid.*). The recovery of sickles at Feudvar would also suggest that they were used for harvesting cereals at the site (Hänsel and Medović 1998).

7.6 Conclusion

The analysis of weed ecology was conducted on three groups of samples: unsieved spikelets, unsieved fine sieving by-products and unsieved products, identified in Chapter 6. Correspondence analysis was conducted for nine different ecological and anthropogenic factors on the weed species in each group. The correspondence analyses showed that all three assemblages presented the same results regardless of crop processing stage. Overall, the ecological indicator values suggest that the species had plenty of light and grew in a mild climate (not too hot or cold) on well drained and slightly alkaline soil. The anthropogenic factors suggest that the crops were grown on disturbed ground, were sown in autumn and were harvested low to the ground, so that both the straw and grain could be collected. In addition, two distinct groups of species, with different ecological requirements, were identified:

- Group A, which includes barley and rye and is characterised by species indicative of low levels of nitrogen and by winter annuals.
- Group B, which includes einkorn, emmer, spelt, bread/durum wheat and broomcorn millet and is characterised by species indicative of higher levels of nitrogen and by summer annuals.

The differences between these two groups of species are likely the result of two different crop husbandry regimes practised (i.e. differences in intensity and scale) at the site, where barley (group A) was cultivated under a more extensive regime, while einkorn, emmer and broomcorn millet (group B) was cultivated more intensively. These results support Kroll (1997), who initially suggested that an increase in the presence of summer annuals within einkorn samples from the Early to Late Bronze Age at Feudvar resulted not from a change in sowing time, but a change in cultivation methods from large-scale extensive to small-scale intensive cultivation. These results could be strengthened further with the possible application of the FIBS method and/or the identification of insitu deposits to help differentiate mixing within the samples. The results will be discussed further in Chapter 9, in relation to the archaeobotanical evidence from the whole of the Carpathian Basin.

Chapter eight
Archaeobotany in the Carpathian Basin

This chapter presents the current archaeobotanical evidence from the Carpathian Basin. The purpose of this is to integrate the results from this study with those from the wider geographic region, providing a basis from which questions concerning the development of agriculture can be addressed. This chapter begins with a discussion on the archaeobotanical evidence available from the Carpathian Basin (8.1). From this, species distribution through time will be examined, focusing primarily on the crop species present (8.2). In order to determine whether regional specialisation or homogeneity can be seen through time within the Carpathian Basin, geographical variations in the suites of crops recovered from different regions are then explored (8.3).

8.1 Archaeobotanical data from the Carpathian Basin

8.1.1 The dataset

A total of 169 records with archaeobotanical remains were collected from sites within the Carpathian Basin (Tables 8.1a-c): 70 from the Mid/Late Neolithic, 30 from the Copper Age and 69 from the Bronze Age (Table 8.2). The majority of the records are from the recent publication by Gyulai (2010), who compiled archaeobotanical evidence from within Hungary from the Early Neolithic to the Medieval period. As a result, the dataset is heavily biased towards the region of modern day Hungary (Table 8.2). Overall, Croatia is only represented by 5 records, which are all located along the Dalmatian Coast. The Mid/Late Neolithic is better represented in both Bosnia Herzegovina and Serbia. In Bosnia, no further sites have yielded archaeobotanical remains during the Copper and Bronze Age. Romania and Hungary have the highest number of records for the Bronze Age (Table 8.2). There is, however, a clear decrease in the number of Copper Age records with archaeobotanical remains within all the countries.

The following section will explore the information available from the previously published sites. Overall, the records can be divided into 3 groups (Table 8.3). The first includes records containing information on only the presence/absence of species available per site. The second includes records containing information on species presence/absence, as well as the overall number of plant remains per site (not by sample). The third includes records containing information on individual samples, context details and information on sampling and recovery methods.

8.1.2 Sampling and recovery

Only 4% of the records contain information about the sampling and recovery methods used (Table 8.3). Many of the site details are lost within the publications and are largely omitted in reports when large datasets are compiled. This is particularly seen in the substantial collection of archaeobotanical data published by Gyulai (2010) who, understandably, didn’t include sample details for each of the 400 sites he examined. Even the original publications, from which Gyulai collected the archaeobotanical information, did not contain the full sample information for each site (e.g. Füzes 1990, 1991). In addition, Gyulai also includes a number of unpublished sites for which no additional sample information is available. Sites excavated over a decade ago also seem to have less information available about individual samples, especially in the recording of sample volumes.

Overall, only six sites (seven records) contain information about sample contexts and recovery methods: Opovo, Serbia (Borojević 2006), Grapčeva Špilja, Croatia (Borojević 2008), Uivar, Romania (Fischer and Rösch 2004), Hódmezővásárhely-Gorzsa, Hungary (Medović and Horváth 2011), Židovar, Serbia (Medović 2002), Santul Mic, Romania (Oas 2010). A number of sites do include information about individual samples, but they did not include the sieve sizes used in flotation or have detailed information about the volumes collected, e.g. Gomolava (Van Zeist 2003) Feudvar (Borojević 1991; Kroll 1991a), Buković-Lastvine and Čauševica (Chapman *et al.* 1996).

Information about sampling strategies per record is therefore restricted. Over 110 records suggest that only one feature type was sampled, while only seven records have samples collected from more than three feature types. This shows a clear restriction in the variety of feature types sampled at any one site, which may ultimately affect the interpretation of the archaeobotanical data. The number of samples collected also ranges per record, from 1 to 231. A total of 27 records had only one sample collected, while only six records had over 100 samples. Therefore, the median number of samples collected is low at only six samples per site. This is particularly problematic, as the collection of only a few samples will not provide a representative range of archaeobotanical remains from the site as a whole.

Where recorded, the sieve sizes used to collect the plant remains during flotation range from 0.25mm-0.5mm. At many of the sites, such as Židovar (Serbia), Opovo (Serbia) and Santul Mic (Romania), a volume of 10 litres per sample seemed to be standard practice; however, without the sample volume it is difficult to get an idea of the seed density per litre at the sites. This is particularly important when interpreting formation processes at a site (section 3.4.3.1). In order to compare the seed densities identified from the study sites, the median seed density was calculated for the tell sites of Židovar, Opovo and Santul Mic. Židovar had the highest overall median seed density per litre of 5, while Opovo had a seed density of 0.5 and Santul Mic of only 0.3. Thus, the sites of Opovo and Santul Mic correspond with the low seed densities obtained from the Croatian study sites, which had a median seed density per litre of 0.6; however, the median seed density of 20 obtained from Feudvar is still extremely high compared to these sites.

8.1.3 Species identification

The nomenclature used varied between records. For example, *Fallopia convolvulus* is also known as *Polygonum convolvulus* L. and *Fagopyrum convolvulus* (L.). Thus, the dataset had to be standardised to match the nomenclature used for the study sites (section 3.2). In addition, a number of sites included further details, such as, whether the grains were germinated, or information on the volume and weight of plant fragments. This information was recorded within the Access database; however, the species information needed to be simplified to allow the easy comparison between species and sites. Therefore, weights and volumes of plant remains were omitted and only their presence/absence was recorded.

8.1.4 The plant remains

8.1.4.1 Crops

From the 169 records, sixteen different crop plants were recovered from the Mid/Late Neolithic, ten from the Copper Age and sixteen from the Bronze Age (Tables 8.1d-f). They include: einkorn (*Triticum monococcum*), emmer (*Triticum dicoccum*), spelt (*Triticum spelta*), bread/durum wheat (*Triticum aestivum/durum*), the ‘new’ glume wheat type (*Triticum* cf. *timopheevii*), barley (*Hordeum vulgare*), rye (*Secale cereale*), broomcorn millet (*Panicum miliaceum*), foxtail millet (*Setaria italica*), bitter vetch (*Vicia ervilia*), grass pea (*Lathyrus sativus*), lentil (*Lens culinaris*), pea (*Pisum sativum*), flax (*Linum usitatissimum*) and gold of pleasure (*Camelina sativa*).

Hungary has the highest crop diversity within the region, with up to fifteen different species (Table 8.4); however, this is probably due to the high number of records identified within the region for the three periods. For the Mid/Late Neolithic, Romania has the second highest crop diversity of thirteen species, which were identified from three records. Croatia has the lowest crop diversity of only four species identified from one record. For the Copper Age, only ten species are identified from the Hungarian records. This is closely followed by eight species identified within the Serbian records, while only one crop was identified from two records within Croatia. Crop diversity increases again by the Bronze Age with sixteen crops identified within the Hungarian records. The second greatest crop diversity is seen within Serbia with thirteen different species identified from four records, while the Croatian records once again contain the lowest number of crops at eight.

8.1.4.2 Fruits and nuts

From the 169 records, twenty different fruit and nut species were recovered from the Mid/Late Neolithic, six from the Copper Age and fifteen from the Bronze Age. These included: wild strawberry (*Fragaria vesca*), cornelian cherry (*Cornus mas*), chinese lantern (*Physalis alkengengi*), bird cherry (*Prunus padus*), sloe (*Prunus spinosa*), dewberry (*Rubus caesius*), blackberry (*Rubus fruticosus*), elderberry

(*Sambucus ebulus*), elder (*Sambucus nigra*), acorns (*Quercus robur*), hazelnut (*Corylus avellana*) and wild grape (*Vitis silvestris*).

The highest diversity of fruit and nut remains were recovered from records dating to the Mid/Late Neolithic and Late Bronze Age in Serbia (Table 8.5). Both periods yielded up to twelve different species. Records from Bosnia, Hungary and Romania also contain ten species dating to the Mid/Late Neolithic. The records from Croatia all have very low fruit/nut diversity for all three periods. The Copper Age records are also very low in fruit/nut remains, with only the Hungarian records yielding up to four species. The Bronze Age shows a slight increase in diversity, although this is only apparent in records from Hungary and Serbia.

8.1.4.3 Wild/weed species

Over 180 different wild/weed species were identified from the records: 188 from the Mid/Late Neolithic, 44 from the Copper Age and 155 from the Bronze Age. The vast majority consisted of species commonly found in arable environments such as *Chenopodium album*, *Bromus* arvensis and *Agrostemma githago*. Others species recovered include small legumes (e.g. *Trifolium* sp., *Medicago sativa*), knotweeds (e.g. *Rumex* sp., *Polygonum* sp.), cleavers (*Galium aparine*) and nettles (*Urtica urens* and *U. dioica*). Wetland species are present at a number of sites, including club-rush (*Schoenoplectus lacustris*), sedges (*carex hirta*, *C. flacca*, *C. rostrata*) and water chestnut (*Trapa natans*). A number of woodland species are also found: Scots pine (*Pinus sylvestris*) and lime (*Tilia* sp.).

Overall, the Mid/Late Neolithic has the highest diversity of species at 188, while the Copper Age once again has the lowest at 44 species. The highest diversity of wild/weed species were identified from the Hungarian records for all three periods: 110 from the Mid/Late Neolithic, 22 species from the Copper Age and 149 species present during the Bronze Age (Table 8.6). For the Mid/Late Neolithic, the second highest diversity is seen within the three records from Romania at 41 species. For the Copper and Bronze Age, the Serbian records have the second highest diversity of 22 and 30 species respectively. Once again, the records from Croatia have the lowest species diversity for all three periods.

8.1.5 Formation processes

There has been a long history of tell research within the Carpathian Basin. As many are prominent landmarks, tells are an obvious target for academic research programmes aimed at exploring the lives of prehistoric communities. Settlement occupation at tells are typically concentrated within the confines of the site, with successive generations building upon previous occupation levels. Formation processes at cave sites are similar, with every successive layer of occupation building on the previous. On the other hand, settlement occupation of flat horizontal sites is more dispersed, with only one or two generations occupying the same area. Thus, in Chapter 4 it was suggested that at multi-level tell sites plant material was more likely to be recovered in higher quantities due to the higher concentrations of settlement activities. These factors will therefore need to be considered when interpreting patterns through time.

Of the 169 records, 53 are from tell sites, 3 from caves and the remaining 113 are from flat sites (Table 8.7). During the Copper Age there is a clear decrease in the number of records from tell sites, compared to the Neolithic and Bronze Age. This disparity may make comparisons between the Copper Age and the period before and after difficult. In addition, 106 records contained information about the contexts that were sampled. Figure 8.4, displays the average number of crops recovered from each feature type. The highest numbers of crops recovered are most typically found in ditches, pits and wells, while samples taken from pottery or clay plaster are far more likely to have only a few crop species present. The number and type of features sampled will therefore have a distinct effect on the range of crop species recovered from a site. These factors will need to be considered when examining and interpreting patterns within the archaeobotanical data.

8.1.6 The study sites

With the inclusion of the study sites the number of records recovered from the Carpathian Basin increases from 169 to 190. From the records discussed above it was clear that sites with archaeobotanical remains were extremely rare in Croatia. This study has therefore increased the number of sites identified from Croatia from 5 to 23. In addition, the previous studies were all located along the Dalmatian coast, while the majority of the study sites are located within mainland Croatia, providing for the first time archaeobotanical evidence within this region. The number of crop species previously identified from each period has also increased considerably, from 4 to 14 during the Mid/Late Neolithic, 1 to 14 during the Copper Age and from 8 to 12 during the Bronze Age.

8.1.7 Summary

Overall, a total of 169 records were collected from the Carpathian Basin, increasing to 190 with the inclusion of the study sites. Individual sample information was rare within the published data, with the majority of sites containing only presence/absence and total number of species identified per site. Crop diversity was particularly high during the Mid/Late Neolithic and Bronze Age, especially within Hungary and Serbia. The records from Croatia had an extremely low crop diversity, which was markedly increased with the inclusion of the study sites. Formation processes also differed between sites, with a distinct decrease in the sampling of tell sites during the Copper Age. These patterns will be explored further below in terms of possible regional and temporal similarities and/or differences in the suits of crop grown within the Carpathian Basin.

8.2 Temporal distribution

This section explores possible temporal trends within the archaeobotanical data at the macro level. In order to discuss possible changes in arable farming during Late Neolithic, Copper and Bronze Age on a regional scale, all 190 records, including the 19 study sites, are examined. Due to the paucity of information available per record, a direct comparison between sites and samples was difficult. As a result, the calculation of frequency per sample for each site was not possible. Thus, the frequency of species was calculated per period and per country.

8.2.1 Cereals

8.2.1.1 Emmer, einkorn and barley

The three main crop species present at the greatest number of sites for each period are einkorn, emmer and barley (Table 8.8). Einkorn and emmer remain relatively stable in frequency through all the periods, although there is a slight decrease during the Copper Age, when barley becomes more frequent (Table 8.8). In addition, up to

10% more sites contain emmer grain than einkorn through all three periods; however, at the site level an increase in einkorn over emmer can be seen at a number of sites in the region by the Late Bronze Age, including Feudvar (Kroll 1991a,1998). Within Hungary, Gyulai (2010:103) also noted that there was a shift from emmer to einkorn during the early and late phases at settlements of the Bronze Age Vatya culture.

Of the chaff remains, einkorn and emmer glume bases are the most frequently identified and are present in similar frequencies through the periods; however, there is a clear increase in frequency during the Bronze Age (Table 8.8). Bottema and Ottaway (1982) also noticed this increase at Gomolava and suggested that this may reflect a change in cereal preparation, moving processing activities within the settlements (Bottema and Ottaway 1982). Other activities may also result in a higher presence of glume bases within the settlement, including its use as fuel (including dung) or its collection for animal fodder; however, without a detailed examination of formation processes at each site it is difficult to determine the cause of this increase.

Barley is the next most frequent species identified from the sites. From the Mid/Late Neolithic to the Late Bronze Age barley steadily increases in frequency becoming equal to emmer in presence (Table 8.8). The frequency of barley compared to emmer and einkorn is also greater during the Copper Age. At Gomolava (Serbia), archaeobotanical evidence also shows an increase in barley frequency during the Copper Age, decreasing slightly during the Bronze Age and increasing again during the Iron Age (Van Zeist 2003). Both hulled and naked varieties of barley were recovered from the different periods, although hulled barley was present at over 40% more sites during the three phases. In the Western Mediterranean (i.e. western Italy, southern France and Spain), a shift from naked to hulled barley has been observed during the first phase of the Bronze Age (Bakels 2002). This pattern does not seem to occur in the Carpathian Basin (see 9.1 for further discussion). The presence of barley rachis at the sites is low for each period and is present at only 9% of the total sites in the Carpathian Basin; however, as discussed in previous chapters, the low occurrence of barley rachis may be a result of differential preservation or as a result of formation processes (e.g. crop processing).

8.2.1.2 Spelt, bread/durum and the 'new' glume wheat

The frequency of spelt grain remains relatively low (14-19% of sites) through all three periods and is likely to have remained a minor crop or admixture within the Carpathian Basin. Bread/durum wheat on the other hand, increases in frequency from 19% in the Late Neolithic to 41% in the Bronze Age, suggesting a possible increase in its importance (Table 8.8). This pattern was also identified from the study sites (Chapter 5), has been identified at Gomolava (Serbia) (Van Zeist 2003) and from sites in Bulgaria (Popova 2010). In contrast, bread/durum wheat is largely absent from Greece during the Neolithic and Bronze Age. It is suggested that this shows a clear choice by farmers not to grow this crop or where found, to only grow it on a small-scale (Valamoti and Jones 2003). Van Zeist (2003) suggests that the increase in bread/durum wheat in the Carpathian Basin does not necessarily imply a reduction in land cultivated for the glume wheats but possibly an increase in acreage to support a growing population.

The identification of the 'new' glume wheat (*Triticum* cf. *timopheevi*) is low in the Late Neolithic and is present at only Uivar and Parţa (Romania) and Hódmezővásárhely-Gorzsa (Hungary) (Fischer and Rösch 2004; Medović and Horváth 2011). It is absent from the Copper Age and is only present at Klara Falva (Hungary) and Feudvar during the Bronze Age (Fischer and Rösch 2004; H. Kroll 2010, pers. comm.). New evidence from Croatia has identified 'new' glume wheat glume bases, although in very low numbers. The low frequency may suggest its cultivation as a minor crop, especially during the Late Neolithic, which slowly decreases in importance by the Bronze Age; however, it is difficult to interpret the cultivation of this species as archaeobotanical material identified before 2000, when the identification of this species was confirmed by Jones *et al.* (2000b), will not include this new wheat classification. From the 190 records, at least 70 represent archaeobotanical material identified before 2000.

8.2.1.3 Rye, millet and oat

The presence of rye at the sites is low during both the Late Neolithic and Copper Age, but increases in frequency from 5% to 14% by the Bronze Age (Table 8.8). The increase during the Bronze Age may indicate a shift in the utilisation of this species at the time. At Feudvar, the analysis of crop processing and weed ecology suggests that the large number of possible rye grains (*Secale* cf. *cereale*) may have been a minor crop at the site by the Late Bronze Age. Rye cultivation during the Bronze Age in Europe has been debated and it is not until the pre-Roman Iron Age that evidence of rye cultivation is confirmed (Behre 1992). In Greece, the low presence of rye from the Neolithic to the protohistoric period suggests it was only ever a cereal weed in prehistory (Megaloudi 2006). Rye is therefore a characteristic crop of northern Europe.

The most significant increase in frequency is seen for broomcorn millet (*Panicum miliaceum*) which is present at 17% of the sites/phases in the Mid/Late Neolithic and rising to 38% in the Bronze Age (Table 8.8). This rise was also seen at the study sites, at Gomolava (Van Zeist 2003) and has been observed at sites in Greece (Megaloudi 2006). Its cultivation has been identified at Late Bronze Age Feudvar (Chapter 6-7) and at contemporary sites of Kastanas and Assiros Toumba in northern Greece (Jones 1981; Kroll 1983).

In the Carpathian Basin, domestic oat (*Avena sativa*) is only identified from Late Bronze Age Mačkovac-Crišnjevi (Croatia). The presence of oat spikelets at the site and the clean grain deposits recovered from three separate contexts may indicate its cultivation; however, in Europe domestic oat does not become abundant in the archaeological record until the Roman period onwards (Zohary *et al.* 2012). In Hungary, Gyulai (2010) does not record the presence of domestic oat until the Late Iron Age. In Bosnia, the earliest occurrence has been recorded at the Iron Age site of Pod (Kroll 1991b). The site of Mačkovac-Crišnjevi is therefore anomalous to the region and will need to be investigated further beyond this study.

8.2.2 Pulses

Pulses represent an important crop in most agricultural systems as they help maintain or increase nitrogen in the soil as well as provide an important source of protein for both humans and animals. The most frequently identified pulses from the sites are lentils (*Lens culinaris*) and peas (*Pisum sativum*) (Table 8.8). Both pea and lentil have a high frequency during the Late Neolithic (up to 31%) and Bronze Age (up to 35%); however, there is a considerable drop in occurrence at sites/phases during the Copper Age (*ca.*10%). The largest numbers of lentils recovered are from the Middle Bronze Age sites of Tiszaalpár-Várdomb and Bölcske-Vörösgyír which had over 4,500 and 3,000 seeds respectively and the Late Neolithic site of Battonya-Parázstanya (Hungary) which yielded over 2,000 seeds (Table 8.1d,f). Of the peas the Late Neolithic site of Berettyóújfalu-Szilhalom (Hungary) had over 1,500 seeds, while over 2,700 seeds were recovered from Late Bronze Age Feudvar (FEU079); however, all these sites are multi-level tells which may account for the good preservation of the pulses and explain, to some extent, their decrease during the Copper Age, when tell sites are less common; however, the large deposits found at the sites clearly shows their cultivation, as well as their importance, as a crop from the Late Neolithic to the Late Bronze Age.

The next most frequent pulse is bitter vetch (*Vicia ervilia*) present at 10% of the sites/phases. There is a clear increase in frequency by the Bronze Age with a number of sites from Bronze Age Hungary containing up to 900 seeds. Bitter vetch can be used to feed ruminants such as cows but is harmful to horses, pigs and poultry and, when raw, to humans (Meyer 1980). In Greece Late Bronze Age deposits suggest that bitter vetch was a crop legume for humans, and not just for animals, due to its mode of storage (Megaloudi 2006); however, evidence of bitter vetch cultivation is sporadic in Central Europe and seems to be more frequent in the regions of Anatolia and the Balkans (Zohary et al. 2012:94).

Grass pea (*Lathyrus sativus*) was also identified from Late Neolithic and Bronze Age sites, although less frequently (*ca*.7%) (Table 8.8). Grass pea is consumed by both humans and animals and is a hardy pulse which is resistant to drought, waterlogging, low temperatures and poor quality soil (Gill 1991); however, grass pea is high in neurotoxins which if consumed in high numbers can lead to neurolathyrism (paralysis of the lower limbs) (Piergiovanni *et al.* 2011). Only two large deposits of over 500 seeds were recovered from the Late Neolithic tell site of Battonya-Parázstanya and Middle Bronze Age tell site of Tiszaalpár-Várdomb (Hungary), which could suggest its cultivation during these periods (Table 8.1d,f).

Broad bean (*Vicia faba*) is also historically consumed by humans and animals and today is a primary food source in Egypt and the Sudan (Murray 2000:642). Within the Carpathian Basin only 4% of Mid/Late Neolithic sites have yielded remains of broad bean (Table 8.8). In addition, quantities are extremely low e.g. only one seed was identified at Uivar (Table 8.1d). It is not until the Bronze Age that a clear increase in frequency is seen, rising to 11% of the sites (Table 8.8); however, the quantity of remains is still extremely low compared to the other pulses. For example, the highest number of seeds identified in the region are those from Middle Bronze Age Bölcske-Vörösgyír (Hungary), which yielded only 19 broad beans (Table 8.1f).

Chick pea (*Cicer arietinum*) is a Mediterranean pulse which is absent from the cooler areas of Central and Northern Europe during the Neolithic (Zohary 2012:89). In the Carpathian Basin, chickpea is absent from the sites until the Bronze Age and even then, is only present at the Middle Bronze Age site of Tószeg-Laposhalom (Hungary). In Greece, chickpea is present from the Neolithic onwards, although in low numbers, suggesting that it was unlikely to have been a major crop at the time (Megaloudi 2006).

8.2.3 Oil/fibre plants

Flax (*Linum usitatissimum*) is both an oil and fibre crop and is present at sites from the Mid/Late Neolithic to the Late Bronze Age in the Carpathian Basin (Table 8.8). There is a slight decrease in frequency during the Bronze Age but it is difficult to determine whether this is a result of decreasing importance as a crop or problems with preservation (see 9.1.3 for further discussion). The highest numbers of seeds found in the region were from Late Neolithic Battonya-Parázstanya and Polgar 31 (Hungary), where over 200 seeds were recovered (Table 8.1d). In addition, evidence of flax fibres found at Gyomaendrőd (Hungary) (Gyulai 2010) during the Early Neolithic suggests that flax could have been cultivated for fibre during the Neolithic in the region; however, no large deposits exist from the Late Bronze Age and even at Feudvar only 42 flax seeds were recovered. This may suggest a reduction in its cultivation during the Bronze Age.

Gold of pleasure (*Camelina sativa*) is the second most frequent oil crop in the Carpathian Basin. Although one occurrence has been reported at Tiszapolgár-Csőszhalom (Hungary) during the Late Neolithic (Gyulai 2010), gold of pleasure is not present in the region in quantity until the Bronze Age. For example, over 1,000 seeds were recovered from Bronze Age Židovar (Table 8.1f) and 681 from Late

Bronze Age Feudvar . To the south, the crop has been identified at Copper Age sites such as Pefkakia (Thessaly) (Kroll 1991b), but it is not until the Bronze Age that sites north of the Carpathian Basin begin to show its cultivation, for example in Austria (Kohler-Schneider 2003) and the French Alps (Bouby and Billaud 2005).

Poppy (*Papaver somniferum*) seeds can be eaten or used to extract oil. In the Carpathian Basin, poppy is not identified until the Late Bronze Age at Feudvar (Serbia) and Ludas, Varjú dűlő (Hungary) and then only in small quantities (Table 8.1f); however, it is interesting to note that poppy is recovered from Central European contexts from the Neolithic through to the Bronze Age (Zohary *et al.* 2012:110). This may indicate connections between the Carpathian Basin and Central Europe.

Another plant which can also be utilised for oil is *Lallemantia iberica*, which first appears in the Carpathian Basin in Middle Bronze Age levels at Feudvar (Kroll 1998). This species first appears in Greece during the Early Bronze Age and is believed to indicate long distance contacts with communities in the Near East, where this species originates (Jones and Valamoti 2005). The presence of the seeds at the Greek sites was suggested to indicate its local cultivation as it would have been possible to import just the oil to these sites (*ibid.*). Its presence at Feudvar may therefore suggest the earliest cultivation of this species in the Carpathian Basin.

8.2.4 Wild resources

Wild fruits, nuts and vegetables would have provided an important supplement to the local diet, providing additional flavours and textures to the local cuisine as well as providing extra vitamins and minerals.

8.2.4.1 Fruits and nuts

Within the Carpathian Basin both fruits and nuts are recovered from all three periods, although in varying numbers. Of the fruits, cornelian cherry (*Cornus mas*) has the highest frequency for all three periods being present at 24% Mid/Late Neolithic, 8% Copper Age and 11% Bronze Age sites/phases. The high presence of cornelian cherry was also seen at Neolithic sites in Bulgaria (Popova 2010). Other edible fruits recovered during the Late Neolithic include wild strawberry (*Fragaria vesca*), chinese lantern (*Physalis alkengengi*), sloe (*Prunus spinosa*), dewberry

(*Rubus caesius*), blackberry (*Rubus fruticosus*), elderberry (*Sambucus ebulus*), elder (*Sambucus nigra*), water chestnut (*Trapa natans*), and wild grape (*Vitis silvestris*). This variety is reduced considerably during the Copper Age when only cornelian cherry (*Cornus mas*), crab apple (*Malus sylvestris*), chinese lantern (*Physalis alkengengi*), elderberry (*Sambucus ebulus*) and wild grape (*Vitis silvestris*) are recovered. By the Bronze Age fruit diversity is back to Late Neolithic levels, although recovered less frequently in the region.

Nut remains recovered from the Carpathian Basin consist of hazelnuts (*Corylus avellana*), acorns (*Quercus pubescens*, *Q. robur*, *Q. petraea*) and almond (*Amygdalus communis*). The first three species are found during all three periods, although almond has only been identified within the Bronze Age levels at Grapčeva Špilja (coastal Croatia). Remains of hazelnuts are found predominantly in the Late Neolithic and Late Copper Age, but generally in small quantities (e.g. Late Neolithic Uivar, Romania). The highest frequency and quantity of acorn remains are from the Bronze Age, including a large deposit of 300 *Quercus robur* recovered from a ceramic pot at Carei-Bobald (Romania). The use of acorns as food has been suggested at Neolithic sites in Switzerland (Akeret 2005) and Copper Age sites in Italy (Rottoli and Castiglioni 2009). This large deposit from Carei-Bobald would therefore support the continued utilisation of acorns into the Bronze Age. At the multi-period cave site of Grapčeva Špilja (Croatia), the relatively high recovery of acorns in hearth contexts were also suggested to represent the roasting of acorns for human consumption (Borojević 2008); however, acorns can also be used as fodder (Valamoti 2004:116).

8.2.4.2 Other food plants

The identification of wild/weed species utilised as food or as other resources (e.g. fodder, building material) is difficult, especially as a number of species could also be weeds in crops e.g. *Chenopodium album*. Overall, the Mid/late Neolithic and Bronze Age have the greatest number of wild/weed species recovered, both over 200 species (Table 8.6). The Copper Age once again has a low number of wild/weed species present. Many of the most frequent species recovered from the three periods can be classed as arable weeds including black bindweed (*Fallopia convolvulus*), false cleaver (*Galium spurium*), common wild oat (*Avena fatua*), common knotgrass (*Polygonum aviculare*), green foxtail (*Setaria viridis*) and field brome (*Bromus arvensis*). High frequency species that could also be utilised as food include fat hen (*Chenopodium album*), common chickweed (*Stellaria media*), field mustard (*Brassica rapa*). Fodder crops could also include black medik (*Medicago lupulina*), common vetch (*Vicia sativa*). Of particular note is the large deposit of *Chenopodium polyspermum* identified from Late Bronze Age Feudvar (Chapter 5) which may indicate the deliberate collection of this plant as a food. Wild carrot (*Daucus carota*) was only recovered from the Bronze Age sites of Ludas, Varjú dűlő and Százhalombatta-Földvár (Hungary).

It is difficult to determine the extent to which wild resources where exploited during the three periods. It may be possible to say that during both the Neolithic and Bronze Age, wild resources were likely utilised to supplement the diet; however, the big reduction in presence during the Copper Age may not necessarily suggest a reduction in utilisation, but may result from formation processes during this period and/or poor recovery.

8.2.5 Summary

In summary, the archaeobotanical data reveals a number of patterns in plant utilisation through time within the Carpathian Basin. The three main cereals recovered from the sites are einkorn, emmer and barley. Emmer has the highest frequency during the Late Neolithic and Bronze Age, although there is an increase in einkorn by the Late Bronze Age at many sites. Barley has the highest frequency during the Copper Age. There is a clear increase in frequency of bread/durum wheat, rye and broomcorn millet in the Bronze Age as well as the appearance of new species such as oat, poppy, chickpea and *Lallemantia iberica*. Wild plant resources are common during the Late Neolithic, becoming less frequent during the Copper Age, but become common again during the Bronze Age; however, it is unlikely that the decrease seen during the Copper Age marks a reduction in wild plant resources and is probably the result of poor sampling during this period.

8.3 Regional variation

Choices about what crops to farm and the husbandry methods to employ would have been intrinsically linked with local social, economic and technological factors as well as the local environment. The Carpathian Basin is a large area of *ca.* 300,000 km² and includes a number of micro-climates and environments ranging from flat plains seen in Hungary and eastern Croatia to more mountainous regions seen in Romania and Bosnia. From the available evidence it may therefore be possible to discern whether different suites of crops were grown within different regions of the Carpathian Basin during each period. The regions of each country approximately represent the different climate zones within the Carpathian Basin, dissecting the region into four areas: Hungary to the north, Serbia to the south, Romania to the east and Croatia and Bosnia Herzegovina to the west (see section 2.1 for discussion on environment).

8.3.1 Mid/Late Neolithic

The three main cereals, einkorn, emmer and barley, are present within all five countries, although in varying frequencies. Hungary in particular has the greatest number of sites with archaeobotanical remains, but is also the only area with a barley frequency higher than einkorn and emmer (Table 8.9). In contrast, Croatia and Romania both have high einkorn frequencies, Bosnia a high emmer frequency and Serbia an equal frequency for both einkorn and emmer (Table 8.9).

Many of the records have few archaeobotanical remains that can be used to identify what the major cereals at the site were, if indeed there was one (Table 8.1d). A number of records from Hungary, with over 1,000 cereal grains, are largely dominated by emmer and barley grain (Polgar 31 (POLG31-2), Battonya-Parázstanya (BATPAR-1), Tiszapolgár-Csőszhalom (TISCSO-1)), while in Serbia two of the large tell sites are dominant in einkorn grain (Gomolava (GOMOLA-1), Okolište (OKOLIS-1)). The dominance of emmer in Hungary seems to correspond with LBK settlements in Central Europe at this time, which were also dominated by emmer (Milisauskas and Kruk 1989). The southern regions of the Carpathian Basin also seem to correspond with a dominance of einkorn cultivation in northern Greece in the Late Neolithic (Valamoti 2004:114).

Further differences between the countries and the crops recovered include: 'new' glume wheat, rye and bitter vetch are only present in Hungary, Croatia and Romania. Romania has the only evidence of broad bean, while Hungary has the only evidence of gold of pleasure. On the whole, there seems to be similarities between the types of crops cultivated within all five countries, showing an overall homogeneity in the Carpathian Basin. Although, the quantity of records and archaeobotanical material makes it difficult to fully understand regional differences at the macro and micro level, a preference for emmer and barley may be seen at Hungarian sites, while einkorn may have been preferred further south in Serbia (see 9.1 for further discussion).

8.3.2 Copper Age

There is a clear reduction in the quantity and diversity of crop species seen during the Copper Age within all the Countries except Croatia (Table 8.10). Bosnia Herzegovina has no archaeobotanical evidence from this period, while Serbia is represented by only one record. Hungary once again has a relatively high barley frequency, while Romania continues to have a higher einkorn frequency (Table 8.10). Croatia has an equal frequency for both einkorn and emmer. In addition, rye was only identified in Hungary and Croatia. Chaff remains are extremely low in this period and only Croatia has evidence of the ‘new’ glume wheat.

Records with over 1,000 grains are rare during the Copper Age (Table 8.1e). At Gomolava (GOMALA-2 (Serbia)), einkorn and barley dominant the assemblage while at Budapest, Albertfalva-Kitérő út (BUDALK-1 (Hungary)), einkorn predominates. Whether this shows a move towards einkorn cultivation is hard to say from the small number of sites. Further research is clearly needed for this period.

8.3.3 Bronze Age

The diversity and quantity of remains once again increases during the Bronze Age along with a greater number of records seen for each country; however, Bosnia Herzegovina continues to have no archaeobotanical remains. During the Bronze Age, Hungary continues to have a high barley frequency, followed by emmer and einkorn (Table 8.11). Romania has an equal frequency for barley, emmer and einkorn, while Serbia has an equal frequency for emmer and einkorn remains. Croatia stands out during this period as it has a high broomcorn millet frequency, compared to the other main cereals.

Looking at the individual records with over 1,000 cereal grains (Table 8.1f), Hungary is largely dominated by einkorn and barley (Bölcske-Vörösgyír (BOLVAR-1), Tiszaalpár-Várdomb (TISVAR-1), Budapest, Albertfalva - Hunyadi J. u. (BUDAHU-1), Pécs-Nagyárpád (PECNAG-1)). In Serbia, Early Bronze Age Feudvar (FEUDVA-1) is dominated by emmer, but by the Late Bronze Age the site is clearly dominated by einkorn. Other sites in Romania and Serbia during the Bronze Age also dominant in einkorn grain (Santul Mic (SANMIC-1), Zidovar (ZIDOVA-1)). Within the whole of Europe, Gyulai (2010:100) suggested that during the Middle Bronze Age settlements in the Balkans and East-Central Europe were typically dominated by einkorn, while Central and Western Europe was dominated by emmer. In northern Italy, Bronze Age sites seem to be dominated by emmer (Mercuri et al. 2006), while in northern Greece emmer predominates until the Late Bronze Age when einkorn becomes the most dominant crop (Megaloudi 2006).

Of the other crops, bread/durum wheat increases in frequency in the eastern Carpathian countries i.e. Serbia, Romania and Hungary, while Croatia and Hungary have the greatest pulse diversity including the other evidence of broad beans. Oil plants are only recovered from Serbia and Hungary, including gold of pleasure and poppy.

8.3.4 Summary

The broad overview of the geographic dispersal of crop species in the Carpathian Basin has highlighted a number of regional differences. Hungary, which is characterised by a cooler central European climate, has a particularly high barley frequency throughout all three periods. In addition, Hungary seems to be emmer dominant during the Mid/Late Neolithic, similar to Central Europe and northern Italy, while the southern countries of Romania, Bosnia and Serbia are more einkorn dominant. The difference in crop choice by the farmers in the region of Hungary during this period may represent either environmental or cultural differences from the rest of the Carpathian Basin; however, from the Copper Age onwards, Hungarian records are more dominant in einkorn, similar to the other countries in the Carpathian Basin, possibly suggesting greater cultural links to the region.

Further regional differences may be seen from the high barley and rye frequencies seen from sites in the more northern regions of the Carpathian Basin (Croatia, Romania and Hungary). Bread/durum wheat seems to increase to the east (Serbia, Romania and Hungary). The greatest diversity of species is seen towards the northwest (Croatia and Hungary), although this may be due to the higher number of sites sampled in these regions. New species, such as gold of pleasure and poppy, are only present in the central region of the Carpathian Basin (Hungary and Serbia) and may indicate a corridor through which new species entered and were initially cultivated during the Bronze Age. See section 9.1 for further discussion on cultural and environmental influences on crop choice in the Carpathian Basin.

8.4 Conclusion

Archaeobotanical data were collected from sites located within the Carpathian Basin. In total, 169 records were compiled for the Mid/late Neolithic, Copper and Bronze Age; however, only 4% of the published records contained full sample information (e.g. individual sample data, context, sample volume). The remaining records consisted of presence/absence data and the number of items identified per site. The records were also geographically biased, with 130 records coming from the region of Hungary. Thus, the limited information available and the unevenness of the data restricted the types of analyses that could be conducted, as well as the level of information that can be obtained about agricultural practices from the Late Neolithic to the Late Bronze Age.

Based on the presence/absence data, the records (190 including the study sites) were examined in relation to possible temporal and spatial patterns. Although many of the records contained few archaeobotanical remains and the number of records varied considerably from country to country, a number of patterns were observed. First, emmer was the most dominant crop during the Mid/Late Neolithic, especially in the region of Hungary, while einkorn became more dominant during the Copper and Bronze Age. Second, there is a clear increase in the frequency of bread/durum wheat, broomcorn millet and rye, as well as the appearance of new crops such as oat, poppy, chickpea and *Lallemantia iberica* by the Late Bronze Age. Third, there is a clear decrease in the diversity and quantity of remains recovered during the Copper Age, although this is likely the result of recovery bias and differences in site type (i.e. formation processes and preservation). The following chapter will discuss these results further in relation to the overall interpretation of agricultural husbandry practices within the Carpathian Basin.

Chapter nine
Discussion

From the previous chapter, a number of temporal and spatial patterns were identified in the archaeobotanical remains recovered from the Carpathian Basin. These patterns are discussed here, bringing together all the results, in order to examine the role of agriculture during the Late Neolithic, Copper and Bronze Age. The chapter begins with a discussion on crop choice in the Carpathian Basin and the reasons why certain species may have been cultivated (9.1). This is followed by an examination of cultivation strategies (e.g. diversification and specialisation) (9.2) and crop husbandry practices, in relation to scale and intensity, for each period (9.3). The chapter concludes with a discussion of the role of labour and social organisation, exploring the relationship between agriculture, the household and the community (9.4). Unfortunately, due to restrictions seen within the published data (e.g. small datasets, no sample details) some of the questions discussed below can only be addressed by part rather than all of the dataset.

9.1 Crop choice in the Carpathian Basin

From the evidence discussed in chapter 8, patterns can be seen in the choice of crops cultivated within different areas of the Carpathian Basin during the three periods under study. But what may be the causes of these variations? The following sections will examine this question in relation to the cultivation of einkorn, emmer, barley and gold-of-pleasure.

9.1.1 Emmer versus einkorn

From the previous chapter, regional and temporal differences were seen in the dominance of emmer and einkorn; for example, the preference for emmer in the north of the Carpathian Basin. Emmer and einkorn are the most common crops found in the Carpathian Basin from the Late Neolithic to the Late Bronze Age, but what may have caused these differences? Bias may be seen from the uneven quality and quantity of the data collected from the region; however, both crops are glume wheats and as such are both subject to similar processing sequences and activities. They are both, therefore, just as likely to come into contact with fire and survive in the archaeobotanical record. In addition, many of the sites have samples ranging from a number of different feature types, which would reduce the possibility of single species storage deposits affecting the overall pattern. It is therefore unlikely that preference for either emmer or einkorn in different regions e.g. north and south Carpathian, as well as during different periods e.g. Late Bronze Age, can be explained by depositional bias.

Could environmental factors explain this pattern? Emmer is still grown today in limited areas of Europe. In Italy, emmer is grown in the mountainous areas due to its ability to provide good yields on poor soils and for its resistance to fungal diseases (Laghetti *et al.* 2009). Einkorn, on the other hand, can produce lower yields to emmer but is the most resistant cereal to low temperatures, is better suited to heavy rainfall and is still grown today in harsh environments and on poor soils in southern Italy (Kreuz *et al.* 2005; Laghetti *et al.* 2009). Settlement distribution in the Carpathian Basin shows that there is little difference in the location of the sites from the Late Neolithic to the Late Bronze Age. Most sites are located on fertile soils or along river valleys which would have been productive for both emmer and einkorn. The fact that in Greece archaeobotanical data shows a geological divide between the south, which is dominant in emmer, and the north, which is dominant in einkorn, may suggest that climate could influence crop choice (Valamoti 2004:114); however, this does not explain the dominance of emmer at sites in Bulgaria (Dennell 1978), Hungary, northern Italy and Central Europe. Even today, emmer is grown on poor soils in the sub-mountainous regions of Slovakia, while einkorn is grown in the foothills of the Harghita Mountains of the inner Carpathians in Romania (Hajnalová and Dreslerová 2010).

Cultural preferences may be a more likely explanation for these patterns. Valamoti (2004:115) concluded that cultural factors seemed the only possible explanation for the dominance of einkorn over emmer in northern Greece during the Late Neolithic. The increase in einkorn at sites during the Late Bronze Age has also been attributed to changes in socio-economic factors. For example, Kroll (1983:116) suggested that einkorn, due to its resilient nature, was selected by farmers at Kastanas (Macedonia) to feed a growing population and produce surplus grain for exchange. This site was a large tell site in the region and has similar parallels with the developments seen at Feudvar (Serbia). This period is also characterised by an increase in social stratification, with central places of power and an increase in exchange networks (see Chapter 2). Changes in the cultivation of einkorn at a number of the large tell sites could therefore be linked to these developments; however, when comparing all the sites in the Carpathian Basin there is no clear distinction between the crops cultivated at tell and flat settlements during this period. Despite this, the increase in einkorn cultivation in the Late Bronze Age is likely linked to cultural/social changes in the region, although further work is needed to determine the driving force behind these changes.

9.1.2 The importance of barley

Barley is the third most common crop cultivated in the Carpathian Basin and geographic and temporal differences were also seen in its distribution. For example, the high dominance of barley remains in Hungary and possible changes in the preference of hulled and naked varieties. In Northwest Europe, 6-row barley, together with emmer wheat, are regarded as the main species cultivated throughout prehistory (Harlan 1981; De Hingh 2000:179). Barley can withstand adverse conditions such as poor soils and drier and warmer environments, making them more drought resistant (Zohary *et al.* 2012:52); however, it is worth noting that these characteristics are observed from modern strains. Despite this research does suggest that barley cultivation did increase dramatically at Copper and Bronze Age sites situated within areas of poor soil (e.g. Schmidl *et al.* 2005). Many authors have described a shift in settlement patterns during the Early Copper Age onto 'marginal' soils (Sherratt 1981; Tringham 1992), which may account for the greater occurrence of barley during this period. Within the Carpathian Basin an increase in barley is also seen during the Bronze Age. This pattern has also been observed elsewhere in Europe and the Mediterranean and some suggest that this was related to increased beer making and the use of barley in ceremonies (Milisauskas and Kruk 2011:238). In addition, some suggest that soil exhaustion and the deterioration of the climate may have contributed to diminishing productivity of crops and the increase in barley cultivation could have been a reaction to this. Gyulai (2010:127) suggests that in Hungary, barley may have had a greater adaptability than emmer to changes in the environment which is why it was the main crop cultivated at the time. Thus, barley cultivation could have been grown to increase the reliability of the crop yield, especially in areas where soil and climatic conditions varied.

Both hulled and naked barley are present in the Carpathian Basin. In Europe, naked barley is slowly replaced by hulled varieties by the Bronze Age (Bakels 1991; Helbaek 1964; Hillman 1981; Van der Veen 1992). Few have discussed why this shift occurred. Van der Veen (1992:75) suggests that the preference for hulled barley was likely the result of two factors: climate change and changes in consumption patterns. The first assumes that naked barley grains are more susceptible to increased moisture in the atmosphere and to fungal attack (Van der Veen 1992:74); however, the change to hulled barley does not occur at the same time across Europe and naked barley is still grown in Northwest Europe in the Iron Age (Henriksen and Robinson 1996). Changes in consumption patterns from human to mainly animal fodder may also explain this change as hulled varieties would not need to be dehusked for animals, but would have been a more time consuming variety if used solely for humans (Van der Veen 1992:75). Thus, barley would have been an important human and animal crop, cultivated alongside emmer and einkorn, and whose importance would have been dictated by the socio-economic environment.

In the Carpathian Basin, barley frequency suggests that hulled varieties seem to predominate throughout all three periods in the Carpathian Basin; however, looking at the data per site, the Late Neolithic settlement of Battonya-Parázstanya (Hungary) has the largest number of naked barley grains (2,792 grains) and it is not until the Middle Bronze Age that large numbers of hulled grain are recovered (e.g. 9,320 grains from Bölcske-Vörösgyír, 4,559 from Tiszaalpár-Várdomb and 3,603 from Százhalombatta-Földvár, Hungary). Whether this suggests a growing preference for hulled barley during the Bronze Age is difficult to say, especially as depositional/recovery bias may contribute to the current pattern. The high frequency of hulled barley at the sites from the Mid/Late Neolithic to the Late Bronze Age suggests that the change from naked to hulled is not evident from the current data; however, overall an increase in hulled barley is seen by the Bronze Age indicating a change in consumption patterns, whether that be human or animal consumption.

9.1.3 The introduction of gold-of-pleasure

By the Bronze Age, new species were being introduced and regularly cultivated in the Carpathian Basin. One such species is the oil crop gold-of-pleasure (*Camelina sativa*). During the preceding Neolithic and Copper Age, flax was the main oil crop cultivated, but by the Late Bronze Age gold-of-pleasure seems to become the main oil crop at many settlements (e.g. Feudvar, Židovar and Gór-Kápolnadomb). Although possible bias may be seen from the uneven quality of data collected from the region, both flax and gold-of-pleasure are processed and used in similar ways and have similar properties, making them both highly flammable and therefore both as likely to be found in the archaeological record.

Episodes of climatic change have been recorded during the Copper and later Bronze Age with the potential for increases in drought. Flax grows best on well drained soils, but is particularly susceptible to droughts (Casa *et al.* 1999). Climatic changes may therefore be one factor in the reduced presence of flax at sites after the Neolithic. Gold-of-pleasure on the other hand is far more tolerant of drought conditions (Zubr 1997). With the increase and expansion of exchange networks during the Bronze Age, crops with more suitable environmental tolerances may have been adopted over more traditional varieties. By the Late Bronze Age in Feudvar, when climatic conditions are suggested to deteriorate, gold-of-pleasure is the main oil plant cultivated with only a small number of flax seeds recovered. This may suggest that flax became less popular by this time or was less suitable to the current climatic conditions.

Flax can also be utilised as a fibre crop, which reaches its highest fibre yield about three weeks before the seeds begin to ripen for oil extraction (Meijer *et al.* 1995). If flax were utilised as a fibre crop, the seeds may not have been collected, resulting in their absence within the settlements and the archaeological record. The increased use of flax as a fibre crop has been suggested at later Iron Age sites in Sweden, where the reduction of flax and increase in gold-of-pleasure seeds coincide with the recovery of flax fibres (in waterlogged deposits) and equipment associated with flax retting and weaving (Viklund 2011). Alternatively, some suggest that the size of flax seeds can indicate its use e.g. big seeds are used for oil while small seeds indicate fibre (Zohary and Hopf 2000). For example, at the Bronze Age site of

Archondiko (Greece), Valamoti (2011) suggests that the small size of the flax seeds recovered may indicate a focus on flax fibre rather than oil extraction.

Although no systematic measurements have been conducted on flax seeds from the Carpathian Basin, the decrease in flax seeds by the Late Bronze Age may indicate a change in use of flax to a fibre crop, rather than the abandonment of the crop altogether. In addition, the location of Feudvar Židovar and Gór-Kápolnadomb near water would have facilitated the preparation of flax fibres through retting (where moisture is used to dissolve the ‘glue’ that binds the fibres). The cultivation of gold-of-pleasure does not vary greatly from flax, as they both require relatively small amounts of nutrients, although the type of soil will affect this; however, flax does not compete well with weeds, while gold-of-pleasure can outperform other plants (Budin *et al.* 1995). This would suggest that one of the benefits in cultivating gold-of-pleasure was a decrease in labour costs, as the crop would still produce good yields without weeding.

Therefore, during the Neolithic evidence of flax fibres (*cf.* Gyulai 2010) as well as seeds would suggest flax had a dual purpose at sites. With the introduction of gold-of-pleasure as a new oil plant in the Bronze Age, a shift in purpose may have seen flax being grown more for fibre than for oil. Changes in climatic conditions may have also influenced changes in flax cultivation, especially during the Copper and Late Bronze Age with episodes of drought, which may have considerably reduced flax yields.

9.2 Diversification versus specialisation

Diversification is a strategy that can be used to minimise the risk of crop failure through the cultivation of a wide range of crops with different growing conditions. At the other end of the scale, specialisation is a strategy used to increase production or utilisation of a narrow range of plants or an emphasis on a particular plant within that range (Halstead 1992:106). One aspect of this strategy may be seen in terms of producing specific surplus goods for exchange and would suggest the presence of a redistributive system or market; however, specialising in a narrower range of crops increases the risk of food shortage if a poor harvest occurs.

The level of diversification and/or specialisation practised in prehistoric farming economies has been widely discussed (e.g. De Hingh 2000; Halstead 1992; Hansen 1988). In Europe and the Mediterranean, specialisation in the production of a particular crop has been attributed to the development of complex societies and social stratification (e.g. Brumfiel 1987). Discussions on specialisation in agriculture have also been largely centred on Bronze Age Greece and the emergence of palatial economies (Halstead 1992). Archaeobotanical studies have shown that a diverse range of species were exploited in the Greek villages but that only a small part of this range was utilised by the palatial centres (Halstead 1999, 1990, 1995a). Within the written records these centres focus almost exclusively on one species of wheat, while the other crops were produced independently of palatial control (Halstead 1992a:113).

The identification of specialisation at a prehistoric settlement has proven to be difficult from archaeobotanical remains. In the past, authors have identified specialisation within the archaeobotanical record through the detection of consumer and producer sites (Hillman 1981; Jones 1985) or from the identification of crop purity within storage contexts (e.g. Dennell 1976; Jones *et al.* 1986); however, models used to detect producer and consumer sites have since been rejected (see Jones 1987; Van der Veen 1992; Van der Veen and Jones 2006 for discussion), while the detection of an overrepresented ‘pure’ crop is difficult due to formation processes and recovery bias. In addition, the production of a small surplus is likely to have been a standard precaution against the risk of crop failure and not an indication of specialised production *per se*.

In contrast, diversification is a technique that can be used to help reduce risk of crop failure, especially during periods of climate change (Halstead 1990, 1995). This regime would allow individual households to be more independent, and less reliant on the state during a poor harvest, as it allows a wide range of crops to be cultivated. Diversification is usually associated with more intensive regimes (e.g. more labour input per area), although, some suggest that an increase in crop diversity may also indicate an increase in agricultural production (Kreuz and Schäfer 2008).

Without examining each site individually, it is difficult to determine whether evidence of specialisation may have existed in the Carpathian Basin during the study period. The rise of large tells in the region has been documented for both the Late Neolithic and the Late Bronze Age, which may indicate centres of distribution and central control (see 9.4); however, from the archaeobotanical remains there is little difference between the range of crops cultivated at tell and flat settlements in the Carpathian Basin during the Late Neolithic and the Bronze Age. In addition, the site frequencies show that both the Late Neolithic and Bronze Age contained a wide range of crop species; however, calculating the average number of crops recovered per site produces an average of 4 for the Mid/Late Neolithic and Bronze Age and 2 for the Copper Age. Although the standard deviation was relatively low, ranging from 2.5-3.4, the low averages most likely result from poor recovery than an accurate estimation of crop diversity.

At a number of sites such as Late Neolithic Uivar and Late Bronze Age Ludas, Varjú dűlő, up to 12 crop species were identified. In addition, during the Late Neolithic diversification extended to the exploitation of wild resources, while in the Bronze Age diversification was primarily seen within the crops, although a number of wild species were also found in the assemblages (Chapter 8). Crop diversity is low during the Copper Age, although, this may be a result of preservation and recovery bias than a change in agricultural practices. In addition, during the Copper Age the climate began to deteriorate, settlements became smaller and more dispersed, and animal husbandry is believed to have become the main agricultural economy. In this environment specialising in only a small range of crops would have been risky.

The increase in diversity seen here during the Bronze Age has been linked with the introduction of new crop species within the Carpathian Basin. Gyulai (2010:127) suggests this was connected to a demographic explosion and increased migrations that occurred during this period, especially within the regions of the Urnfield Culture. This increase in diversification and the cultivation of new species during the Bronze Age has also been observed in Central Europe (Bakels 1991; Kroll 1997) and the Mediterranean (Halstead 1994). Zooarchaeological evidence also shows that a wide range of livestock was also kept from the Late Neolithic to the

Bronze Age, mirroring the crop husbandry methods (Halstead 1994:201). Although diversification may therefore be seen within the overall assemblage, at the site level some show a high dominance of a particular crop, which may suggest a slight shift towards specialisation. For example, at Feudvar (Serbia) and Kastanas (Macedonia) the Late Bronze Age assemblage is dominated by einkorn; however, at both sites a wide range of other crops are also cultivated suggesting that diversification was still the major strategy performed during this period. Further research at the site level is therefore important to understanding these possible strategies.

9.2.1 Summary

From the available archaeobotanical data it is difficult to examine possible differences in specialisation and diversification without detailed site/sample information and representative quantities of archaeobotanical remains. From the presence/absence data, diversification seems to be the main strategy used in both the Late Neolithic and Bronze Age in the Carpathian Basin. Whether this strategy occurred in the Copper Age is still hard to assess from the available data, but similarities in the datasets from the Neolithic may suggest a continued practice of diversification into the Copper Age.

9.3 Reconstructing crop husbandry regimes in the Carpathian Basin

The scale and intensity of food production is a key aspect in interpreting agricultural regimes. Different strategies exist for a farmer to adopt, depending on local circumstance, such as land availability, population pressure, labour availability, the local political system and the opportunity to exchange. In addition, a large number of more specific agricultural variables, such as the types of primary crops cultivated, the presence of livestock, the use of specified tools, climate, topography, soil conditions and the application of cultivation techniques (e.g. weeding, manuring) will also impact on the cultivation methods implemented.

The use of either ‘intensive’ or ‘extensive’ crop husbandry regimes can be used alongside other strategies of diversification or specialization. ‘Intensification’ can be a nebulous term but it is usually used to describe a process where a high input of resources into a given area of land, e.g. labour, manure, irrigation, results in high area yields (Bogaard 2004; Hunt 2000; Van der Veen 2005). De Hingh suggests that, “intensive systems are not only those with a higher output from the same amount of land by means of more input of labour or other resources, but also those with a consistent agricultural production from a smaller plot of arable land (e.g. a relative increase per unit of land) with a constant input of labour” (De Hingh 2000:43). Van der Veen (2005) warns against confusing the term ‘intensification’ with the word ‘expansion’, where ‘intensification’ means the increased productivity of an area, whereas ‘expansion’ is used to describe an increase in the area of land under cultivation. Extensive cultivation involves smaller inputs per unit area resulting in smaller area yields. This regime tends to use larger areas of land which produces a higher output average per person (Van der Veen 2005).

9.3.1 Models of intensive and extensive cultivation

Four main methods of crop cultivation have been suggested for Neolithic and Bronze Age Europe. The first two, shifting cultivation and extensive ard cultivation, are less labour intensive regimes, while floodplain horticulture and garden cultivation are far more labour demanding.

Shifting or swidden cultivation involves the cultivation of new land for short episodes and then abandonment. The advantage of this method is that it requires less labour than more intensive methods, with the expectation of relatively high yields due to the growing of crops on fallow soil; however, this regime is typically associated with small populations living in semi-permanent settlements and large areas of land will need to be available to move cultivation plots annually. This method of cultivation in prehistoric Europe is highly debated. Previous theories suggest that Early Neolithic communities adopted this method of cultivation due to the semi-permanent nature of the settlements (Childe 1929; Conklin 1961; Schier 2009). More recently, this argument has been used to suggest evidence of shifting cultivation at Bronze Age sites in southern Italy (Attema *et al.* 2011:74). Evidence of deforestation, forest regeneration and burning, have also been used as evidence of shifting cultivation in both the Neolithic and Bronze Age (Berglund 1991:129-130; Gerittsen 2002; Rösch 1996:228); however, some authors refute the practice of swidden cultivation in prehistoric societies in Europe based on ecological potential and actual archaeobotanical evidence (e.g. Bogaard 2002a, 2005; Jones 2005;

Sherratt 1980). For example, recent archaeobotanical studies examining weed functional attributes also point to regimes of permanent intensive garden cultivation (cf. Bogaard 2004). In addition, Van der Veen (2005) suggests that shifting cultivation is a tropical regime adapted to particular ecological characteristics and is therefore ecologically unsuited to most of Europe.

Garden cultivation has been interpreted as a small-scale intensive regime where plots are watered, weeded and/or manured (for further discussion see Bogaard 2004; Van der Veen 2005; and Jones 2005). The advantage of this method is that high yields can be attained from an increased input (e.g. weeding, fertilising, watering) per area and is suited to the cultivation of greater diversity of crops. In addition, this method of cultivation is relatively flexible as a variety of different intensive practices can be applied in any combination; however, this method is labour intensive, so the area of land that can be managed depends on the availability of labour during the year. This type of regime has been identified from archaeobotanical remains from Early Neolithic Bandkeramik sites in Central Europe (Kreuz and Schäfer 2011), from Neolithic sites in the loess belt and Alpine foreland (Bogaard 2004) and is suggested to be the main cultivation regime in Neolithic Greece (Halstead 1981:319).

The exact meaning of the term ‘garden’ is debated. A ‘garden’ for example could imply a small plot (Van der Veen 2005); however, recently Kreuz and Schäfer (2011) suggested that up to 5 ha, around five football pitches, would have been needed to support a group of 10 people. This is much larger than the implied ‘garden’ plot. Calculations of plot sizes do vary, as they depend on multiple factors such as crop yields and soil fertility. For example, Hillman and Davies (1990: Table 1), estimated that on average 0.75ha would be needed to feed 5 people for a year based on an average wheat yield of 500kg/ha. Some suggest yields of up to 1,000 ha/kg (e.g. Lüning 1979/1980; Gregg 1988) or even 1,700-1,900 ha/kg (Charles *et al.* 2002) can be achieved through past intensive regimes. Thus, if the yield was higher at around 1,000 ha/kg, then, according to Hillman and Davies (1990) only 0.4ha of cultivated land would be needed. These calculations are, however, based on grain providing just 25% of a person’s calorific requirements (Hillman and Davies 1990). Historical studies on the daily standard rations of Athenians during the 5th-4th

centuries BC have shown that cereals supplied 70-75% of their caloric intake (Foxhall and Forbes 1982). If Hillman and Davies' calculations are increased to 75% then an average of 1.15ha may be expected to feed five people, if the wheat yield is at 1,000kg/ha.

Another intensive regime is that of floodplain horticulture, which utilises the seasonal re-fertilisation of soils from flooding to grow crops (Sherratt 1980). The benefit is that soil fertility can increase with little input, producing good crop yields. Some argue that the location of Neolithic settlements along the river and creek systems would support the utilisation of these alluvial areas for cultivation (Kosse 1979; Roberts and Rosen 2009; Sherratt 1980); however, this method is geographically restricted to floodplains and would require the crops to be grown in the summer to avoid winter flooding. In addition, this regime is reliant on flooding patterns, which are likely to fluctuate. This regime is well suited to areas of low-rainfall such as in southern Greece or areas of the Near East (Bintliff *et al.* 2006), but may be less beneficial when applied to the Carpathian Basin where large areas of fertile soils exist.

During the Late Neolithic extensive ard cultivation is suggested to have developed (see 'secondary products revolution', Chapter 2). As already discussed this method allowed greater areas of land to be cultivated in a shorter time by harnessing animal power; however, this method is an extensive method resulting in lower yields per area. The majority of evidence for ard cultivation comes from animal depictions and animal pathologies showing evidence of heavy pulling, although plough marks have been found in North-West Europe from the Late Neolithic onwards (Chapter 2). Little evidence exists for the identification of extensive ard cultivation from the arable weeds at this time (e.g. a possible increase in winter annuals and a decrease in nutrient loving species). The use of ard cultivation has also been associated more with large-scale farming, where surplus crops are needed to pay taxes etc., rather than a method used by single households to feed the family unit (Halstead 1995b).

9.3.2 Sowing times

Research into the sowing times of crops in prehistoric Europe is widely debated. Hillman (1981:147) suggests that all cereals were initially autumn-sown, similar to their wild predecessors, as well as producing the greatest crop yields. He suggests that minor crops may have been spring sown, reducing the burden on winter cultivation or if the local environment would hinder autumn-sown crops e.g. harsh winters, flooding etc (*ibid.*). In Central Europe, research has largely supported the autumn sowing of crops during the Neolithic (Bogaard 2004; Willerding 1980); however, recent research suggests that einkorn and emmer could have been spring sown at a number of early Neolithic Bandkeramik sites (Kreuz and Schäfer 2011).

Typically, researchers have inferred summer sowing from the high incidence of Chenopodietea (mostly summer annuals) within cereal remains; however, Jones (1992) suggests that the large numbers of Chenopodietea weeds found within crop stores at the Late Bronze Age site of Assiros Toumba reflects the use of an intensive garden regime (e.g. weeding). This is further supported by the Evvia study which showed that garden plots were consistently rich in Chenopodietea, while extensive field plots were generally rich in Secalinetea weeds (Bogaard *et al.* 2000). Alternatively, Willerding (1981, 1986, 1980, 1983), proposed that Chenopodietea species reflect an 'open' stand of autumn-sown crops sown in rows which allow root/rowcrop weeds to germinate in the gaps and compete with the established plants.

Evidence of cereal sowing times during the Neolithic is rare in the Carpathian Basin. The earliest evidence of possible autumn-sown einkorn, emmer and barley is seen at the Early Neolithic site of Ecsegfalva 23 (Bogaard *et al.* 2007). At Late Neolithic Opovo, the presence of both spring and autumn germinating weed species suggested that einkorn was a winter crop, while barley, emmer, lentil and flax was grown in the summer (Borojević 2006:162); however, the high association of summer annuals with barley and emmer at Opovo may result from an intensive cultivation regime, rather than evidence of spring sowing. No evidence is present on sowing times from the Copper Age and it was not possible to identify sowing times from the Croatian sites, due the low quantity of cereal and weed remains.

During the Bronze Age archaeobotanical remains from Hungary suggest that wheat (einkorn, emmer and bread wheat) was autumn-sown, broomcorn millet was spring sown, but barley could have been either autumn or spring sown (Gyulai 2010). For example, at Late Bronze Age Mosonmagyaróvár-Németdőlő and Dunakeszi-

Székesdűlő (Hungary), weed associations identified autumn-sown emmer, bread wheat and barley and spring sown broomcorn millet and possibly barley (Gyulai 2010:132-3). Generally, this corresponds to the results from Feudvar, which suggest that einkorn, emmer and barley were sown in autumn, while broomcorn millet may have been spring sown (7.5.2.2). It is therefore likely that the wheats (einkorn, emmer and bread wheat) were typically autumn-sown and broomcorn millet spring sown in the Carpathian Basin. Evidence for barley cultivation varies, suggesting that both autumn and spring sown varieties were cultivated during the Bronze Age. More research is needed to determine the sowing pattern of barley in the region.

9.3.3 Mid/Late Neolithic crop husbandry regimes

Resent research suggests that small-scale intensive cultivation was the major method employed in Neolithic Europe (see above 9.3.1). Evidence from Bulgaria (e.g. Marinova 2006) and Greece supports this, however, the reconstruction of agricultural regimes from archaeobotanical data in the Carpathian Basin is lacking. The earliest and only evidence of intensive garden agriculture from archaeobotanical remains in the Carpathian Basin is from the Early Neolithic site of Ecsegfalva 23 in Hungary (Bogaard *et al.* 2007). From this study evidence suggests autumn-sown crops were intensively cultivated in permanent plots close to the settlement (Bogaard *et al.* 2007:441). In addition, evidence of autumn sowing of crops would suggest that floodplain cultivation was not the main method used at this time.

Previous interpretations by Chapman (1981:92-4) suggested that ard cultivation may have developed at some of the large Late Neolithic Vinča sites, as an ard would have been needed to utilise the fertile chernozem soils in the region. More recently, archaeobotanical evidence from Late Neolithic Opovo has suggested a regime of crop rotation and fallowing (Borojević 2006:162). Fallowing is, however, an extensive method which requires a greater amount of land than intensive cultivation. One advantage of leaving fields fallow is that it could have provided grazing land for domestic livestock (Valamoti 2004:130), which would have increased soil fertility from the animals manure.

From the study sites and the current archaeobotanical data, it is difficult to determine whether small-sale intensive agriculture occurred. The permanent nature of the settlements (e.g. Sopot, Croatia, where over 1,000 years of occupation is recorded) and the suggested cultivation of a diverse range of crops may support the application of a small-scale intensive regime; however, there is no adequate archaeobotanical evidence to support this. There is no evidence of crop specialisation at this time, which could be linked with extensive ard cultivation. Further research is clearly needed for the Neolithic.

9.3.4 Copper Age crop husbandry regimes

The increase in barley during the Copper Age has been attributed to a change towards cattle herding and a semi-sedentary life. The low recovery of crops in Hungary during the Early Copper Age has also been attributed to agriculture becoming less important (Gyulai 2010:82). Further suggestions include climate change (e.g. onset of sub-boreal) and soil deterioration, as reasons for the development of animal husbandry at the expense of arable farming (Gyulai 2010; Kosse 1979); however, a number of points can be made to contest these theories. First, the low number of sites and samples that have produced archaeobotanical remains make direct comparisons between the Late Neolithic and the Early Copper Age difficult. Thus, the reduction in quantity and diversity of species may simply be a result of sampling bias and not a change in husbandry practices. Second, the archaeobotanical results from Croatia show a continuation in the crops cultivated from the Late Neolithic through to the Late Copper Age. It is possible that socio-economic developments in the region of Croatia differed slightly from the rest of the Carpathian Basin; however, if climate change and soil deterioration were major contributors to changing practices during the Copper Age then eastern Croatia is also likely to have been affected.

From the study sites and the current archaeobotanical data from the region, it is not possible to determine the type of cultivation regime practised. The wide variety of crops present at Copper Age sites and the permanent nature of these settlements may indicate continued importance of agricultural practices, similar to the Neolithic, rather than a shift towards pastoral economies, and may suggest a continuation of intensive small-scale cultivation. Identifying a shift in agricultural focus, however, may be difficult to discern from the archaeobotanical data, as the reduced farming population may continue to use intensive practices as a response to less land being cultivated. Alternatively, with a decrease in agricultural importance, labour availability may also reduce, resulting in a need to implement an extensive regime. Further archaeobotanical investigations are clearly needed to determine whether there is indeed a change in subsistence practices during the Copper Age.

9.3.5 Bronze Age crop husbandry regimes

As with the other periods little research exists on reconstructing crop husbandry regimes for the Bronze Age in the Carpathian Basin. From archaeobotanical remains recovered from Middle Bronze Age settlements in Hungary, Gyulai (2010:106) suggests that areas were cleared and both autumn and spring crops were cultivated until the soil was exhausted, then left fallow. This would suggest a form of extensive agriculture was practised at Bronze Age sites in Hungary. In addition, the continual recovery of pea and barley in Bronze Age levels in Hungary has been suggested to represent evidence of crop rotation at some sites (Gyulai 2010:102). At the Bronze Age site of Ganglegg (northeast Italy) analyses of the arable weeds showed that a crop rotation system was practised within a 500m radius of the settlement (Schmidl and Oeggl 2005). This involved the summer growing of broad bean (*Vicia Faba*), pea (*Pisum sativum*) and broomcorn millet (*Panicum miliaceum*), while barley was sown in the autumn. The increase in bread wheat, which is a more demanding crop in relation to soil moisture and fertility, by the Bronze Age has also been attributed to agricultural techniques such as crop rotation (Hansen 1988).

As no other reconstructions have been published for this period, the results from Feudvar provide the best evidence of crop husbandry regimes in the region (Chapter 7). From the analysis of weed ecology at the site two different crop regimes were identified, where barley was cultivated under a more extensive regime and einkorn, emmer and broomcorn millet were cultivated more intensively. Although, no physical evidence exists in the archaeological record, the use of an ard at Feudvar would have reduced labour costs while preparing the soil for sowing and would have allowed greater areas to be cultivated. The possible use of an extensive regime for the cultivation of barley does not necessarily indicate ard cultivation; however the large permanent settlement of Feudvar, as well as the possible socio-economic environment (e.g. centralisation of power that controlled the redistribution of resources), could have made the keeping of oxen more economical or socially significant (in relation to settlement hierarchies). The association of extensive ard cultivation, however, with large palatial centres dating to the Late Bronze Age in southern Greece, showed a preference for the growth of one type of cereal (Halstead 1995a). The rest of the population in Bronze Age Greece is suggested to have practised intensive garden cultivation (*ibid.*). Although storage is discussed below, many of the palatial centres show the storage of large quantities of mainly emmer within spikelets, as well as the storage of a range of legumes such as broad bean, lentil and pea (Halstead 1992). It is suggested that these central authorities would have provided risk-buffering assistance to small-scale farmers or could have offered them access to inputs/resources, e.g. capital and/or labour (Halstead and O'Shea 1989); however these palatial economies do not seem to extend into northern Greece. For example, at the large Late Bronze Age tell site of Assiros Toumba (Macedonia), intensive garden cultivation was identified as the main cultivation regime used at the site (Jones 1992). Parallels between Feudvar and northern Greece may therefore me more likely, than with the palatial centres of southern Greece, especially as a wider range of crops seem to be cultivated and stored at Feudvar.

Patterns have also been observed between the scale of intensity and the location of fields to the settlement. For example, under intensive gardening regimes, plots are usually less than 1 km from the village boundary, with the majority being located within 500 meters of the settlement (Charles *et al.* 2002; Jones *et al.* 1999; Jones 2005). On the other hand, people using extensive cultivation regimes have to travel up to 4km away from the settlement (Charles *et al.* 2002; Jones *et al.* 1999). At Feudvar, the introduction of more extensive regimes may have seen an increase in the cultivation of fields within the greater environs of the settlement. Einkorn, emmer and millet on the other hand, which were cultivated more intensively, could have been cultivated closer to the settlement, likely on the well drained chernozem soils of the Titel plateau.

9.3.5 Summary

In summary, through the examination of all the archaeobotanical data from the Carpathian Basin, the majority of cereals, based on general ecological plausibility, were likely autumn-sown with the exception of broomcorn millet which was probably a summer crop. Small-scale intensive cultivation was likely the main crop regime practised during the Neolithic, Copper and Early Bronze Age; however, by the Late Bronze Age, some crops (particularly barley) may have been cultivated more extensively (e.g. less labour input per area), possibly linked to population increases and the development of regional centres. The following section will discuss this further in relation to labour and social organisation.

9.4 Labour and social organisation

The evidence above has outlined a series of agricultural strategies and practices implemented at settlements during the Neolithic – Bronze Age. This next section will discuss how these agricultural methods may relate to activities conducted by the farmer and whether community activities can be deduced from the archaeobotanical evidence.

Agricultural production is frequently associated with the development of social complexity, surplus production, labour mobilisation and 'cash' crops (Fuller and Stevens 2009). Boserup (1965:72) suggested that land productivity in traditional agricultural societies is limited not by how much food it can grow, but by how much labour is available in the harvest season. In addition, the harvest season is invariably associated with labour shortages (the high-season bottleneck on production), while there might be labour surplus during the low season (*ibid.*).

Based on general analogies and ecological plausibility with other sites in Southeast and Central Europe, agricultural regimes indicate intensive garden regimes were predominantly practised during the Neolithic and Bronze Age. This regime requires a large about of labour input through the growth season, including the weeding and manuring of the plot. By the Late Bronze Age a greater differentiation in crop treatment occurred (e.g. more extensive crop husbandry practices or infield versus outfield cultivation), suggesting a reallocation in labour input per area. The use of extensive methods can allow greater areas of land to be cultivated; for example, Borojević (2006:151) calculated that to hand till 1.5 ha, 600 hours would have been required for one individual and households would have probably exchanged labour during these periods to accomplish the work. The introduction of the plough would have reduced this time considerably (up to 15x faster), requiring less labour and therefore reducing one of the main labour bottlenecks in the agricultural year (Halstead 1995); however, with the adoption of the plough, labour demands could in fact increase during the harvest season as more land is cultivated. In addition, the adoption of the plough has been linked to social complexity and the development of land ownership or rights (Sherratt 1981; Thomas 1997).

Whether intensive or extensive agriculture was implemented, household and community cooperation would have been an important part of life, possibly leading to periodic gatherings and feasting. Evidence of feasting is rare in the Carpathian Basin. At Late Neolithic Opovo (Serbia), feasting has been inferred from the animal bones recovered from pits suggesting prestige was gained through hosting a feast (Borojević 2006:152). This has parallels with Neolithic Greece, where evidence of large-scale feasting suggests these activities were a regular social event (Halstead 2004). At Makriyalos, for example, a substantial deposit of animal remains was found, most likely deriving from large-scale feasting on domestic animals (Pappa *et al.* 2004); however, no further feasting evidence is found in the Carpathian Basin during the study period and no archaeobotanical remains suggest such activities occurred. Regardless of this, the need for social cohesion makes it likely that households would have gathered to maintain and strengthen social ties. By examining crop processing activities as well as storage strategies, it may be possible to elucidate further on the relationship between the farmer and his community.

9.4.1 Crop processing activities

Although few studies have focused on social organisation from the archaeobotanical evidence, the social impact of crop processing on communities and individual households would have been significant. As the harvest period is referred to as a labour bottleneck, large groups of mobilized people can get more of the crop processed and stored, while the seasonal demands on smaller groups will make it more efficient to store the crop less processed and carry out the full processing sequence on a day-to-day basis. Thus, storage of semi-clean spikelets will create a great demand on labour after harvest and prior to storage, but less demand through the year (Fuller and Stevens 2009). Those storing relatively unclean crops (e.g. partially threshed ears) will have less intensive demand on labour in summer but routine ‘daily processing’ will consume more time. Thus, those storing crops with little to no processing will be able to perform harvesting and perhaps preliminary threshing and raking within just the nuclear household (Fuller and Stevens 2009).

Crop processing analysis in the Carpathian Basin is rare as samples are usually not rich enough in crops and weeds to allow statistical analysis. Thus, the analysis of crop processing at Feudvar provides important information about crop processing activities for the region. By the time the crops reach the settlement at Feudvar, the crops have already been threshed and winnowed. As already mentioned this would create a high labour demand at harvest. The subsequent choice of whether or not to sieve before dehusking (glume wheats) may result from a number of factors including climate, time, and labour availability. As both types of remains are present and no discernible pattern can be seen between the features and areas of the trench, it is unclear whether these differences occur as a result of different family groups; however, as sieved spikelets are present within the assemblage it is clear that in certain years the time was taken to sieve the crop before dehusking.

At Early Bronze Age Albertfalva, soil samples taken from two ‘workshops’ contained remains of threshing waste (of mainly einkorn and emmer), including a high number of weed remains. It was suggested that threshing took place in a single process and the by-product was then used as fuel (Gyulai 2010:94). At the Middle Bronze Age site of Százhalombatta-Földvár (Hungary), crop processing waste was identified outside the houses, while inside the houses different stages of crop processing seemed to correspond with different areas. For example, in the central and southern end of the houses the final cereal cleaning was carried out, while only cleaned grain (final products) were recovered from areas with hearths (Berzsenyi *et al.* 2010). Later stages of crop processing are also evident within the houses at Feudvar, where remains of spikelets, fine sieving by-products and products were identified (Chapter 6). In addition, sieved samples occur more regularly in the southern half of the ‘fish’ house, which may suggest similarities between the two sites. At the Bronze Age site of Túrkeve-Terehalom (Hungary), stored cereal remains (mainly einkorn and emmer) were also identified with a number of wild weed seeds (Gyulai 2010:104). This may show similarities with Feudvar, where the cereals are not fully sieved before storage, but sieved piecemeal when required. This would suggest that the later stages of crop processing during the Bronze Age were household activities.

Evidence of the creation of products for exchange is difficult to identify in prehistory. Although some authors have suggested models to identify producer and consumer sites from archaeobotanical remains (*cf.* Hillman 1981, 1984a, Jones 1985), these have now been largely rejected (*cf.* Jones 1987a; Van der Veen 1992; Van der Veen and Jones 2006). Evidence of surplus grain production in Britain is not identified until the Iron Age, when large storage pits and four-poster granaries are recognized at hillforts and then later when large granaries are seen in the Roman period (Van der Veen and O’Connor 1998). Although a thorough discussion on the intricacies of social stratification in the Bronze Age is outside the remit of this study, politically the large Mid/Late Bronze Age tells in Southeast Europe have been typically associated with central places of power, distributing goods to smaller settlements within the region (*cf.* Kristiansen 2007; Gogâltan 2008; Artursson 2010:106).

9.4.2 Storage

Storage can also represent a dividing point between bulk processing after harvest and 'daily' routine processing (Fuller *et al.* in press). After harvest, crops must be processed quickly in order to ensure dry storage. Hillman (1981) suggested that differences in storage patterns in modern Turkey were based on whether farms occupied wet or dry regions. As such the number of dry days would limit the amount of processing necessary to ensure that crops are stored dry; however, these patterns did not correspond to those observed at both modern and archaeological sites in Greece (Jones 1984; 1987). It is therefore suggested that these differences are unlikely to be climatically orientated, but may indicate differences in cultural practice and an ability to organise large numbers of people for agricultural purposes (Fuller and Stevens 2009). The storing of grain within pits in houses has also been seen experimentally to be the most successful way to protect the pits from temperature and rain damage (Reynolds 1974).

Storage, along with diversification and exchange, is another mechanism to buffer against seasonal and/or long-term variability in the food supply, allowing the year round occupation of a site (Halstead and O'Shea1989). A number of storage systems have been identified ranging from the household to the regional level. The level of storage is linked to the relationship between the farmer and the socio-economic structure in place. For example, the farmer would need to ensure that he has enough food for his family, as well as surplus for the community or state. Therefore, the location of storage inside or outside the house or the desire to use communal storage is also related to the social and economic organisation of the site as a whole (Halstead 1999).

Evidence of storage at archaeological sites is usually inferred from concentrations of plant remains and/or built storage facilities (Bogaard *et al.* 2009). The presence of storage facilities have been identified at a number of Neolithic sites such as Çatalhöyük, Turkey (Bogaard *et al.* 2009), Slatina and Kapitan Dimitrievo, Bulgaria (Marinova 2007), and a storage jar found at Hódmezővásárhely-Gorzsa, Hungary (Medović and Horváth 2011). The location and size of storage facilities can also reveal household behaviours e.g. domestic storage for domestic use, external storage for communal use or excess goods for exchange. For example, one person on average needs at least 300 litres of grain per annum (Unger 1999) so a small family of 5 would need at least 1,500 litres of grain.

In prehistory, the layout of settlements including the location of storage pits, hearths and wells can also be used to infer social organisation and the storage system implemented. During the Mid/Late Neolithic in Southeast Europe, house clusters have been identified with their own cooking and storage facilities suggesting these activities occurred within individual households (Sherratt 1982; Whittle 1996). At Late Neolithic Sopot, the well preserved remains of house 23 shows no evidence of storage pits within the structure, although large vessels ("buda" type), that could have been used for storage, were recovered (Krznarić Škrivanko 2003). During the Copper Age, some have suggested that the remains of storage and cooking facilities located outside the houses indicate communal activities and a shift towards integrated settlements and household specialisation (Bognar-Kutzian 1972; Parkinson *et al.* 2002-4); however, at Copper Age Vučedol, over 20 houses were excavated along with external pits (Forenbaher 1995). It was argued that each house was associated with two external storage pits, representing a household cluster, similar to sites in the Late Neolithic (*ibid.*). Storage within the house has been identified at the Copper Age settlement of Đakovo-Franjevac, where carbonised remains were recovered from large storage pits within the southern end of a number of supposed pit-dwellings (Balen 2011:86). Some of these pits were later used as refuse pits or places for burying the dead or ritual animal offerings (*ibid.*).

During the Bronze Age in Hungary, some have noted that houses of the Early Bronze Age Nagyrév phase had storage pits placed outside the houses; however, by the Middle Bronze Age Vatya phase, storage pits are located within the house (Sofaer 2011). This widespread change suggests a collective agreement to change the domestic space to one of a more private storage within the home, where a greater amount of control of resources may be achieved (*ibid.*). At the Middle Bronze Age site of Százhalombatta **(**Hungary**)**, clay storage bins were excavated against the walls of the houses (Sofaer 2011; Sørensen 2010). The excellent preservation at the site also showed the internal organisation within the houses where storage vessels were placed near the ovens and storage pits were located in the centre of the house. The storing of plant remains in vessels is also seen at the Middle Bronze Age settlement of Füzesabony, where carbonised remains were recovered from within a number of pots (Gyulai 2010:107). The recovery of a relatively clean sample of two-grained einkorn, in spikelets, found scattered around a pot at Feudvar suggested the utilisation of vessels as house storage (Kroll 1992).

Work by Jones (1987b) on two Bronze Age sites in Greece, identified two different storage practices. At Assiros (Greece), large long-term storage was suggested of semi-cleaned spikelets, which potentially provided grain for up to 20 people. On the other hand, at the Unexplored Mansion (Knossos), grain was clean of weeds and located in a smaller store room, potentially providing grain for 2 or 3 people. Jones (1987b) suggests that at the Unexplored Mansion a full range of processed plants were stored prior to their preparation as food, with the main bulk of the harvest being stored in a central location elsewhere. Evidence of spikelets, products and fine sieving residue within the houses at Feudvar would suggest that there was no central bulk storage of semi-cleaned grain, but that each household took responsibility for the processing of their crops. The fact that a number of samples contained unsieved spikelets within the houses at Feudvar may also suggest long-term storage, similar to the remains found at Assiros; however, the capacity of the storage structures has not be estimated at sites within the study region, making further statements about households producing communal, surplus or individual stores difficult.

9.4.3 Summary

The identification of crop processing and agricultural activities provides further insight into the social organisation of a settlement. Intensive plant cultivation indicates high labour input per area cultivated, while more extensive practices require less manual labour per area. At the time of harvest, labour requirements are, however, likely to be high and possibly during the early crop processing stages of threshing and winnowing, possibly requiring cooperation with other households. From the evidence from Feudvar and other Bronze Age sites in Hungary, the spikelets (in the case of einkorn and emmer) would then be transferred to the house, where the crop could be stored, dehusked then stored or fully processed, depending on the needs of the household. Discrete areas of cereal processing also seem to occur within the southern area of many of the houses at a number of Bronze Age sites, including Feudvar, providing an insight into the social organisation of the home.

During the Neolithic and Copper Age patterns suggest that one or two external pits were located close to houses. Whether this indicates communal storage is debatable, and some suggest that houses formed household ‘clusters’. This pattern seems to continue into the Early Bronze Age. By the Middle Bronze Age, a change occurs in the location of storage, moving into the house, possibly indicating a desire for greater control over resources. At Feudvar, there is no evidence of large storage facilities and the remains of crop processing within the houses suggest that each family had control over the processing and storage of crop resources.

9.5 Conclusion

An examination of all the archaeobotanical material, including the study sites, from the Carpathian Basin has identified a number of patterns. By exploring the area at the micro and macro level, agricultural activities seem to be intrinsically linked with the socio-political, economic and technological environment of each period. During the Mid/Late Neolithic to the Early Bronze Age, continuation in the cultivation of a diverse range of crops under intensive cultivation methods is likely, although variation may exist between sites. Cereals were typically sown in autumn and external storage pits are seen to be clustered near individual houses, possibly representing household rather than communal storage. Despite the fact that changes are seen in Copper Age settlements (i.e. smaller settlements, few tells, small houses) and a shift in agricultural focus has been previously suggested, this study suggests that crop husbandry was similar to that of the Late Neolithic and continued in importance. During the Bronze Age, changes in settlement, exchange networks and society seem to be linked with changes in agricultural practices. New crops are introduced into the region and new extensive methods of cultivation begin to be practised, as well as an increase in summer crops such as millet. The growing of a diverse range of crops at Feudvar suggests households were independent units, with internal storage and crop processing indicating a high level of control of resources. This is also evident from the use of a diversification strategy, which provides a robust crop production system that buffers against crop failure, reducing household reliance on others in society.

Chapter ten

Summary and Conclusions

The aim of this thesis was to examine archaeobotanical data from Croatia and northern Serbia, in order to investigate crop husbandry in relation to changing socio-economic and technological changes within the Carpathian Basin from the Late Neolithic to the Late Bronze Age. This included:

- documenting the agricultural base of the Late Neolithic, Copper and Bronze Age within Croatia and northern Serbia, by establishing which crops were cultivated and when they were introduced (Chapters 4 and 5);
- reconstructing the nature of farming systems at Late Bronze Age Feudvar, in terms of scale, intensity and variability, from the analysis of crop and weed assemblages (Chapters 6 and 7); and
- establishing regional and chronological patterns within the Carpathian Basin and exploring how agriculture developed over time in relation to socio-cultural, economic and technological changes (Chapters 2, 8 and 9).

Three datasets were used in the study. The first consisted of new archaeobotanical data collected from eighteen sites in Croatia dating from the Mid/Late Neolithic to the Late Bronze Age. The second dataset was from Late Bronze Age levels at Feudvar (Serbia), which provided a large dataset at the site level in order to reconstruct crop husbandry regimes. The third involved the compilation of all the archaeobotanical data available from the Carpathian Basin from the Middle Neolithic to the Late Bronze Age. All three datasets focused on carbonised plant remains only.

Each of the three sets of data will be examined in turn in relation to the objectives outlined above and the six hypotheses in Chapter 2: section 2.3 (10.1-3). Methodological problems that occurred during the study are then addressed (10.4), as well as suggestions for future research in the region (10.5). This is followed by the final conclusions of the study (10.6).

10.1 Farming in Croatia: Mid/Late Neolithic - Late Bronze Age

Hypotheses 1, suggested that differences would be seen between farming regimes at flat settlements and tell sites; however, due to differences in formation processes, sample recovery and preservation, it was not possible to determine farming regimes at the two sites. Nevertheless, clear patterning was observed in the type of remains found at both types of site. For example, the high percentage of cereal grains within house and hearth features indicated areas for the preparation of cereals for human consumption. The collection of fruits to supplement the diet may also be indentified from the high proportion of remains found in house and hearth deposits. The high chaff content (mainly glume wheat glume bases) within pits and ditches could have resulted from the deposition of crop processing waste. The high wild/weed content within the general occupation layers may result from a number of sources including, crop processing waste, the remains of collected foods as well as the accidental burning of local flora.

Hypotheses 5 and 6, suggested that the archaeobotanical remains would show changes in subsistence practices during the Copper Age. Overall, the results of the archaeobotanical analysis of the Croatian data indicates a continuation in the range of species present between the Late Neolithic and the Copper Age. This would suggest that, contrary to previous theories, agriculture continued to be an important part of life during both the Late Neolithic and Copper Age; however, the current data may not be fully representative of the whole region and further archaeobotanical work is needed.

10.2 Crop husbandry strategies at Late Bronze Age Feudvar

The high seed densities per litre (20 seeds per litre) as well as the large quantities of grain, chaff and wild/weed seeds facilitated further statistical analyses at the Late Bronze Age site of Feudvar. To explore crop processing at the site, ratio analysis was conducted on the dataset and correspondence analysis was used to clarify ambiguous and possibly mixed samples. From this, six different processing stages were identified: sieved and unsieved spikelets, sieved and unsieved fine sieving residue and sieved and unsieved products. The identification of crop processing at Feudvar provides evidence of human behaviour in relation to post harvesting activities as well as formation processes at the settlement. The distinction between sieved and unsieved crop remains shows a clear choice by farmers to either process everything before storage or only partially process the crops with the intention of later processing them piecemeal within the household. These choices would have been based on a number of factors, such as time, labour availability and weather conditions, as well as the intended purpose of the crop.

Spatial analysis within the trench also suggested possible differences in activity areas associated with different houses. Of particular note was the high incidence of unsieved remains within the centre of two of the northern houses, a high association of millet grains within pit features and the high presence of barley remains at the southern end of the trench. The significance of these patterns is at present unclear and will need to be examined further when the distribution patterns of other archaeological data becomes available for the site.

The presence of such rich samples allowed the detailed analysis of conditions in the fields and the reconstruction of how the crops were grown and treated. Samples identified as unsieved, spikelets, fine sieving by-products and products were therefore examined using the autecological approach to analyse the ecological characteristics of the weed species present within the samples. From the weed species recovered from Feudvar, the overall picture shows that the environment within which the crops grew had plenty of light, grew in a mild climate (not too hot or cold) on well drained, slightly alkaline soil with an overall medium nitrogen value. The anthropogenic factors analysed suggest that the crops were harvested low to the ground and grew on heavily disturbed soil.

The correspondence analysis also highlighted differences between the crops, although differences in crop processing methods can’t be excluded. Barley and rye generally plotted separately and had a higher number of associated weeds compared to einkorn, emmer, spelt, bread/durum wheat and millet. A number of patterns were also observed. First, a slight increase in moisture loving species were identified in samples near emmer was observed from the unsieved products. Second, einkorn and emmer showed a greater association with high nitrogen weed species in all three groups of samples. Third, barley had a greater association with winter annuals. The differences between the two groups may suggest differences in crop husbandry regimes and thus differences in labour investment (i.e. intensity) and scale. Barley had a more extensive regime (large-scale and low labour input), while einkorn and emmer may have been more intensively gardened (small-scale and high labour input regime), where additional practices of manuring and weeding occurred.

The use of a plough would have allowed greater areas to be cultivated aiding in the implementation of extensive regimes; however, the plough could have equally aided in more intensive regimes, reducing the time and labour required to initially till the ground. Although it is difficult to determine whether ploughs were used at Feudvar or any of the other sites in the Carpathian Basin, due to the lack of archaeological evidence, its implementation would have had an impact on agriculture (Hypothesis 4), whether through the reduction in time and labour costs, or allowing greater areas to be tilled.

10.3 New interpretations on the development of society in the Carpathian Basin

When bringing together all of the data from the wider geographic region (i.e. published data and data collected for this thesis), a number of broad patterns relating to subsistence practices during the Late Neolithic to the Late Bronze Age were identified. The three main cereals grown in the Carpathian Basin were einkorn, emmer and barley. During the Neolithic, emmer is the most dominant species present. During the Copper Age, barley has the highest presence at sites. Emmer remains dominant in the Early Bronze Age and it is not until the Late Bronze Age that einkorn shows a clear increase in cultivation. The Bronze Age is also characterised by an increase in crop diversity as well as the cultivation of new species. In particular, bread wheat, millet and rye become more frequent at Bronze Age sites. The introduction of new species and increase in species diversity may be linked to the increase in exchange, migrations and increased population pressures during this period. Differences seen between the cultivation of emmer and einkorn also suggests cultural differences within the Carpathian Basin. In particular, settlements within Hungary show a preference for emmer and barley, while the regions to the south and east had a higher incidence of einkorn, indicating regional differences in crop choice.

Changes in crop husbandry regimes may also be seen in the region. During the Middle to Late Neolithic it is likely that small-scale intensive cultivation occurred, similar to Central Europe and Greece. During the Copper Age the quantity and diversity of plant remains are particularly low, making interpretation difficult; however, the continuation in agriculture within Croatia may suggest that this form of agricultural regime continued to be practised and not a change towards a more pastoral economy (i.e. semi-sedentary animal husbandry regime). The reduction in settlement and population sizes may have resulted in reduced crop production and not the decline of crop cultivation *per se*. In addition, some suggest that cultivation during the Copper Age was practised on marginal soils; however, the locations of the sites sampled do not differ greatly, suggesting that the same type of soil was available for cultivation from the Neolithic to the Bronze Age. The use of intensive methods would have also allowed a relatively high yield to be achieved from a small plot area, as well as the benefit of growing a diverse range of crops.

During the Bronze Age, new crop husbandry regimes came into practice as well as the adoption of new crops. The introduction of new crops is likely linked to the increase in exchange and the extending of exchange networks during this period (Hypothesis 3). The new crops would have provided the farmer with species with different ecological characteristics, which may have been better suited to the local environment than previous species. An example of this may be seen with the introduction of gold of pleasure, an oil plant which is less demanding than flax, which had been the main oil plant prior to the Bronze Age. Further developments during this period have been identified from the Feudvar material when both small-scale intensive cultivation and large-scale extensive cultivation are practised during the Late Bronze Age (identified at Feudvar), showing possible differences in settlement needs at this time. The increase in einkorn cultivation as well as summer crops such as broomcorn millet show a clear increase in agricultural production at this time, which is likely linked to increased population and settlement size. The identification of internal storage within houses can also indicate a high degree of household control over resources and may be associated with the wider socio-economic environment, which saw a rise in regional centres at the time.

10.4 Methodological, analytical and interpretive issues

The level of analysis that could be obtained from the three datasets varied considerably. This included different, and in some cases inadequate, sampling strategies. Due to the low quantity and density of plant remains from many of the sites, often only presence/absence data could be used and not detailed statistical analyses of sample composition. In contrast, the opportunity to examine the extremely rich archaeobotanical remains from the partially published Late Bronze settlement of Feudvar in Serbia, allowed detailed qualitative analysis of archaeobotanical remains from one site. The extensive sampling strategy implemented by Prof Kroll provides an exceptional dataset from which to explore agricultural practices within the Bronze Age in the Carpathian Basin; however, the archaeological analysis of Feudvar is still ongoing, which prevented a more extensive discussion on depositional patterns through time and space within the houses.

The collection of additional published archaeobotanical data from the wider Carpathian Basin highlighted considerable variability in the quantity and quality of the plant remains from individual sites, but also in the information provided. This restricted comparisons between the sites and prevented any further detailed analyses or interpretation of the agricultural development within specific regions of the Carpathian Basin. Consequently, presence/absence data were the main form through which temporal and geographic changes were considered. This allows species to be considered equally, but it ignores taphonomic, sampling and recovery issues, which may result in inaccurate interpretations and provides no information about farming strategies.

A prime example of how presence/absence may offer unreliable results is the inference that the reduction in plant remains recovered during the Copper Age indicates a decline in agriculture. As seen from Chapter 8, this is more likely to result from the fact that too few sites have been excavated compared to the other periods and that too few archaeobotanical samples have been collected. In addition, the increase in flat horizontal sites will also have an impact on the density of plant material, compared with the tell sites, which are more prevalent during the Late Neolithic and Bronze Age. The new evidence from Croatia is highly significant in this context then: the archaeobotanical remains collected from Croatia for this project suggest that crop husbandry continued unabated till the Late Copper Age, with no evidence of any change in the range of crop species cultivated.

The low plant densities within the Carpathian Basin have also restricted further analyses of crop husbandry regimes. This has resulted in a large gap in knowledge from the Early Neolithic when Bogaard *et al.* (2007) identifies intensive garden agriculture in Hungary and the Late Bronze Age where this study has identified a relative contrast in intensive and extensive cultivation regimes in northern Serbia. Further research is clearly needed within this area, especially in the recovery of adequate and representative quantities of plant remains from settlements in the region.

10.5 Recommendations for future research in the Carpathian Basin

The plant remains recovered from a site are in themselves only a fraction of the once living community they represent, resulting from numerous formation processes that ultimately affect the final content of the assemblage. As archaeologists it is our job to recover the maximum amount of information possible to facilitate meaningful interpretations of the results. From all the sites studied within the Carpathian Basin, major differences in the sampling strategies, methods of recording and report writing can be seen. In addition, the majority of the sites yielded low quantities of plant remains. The Croatian sites in particular had very low seed densities (<1 seed per litre), which had a major impact on the level of analysis that could be conducted.

How then can archaeologists in the future recover archaeobotanical samples in the best possible way to potentially provide a large and statistically meaningful dataset for archaeobotanical analysis? Three points need to be considered. First, is the volume of soil sampled sufficient to recover adequate quantities of plant remains from the site? Second, is the recovery method adequate? Third, is whether the samples are representative of the whole site (i.e. recovered from different feature types)?

Sample size

Melzter *et al.* (1992) and Grayson (1981) highlight the relationship between sample size and diversity. For example, while examining faunal remains, Grayson (1981) suggests that small samples are more likely to over-represent more abundant taxa, while there is a greater probability of encountering rare taxa in larger samples. Van der Veen and Fieller (1982) calculated that a sample of 384 seeds, with one taxon making up 50% of the assemblage, was needed to ensure a 95% chance of estimating the contribution of each taxon. Samples with fewer than 50 or 100 items are also often excluded from crop processing and husbandry analysis (Bogaard 2004; Valamoti 2004; Van der Veen 1992).

Using the median seed density for each of the Croatian sites, Table 10.1. presents the numbers of litres needed per sample to obtain 100 and 300 seeds per sample. Only four sites, Turska Peć, Slavča, Ravnjaš and Vinkovci/Matije Gupca 14, require samples of 50 litres or less to obtain a 100 seeds. To obtain 300 seeds per sample many of the sites would need up to 3,000 litres. This is not a practical solution to obtaining high seed densities per litre; however, it does highlight the need to take large samples where possible. As a more realistic suggestion, a sample size of around 50 litres may provide more adequate results than the average 10-20 litres that were collected from the study sites.

Recovery

It is generally accepted that a sieve of 500 µm or 300 µm is sufficient for the recovery of most archaeological plant material, even though this does not correspond with the smallest plant remains such as Juncacaeae and Ericaceae (Keeley 1978; Pearsall 2000). As such, a maximum mesh size of 500 µm should be implemented within the region in the future to ensure the recovery of small plant remains that may otherwise be lost.

Sample context

Another aspect highlighted by the Croatian samples was the relationship between the number of samples collected and the number of different taxa identified. Figure 10.1., shows a positive correlation between the number of samples and number of crops identified at each site, although the r^2 value is slightly weak at 0.386 (where 1 = a good fit and 0= no relationship). Sopot in particular has the highest number of samples collected, from which 12 crops were recovered.

Reporting

On a regional scale, a standard way of reporting archaeobotanical remains would be extremely useful and would help facilitate site and regional comparisons. It is therefore suggested that the following information be included in the archaeobotanical sample tables: the sample numbers, their volumes and context (e.g. context number and context type). It would also be useful to include the basic site information, such as the type of site (e.g. flat, tell, cave, necropolis) and its exact location (e.g. latitude and longitude). With the growing number of archaeobotanical results coming out of the Carpathian Basin, it would also be worth considering the introduction of a centralised national database within each country, which could be continuously updated. This would allow more detailed information to be stored about each sample and site, and help facilitate research in the region.

10.6 Concluding remark

The results of this study indicate that crop agriculture played an important role in the economy of the Carpathian Basin from the Late Neolithic through to the Late Bronze Age. The analysis of the crops and their associated weed species has shown that cultivation and post harvest processes can provide important information on human activities and economic impact at both the regional and site level. Further research is needed to build on what has been achieved so far and to improve our understanding of the importance of agriculture or the role agriculture played in underpinning social, cultural and/or economic changes in the Carpathian Basin.

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Appendix I
Site summaries

Middle Neolithic

Virovitica-Brekinja

The excavation site of Virovitica−Brekinja is situated in a lowland region, west of Virovitica. Between June and August 2005 rescue excavations were conducted at the site by Tanjana Sekelj Ivančan (Institute of Archaeology, University of Zagreb) and Jacqueline Balen (Archaeological Museum Zagreb). Excavations revealed the edge of a single-layered, late Starćevo culture settlement extending over 5,400m² (Sekelj-Ivančan and Balen 2006). Within the trench work areas, fencing and a section of a house (the rest was located outside the trench line) were identified. Finds included worked stone, querns, grinding stones, pottery and a female figurine (*ibid.*). AMS dates of *ca.* 5400-5200 cal BC have been retrieved from the site (J. Balen. 2011, pers. comm.). Five samples (*ca.* 55 litres) were collected from pits excavated within the settlement area.

Late Neolithic

Turska Peć

Turska Peć cave is situated above the hamlet of Zeljovići at the height of about 355 metres above sea level, near Dugi Rat along the Dalmatian coast. Small-scale excavations began in 1989 and identified a multi period site including Late Neolithic deposits (Kliškić 2006a). In 2003 the Archaeological Museum Split began systematic excavations directed by Damir Kliškić. These excavations are still ongoing. From pottery typologies, deposits dating to the Late Neolithic Hvar culture have been identified. To date three trenches have been opened (Fig I). Finds include pottery, stone tools, animal bones and small personal ornaments (Kliškić 2006b; Kliškić 2007). During the 2008 excavation season, 13 samples (186 litres of sediment) were collected from levels dating to the Hvar period in Trench 2 (2x3m²) and nine samples (118 litres) from the same period within Trench 3 (2x2m²).

Čista Mala - Velištak

The archaeological site of Čista Mala – Velištak is situated in Velimsko polje (Velim plain) to the north of Vodice in Dalmatia. The site was discovered in 2007 during construction work and excavations subsequently began in the same year by Emil Podrug (Šibenik Municipal Museum). The excavations are still ongoing. To date six trenches have been opened (A-F) covering over 196 m² (Fig II). Initial pottery analysis suggested that the settlement dated to the Late Neolithic Hvar culture. This was later confirmed by two radiocarbon dates, which ranged from 4900-4700 BC (Podrug 2010). Traces of house floors, fireplaces and pits have been identified within the four trenches. In particular, pits SU24 and SU46 showed periodic layering of soil and hearths (*ibid*.). Seventeen samples were collected from Trench A (6.5x5m²), two from B (5x5m²), four from C (5x5m²) and five from D (5x6.5x2.5m).

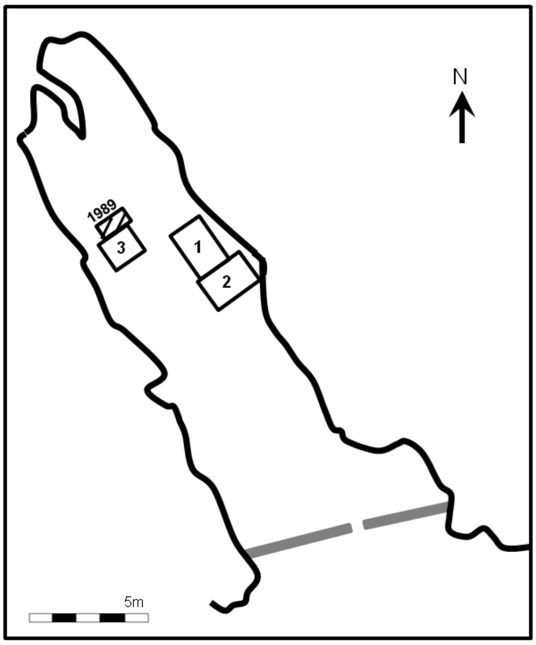

Fig I. Turska peć trench locations. After Kliškić 2007:535.

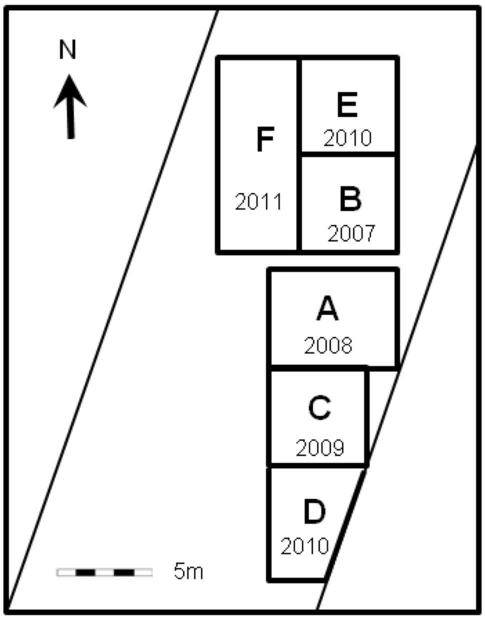

Fig II. Čista Mala Velištak trench locations and year excavated (E,Podrug 2012, pers. comm.)

Ivandvor-Gaj

The site of Ivandvor – Gaj is situated on an elevated ridge, 3.5 km west of Đakovo and was excavated during 2005-2007 by the Institute of Archaeology, University of Zagreb and the Archaeological Museum Zagreb. This excavation was conducted due to the construction of the A5 motorway, from Beli Manastir to Osijek. An area of 16,000m² was excavated, revealing structures dating mainly to the Late Neolithic, Roman and Medieval period (Balen *et al.* 2009; Lipovac Vrkljan and Šiljeg 2006). The earliest settlement dates to the Sopot culture which is potentially enclosed by a circular ditch (Balen *et al.* 2009). A number of small and large pits were identified, but no houses or hearth features were recognised. AMS dates have produced two clusters: 5050-4780 and 4730-4490 (*ibid.*). Fourteen pits were sampled (*ca.* 154 litres) from the Sopot settlement.

Sopot

The eponymous site of Sopot is situated 3 km south-west of Vinkovci, on the right bank of the river Bosut. The tell site is elliptical in shape, measuring 113m by 98m and 3 metres deep. Previous excavations have been conducted by M. Klajn in the late 1930s and S. Dimitrijević in 1967 (Dimitrijević 1968). Systematic excavations at Sopot were conducted between 1996 and 2008 by Vinkovci Municipal Museum, directed by Maja Krznarić Škrivanko. A total of 376m² was excavated from a 37m long section transecting the settlement, beginning in the south-west corner (Krznarić Škrivanko 2000, 2003)

Three Late Neolithic Sopot phases have been identified at the site as well as an Early Neolithic Starćevo settlement (Krznarić Škrivanko 2011). During the early Sopot phase (5050-4550 BC), a fortified ditch, 6m wide and 6m deep, surrounded the settlement (Krznarić Škrivanko 2003). The ditch is clearly seen from the magnetic survey conducted at the site during 2010 (Fig III). At the end of phase I the ditch was filled in and during phase II (4790-4320 BC) the settlement expanded (*ibid.*). One house (SJ23) excavated above the ditch was rectangular with the dimensions 6.70 x 4m and had evidence of internal room divisions and artefacts such as grindstones, blades, burins, clay weights and pieces of bracelet and pendant made of the *Spondylus* shell (*ibid.*). The final Sopot phase has been dated to 4340-3940 BC (Krznarić Škrivanko 2011). Building cycles at the site are typically characterised by the burning of an old house, which is then covered with a layer of soil, before a new house is constructed.

In 2000 one environmental sample was sent to the Botanical lab in Zagreb University to be processed. This sample yielded grains of spelt (*Triticum spelta*) and bread wheat (*Triticum aestivum* ssp. *vulgare*) and a C14 date of 4540-4310 cal BC was retrieved (M, Krznarić Škrivanko 2007, pers. comm.). A total of 144 samples (2,842 litres) were collected from across the excavated area (Fig III).

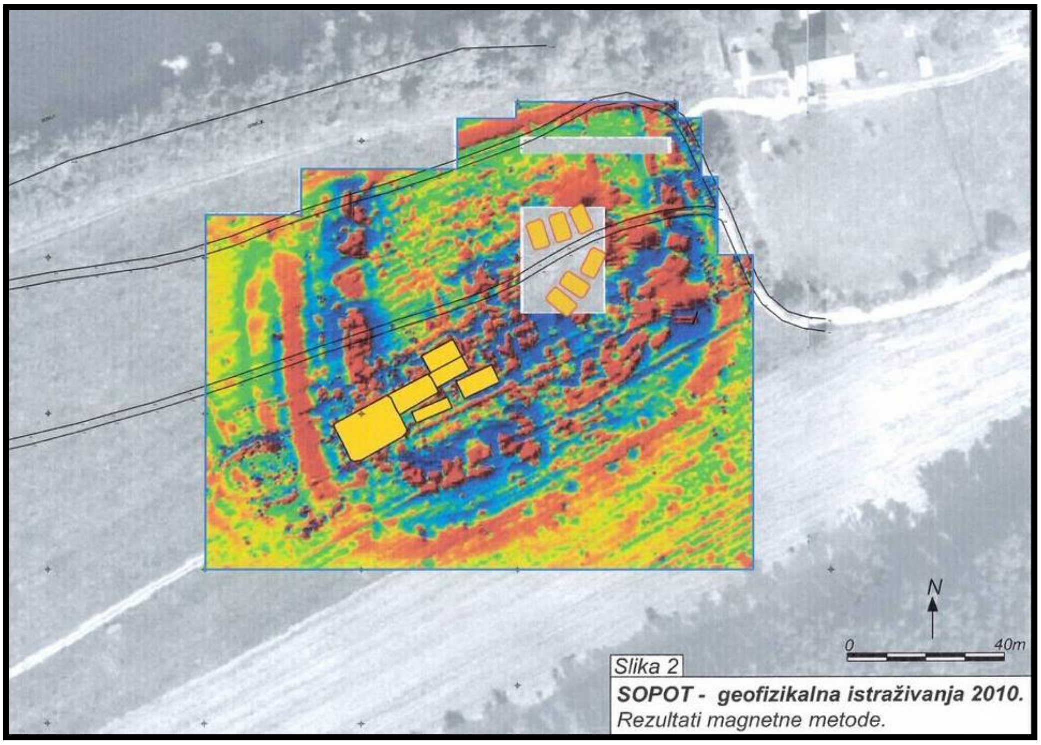

Fig III. Detailed magnetic survey of Sopot including the position of the 1996-2008 excavation trenches (in yellow) in the bottom left of the settlement. Courtesy of Vinkovci Municipal Museum.

Ravnjaš

Test excavations began at Ravnjaš near Nova Kapela in 2006 by Nova Gradiška Municple Museum, directed by Marija Mihaljević. Between 2006 and 2008 excavations revealed a phase 2 Sopot Culture tell settlement (Mihaljević 2006a, 2007b, 2008a). A series of house floors and pits were excavated and a considerable amount of pottery, lithics and flat weights were recovered from two trenches (1 and 2). During the excavations, 48 samples (528 litres) were collected from features in Trench 1 and 23 samples (*ca.* 253 litres) from Trench 2.

Late Neolithic/Copper Age

Slavča

Slavča is located 1km north of Nova Gradiška, on the Slavča Hill, which is part of the Psunj mountain range. The tell site has been continuously excavated since 1997 by Nova Gradiška Municple Museum, directed by Marija Mihaljević. To date a number of trenches have been opened across the settlement covering an area of over 500m² (Mihaljević 2004, 2005, 2006b, 2007c, 2008b, 2009). Pottery styles have indicated a number of cultures at the site such as Sopot, Lasinja, Kostolac and Vučedol Cultures (Skelec 1997). Numerous pits, postholes and general occupation layers have been excavated producing a large amount of pottery, lithics and animal bones (e.g. Miculinić and Mihaljević 2003; Šošić and Karavanić 2004). Between 1999 and 2007, 82 samples (*ca.* 902 litres) were collected from all four cultural phases across the settlement.

Copper Age

Đakovo-Franjevac

During 2007, rescue excavations directed by Jacqueline Balen (Archaeological Museum Zagreb) were conducted at Đakovo-Franjevac prior to the construction of the A5 motorway from Beli Manastir to Osijek. The site is located on an elevated position 2 km northeast of Đakovo. A total of 36,000m² was excavated revealing a large Copper Age settlement and a smaller Medieval site (Balen 2007a). AMS dates suggest the prehistoric settlement spanned the period 3300 - 2700 BC and the pottery belongs to the Kostolac Cultural tradition (Balen 2011:9). Numerous features were identified at the settlement including pits, fences, hearths, as well as a burial and most importantly pit dwellings revealing both work and residential areas (*ibid.*). Eighteen pits were sampled, including an irregularly shaped pit (SJ19), 7x5m and 0.7m deep, which contained 3 ovens exhibiting intensive burning within the feature. A storage pit that was subsequently turned into a burial pit (SJ160) containing a man and two animals was also sampled (Balen 2011:88). A total of 29 samples (*ca.* 302 litres) were collected.

Jurjevac – Stara Vodenica

During 2008, rescue excavations directed by Jacqueline Balen (Archaeological Museum Zagreb) were conducted at Jurjevac-Stara Vodenica prior to the construction of the A5 motorway from Beli Manastir to Osijek. The site is located on a mildly elevated position next to the Vuka River, 5 km north of Đakovo. A total of 16,000m² was excavated revealing two small prehistoric settlements and a Medieval site (Balen 2008a). AMS dates from one of the sites spanned the period

4320 - 3960 BC and contained pottery belonging to the Lasinja Cultural tradition, while the other dates to the Middle Bronze Age (*ibid.*). At the Copper Age site no houses or hearth features were identified, only a number of pits were present. Twelve samples (*ca.* 132 litres) were taken from 12 pits within the Copper Age settlement.

Pajtenica-Velike Livade

During 2006, rescue excavations directed by Jacqueline Balen (Archaeological Museum Zagreb) were conducted at Pajtenica-Velike Livade, located to the north of Đakovo, prior to the construction of the A5 motorway from Beli Manastir to Osijek. A total of 18,000m² was excavated revealing the existence of two settlements, one from the Copper Age and one to the late Middle Ages (Balen 2006a). AMS dates suggest the prehistoric settlement spanned the period 4350 - 3540 BC and pottery from the site belongs to the Lasinja Culture (*ibid.*). Only a small section of the settlement was examined due to the extent of the excavation line but pits and pit dwellings were identified. Twenty seven samples (*ca.* 297 litres) were collected from 25 pits within the Copper Age settlement.

Potočani

The site of Potočani, located to the west of Velika in the Požega valley was initially surveyed in 2000 and 2003 when a number of prehistoric and medieval settlements were identified. A probe trench was subsequently excavated in 2007 by Hrvoje Potrebica (Institute of Archaeology, University of Zagreb) and Jacqueline Balen (Archaeological Museum Zagreb). Excavations revealed a large burial pit filled with 50 individuals of different ages and sex (Balen 2007b). The manner of deposition suggests that the bodies were not buried *per se* but dumped in a mass grave (*ibid.*). Pottery within the pit is that of the Copper Age Lasinja Culture and an AMS date of one of the bones is from 4200 BC (Balen 2007b). Five samples (*ca.* 55 litres) were collected from the burial pit.

Vučedol

The latest large-scale excavations at Vučedol began in 1984, involving the Archaeological Museum Zagreb, Zagreb University and the Municipal Museum of Vukovar. The site is currently directed by Jaqueline Balen (Archaeological Museum

Zagreb). The Copper Age tell settlement is situated on the right bank of the Danube, in eastern Slavonia, 5 km east of Vukovar. The settlement occupied four flat-topped mounds, up to 5m above the surrounding land (Forenbaher 1994). Excavations over the last two decades have focused on Streim's Vineyard (Fig IV). The settlement can be roughly divided into three occupational phases: the earliest characterized by early, classic Baden pottery; the next by Kostolac pottery; and the latest by classic Vučedol incrusted ware (Forenbaher 1994).

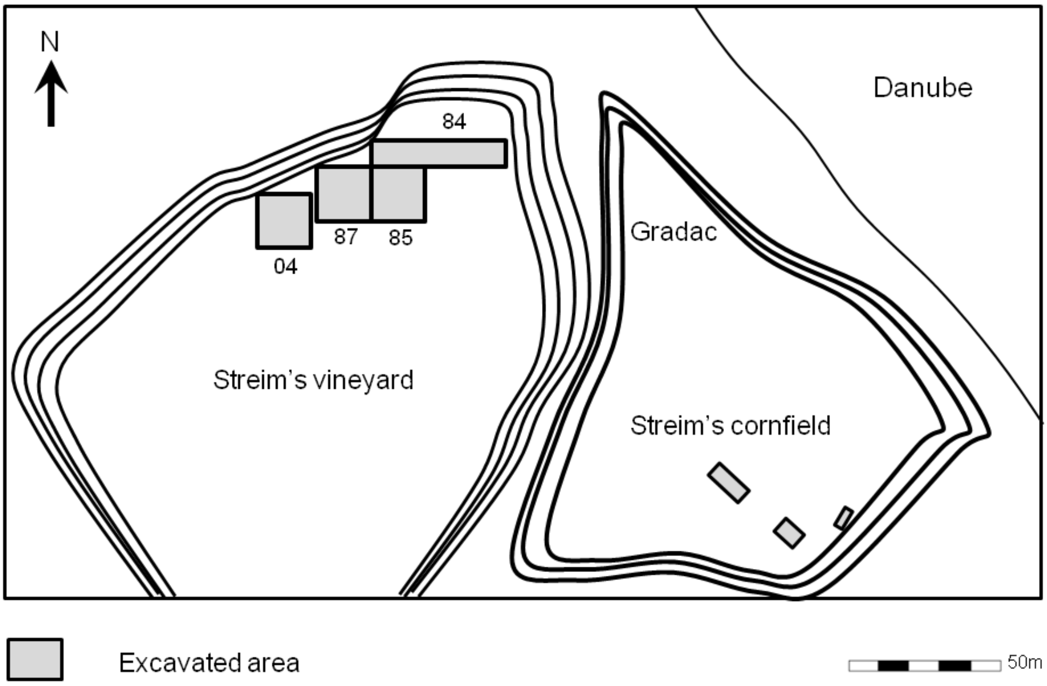

Fig IV. Map of three of the mounds upon which the Vučedol settlement is located and the excavated trenches. Adapted from Balen 2005b:43

Between 2004 and 2008 a new trench was opened (04, Fig IV) covering 400m² within which Vučedol culture levels were excavated (Balen 2004, 2005b, 2007c, 2008b). A number of house floors were discovered situated E-W and SJ56 in particular showed 3-6 episodes of restoration where 2-6 cm of flooring was periodically relayed (Balen 2008b). Within the house floor of SJ54, along with other moveable finds, was discovered a decorated clay model boot (Balen 2007c). Thirty five samples (385 litres) were collected from trench 04 during 2005-2008, including twelve samples (132 litres) from SJ54 and nine (99 litres) from SJ56.

Virovitica-Batelije

During 2005 an area of 4500m² was excavated, directed by Jaqueline Balen (Archaeological Museum Zagreb), in response to plans to build the Virovitica bypass. Located in the lowland area west of Virovitica, the site of Virovitica-Batelije has been extensively damaged by intensive ploughing. AMS dates suggest the prehistoric settlement spanned the period 3700 to 3400 BC and artefacts from the site belong to the Retz-gajary and Boleraz Cultural traditions (Balen 2006b). The trench encompassed only a small part of the settlement which stretched out in a SW-NW direction from the bypass. A number of pits, postholes and channels were identified; however, no houses or hearth features were preserved (*ibid.*). Three samples (33 litres) were collected from three pit features from the Copper Age settlement.

Vinkovci/ Matije Gupca 14

In 2007, rescue excavations were conducted at the address of 14 Matije Gupca in Vinkovci, near the river Bosut. Due to the area being in the registered and protected archaeological zone of Vinkovci town, full excavations were conducted by Maja Krznarić Škrivanko, Anita Rapan Papeša and Hrvoje Vulić (Vinkovci Municipal Museum). An area of 250m² (15.05 x 16.65m) was excavated (Miloglav 2007). Sixty two stratigraphic units were recorded from the Late Neolithic, Copper Age and Roman period, including 16 pits and a sequence of 6 Vučedol house floors (Krznarić Škrivanko 2007; Miloglav 2007). Four samples (216 litres) were collected from three pits dating to the Copper Age Vučedol culture.

Neolithic/Copper/Bronze Age

Tomašanci – Palača

During 2008, rescue excavations, directed by Jacqueline Balen (Archaeological Museum Zagreb), were conducted at Tomašanci – Palača prior to the construction of the A5 motorway from Beli Manastir to Osijek. The site is located on a ridge and descends down to a flat, lowland, marshy area, 8km north of Đakovo. A total of 64,000m² was excavated revealing Early and Late Neolithic levels, two middle Copper Age settlements and an Early Bronze Age site (Balen 2008c). AMS dates from the Late Neolithic levels date to *ca.* 4300-3900 BC, while the Copper Age site dates to *ca.* 3700-3600 BC. The pottery traditions also ranged from the Neolithic to Bronze Age including Starčevo, Sopot, Lasinja, Retz-gajary and Vinkovačka cultural groups (J, Balen 2012, pers. comm.). A number of pit features were identified as well as pottery, animal bone and worked stone (Balen 2008c). In total 55 samples were collected from three different periods, one sample from a Sopot pit, 26 from the Copper Age settlement and 28 from the Early Bronze Age site.

Late Bronze Age

Mačkovac-Crišnjevi

Systematic excavations began at the site in 1997, directed by Marija Mihaljević (Nova Gradiška Municipal Museum). The settlement is located 1 km north of Mačkovac which is situated on the left bank of the Sava River, approximately 15 km south of Nova Gradiška, Croatia. The settlement is elevated up to 2m above the floodplain and covers an area of approximately 2 hectares (Karavanić et al. 2002). Three trenches were opened in 1997 and 1998 covering around 323m². Numerous features have been identified within the excavated area including house floors, hearths, pits and in particular evidence of a metallurgical work area (ibid.). Previously a Bronze Age hoard was recovered from the site in 1985 and since then further bronze items as well as pottery and animal remains have been found (Karavanić et al. 2002). The identification of a number of bronze needles and pottery types have dated the site from the middle to beginning of the Late Bronze Age, concurrent with the Virovitica group and culturally belonging to the Barice-Gređani group (ibid.). Between 2000 and 2003, 28 samples (308 litres) were collected from 18 features.

Crišnjevi – Oštrov

Crišnjevi – Oštrov is a Late Bronze Age necropolis and is believed to have belonged to the nearby settlement of Mačkovac-Crišnjevi. Between 2003 and 2009 excavations were conducted by Marija Mihaljević (Nova Gradiška Municipal Museum). To date the excavations have revealed 73 graves, belonging to the Barice – Gređani group (13^{th} -12^{th} century BC) of the Urnfield Culture (Mihaljević and Kalafatić 2005, 2008, 2009; Mihaljević 2007a). All the graves show a similar burial ritual, where the burnt bones of the deceased are collected into a vessel and laid into the ground upside down (Mihaljević and Kalafatić 2008). Three samples (33 litres) were collected from three different grave areas, although two (from area M10) were from two closely associated graves.

Orubica-Veliki Šeš

During 2007 a test trench was excavated north of Orubica to establish whether archaeological remains were present. Directed by Marija Mihaljević (Nova Gradiška Municipal Museum), an area of 50m² was examined, revealing the remains of a Late Bronze Age settlement, *ca.* 13th – 12th century BC (Mihaljević and Kalafatić 2007). Features such as a house floor, hearth, ditch and pits were identified along with pottery and bone (*ibid.*). Two samples (22 litres) were collected from two different general occupation levels.

Feudvar

Feudvar is located on the western edge of the Titelski Breg Plateau near the modern village of Mošorin. The loess plateau is 50m high, 17 km long and 7 km wide. It is situated in a broad flood area called Šajkaška on the western fringe of the convergence of the Tisa and Danube rivers in the wider region of Vojvodina (Hänsel and Medović 1998). Vojvodina is a part of the larger fertile lowlands of the Pannonia Plain, and has similar climatic and geological characteristics to Slavonia in eastern Croatia. Directed by P. Medović, Museum of Vojvodina, Novi Sad, and B. Hänsel, Freie Universität, Berlin, substantial excavations and environmental recovery were conducted on the core Bronze and Iron Age fortified tell settlement of Feudvar between 1985 and 1990. The archaeobotanical work was undertaken by Prof Helmut Kroll, Kiel University, Germany. To date a number of publications exist on the archaeological remains, including an archaeobotanical summary of the results from the site as well as a more detailed report of the Early Bronze Age levels (e.g. Kroll 1997; Kroll 1998). From these reports it is clear that the archaeobotanical remains from this site are extremely rich, especially for the region. With the kind permission of Prof Helmut Kroll and the current director Prof Frank Falkenstein (University of Würzburg, Germany), samples collected in 1988 from the Late Bronze Age levels located in the western trench (19m x 46m) were chosen for analysis (Fig V).

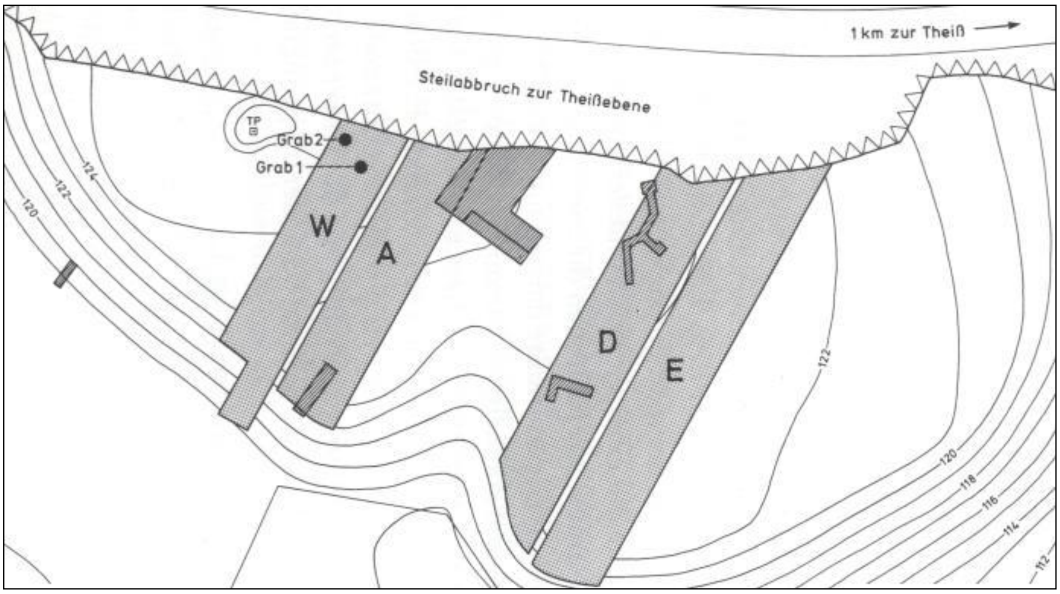

Fig V. Excavated trenches at Feudvar (W = western trench). Taken from Hänsel and Medović 1998:53, abb.3.

Within the western trench, excavators uncovered a number of rectangular wattle-and-daub houses of varying sizes (up to 12 x 6m) situated in rows and separated by narrow alleys. Most had interior plastered hearths and grain storage vessels, while some had loom weights and grinding stones on the floors (Hänsel 1991). Two houses were particularly characteristic, with one known as the fish house, containing large numbers of fish remains, and the baker house, which contained large numbers of grain and chaff (H, Kroll 2010, pers. comm.). The recovery of bronze and flint sickles attests to the harvesting of crops at the site. Aside from the common domestic animals, wild cattle, deer, and wild pigs were also found at the site indicating hunting, while remains of harpoons or hooks indicate fishing (Becker 1991). Worked bone, horns and antlers were also found at the site, particularly in refuse pits. See Hänsel and Medović 1991,1998 for further details of the excavation.

Farmers in Transition

The archaeobotanical analysis of the Carpathian Basin from the Late Neolithic to the Late Bronze Age (5000-900 BC)

Thesis submitted for the degree of

Doctor of Philosophy
at the University of Leicester

by

Kelly Reed

VOLUME II

School of Archaeology and Ancient History

University of Leicester

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Abstract

This thesis examines the development of agriculture within the Carpathian Basin from the Late Neolithic to the Late Bronze Age. Information on prehistoric crop practices within Croatia have been absent from current debates on the spread and development of agriculture in Southeast Europe. The aim of the study is to examine new archaeobotanical data and provide information on subsistence practices within Croatia and integrate these results with those available from the wider region of the Carpathian Basin. The re-examination of archaeobotanical material from Late Bronze Age Feudvar has also allowed the identification of crop husbandry regimes at the site level.

The results indicate continuous crop cultivation, as well as the collection of wild resources, within Croatia from the Late Neolithic to the Late Bronze. At Feudvar, crop processing analysis indicated that a number of socio-economic factors dictated whether a crop was fully cleaned after the harvest, sieved at a later stage or left full of impurities. Further investigation into ecological characteristics of weed species within three groups of samples (unsieved spikelets, products and fine sieving by-products) identified the practice of two distinct crop husbandry regimes at Feudvar. The first represents small-scale intensive cultivation associated with the wheat crops (i.e. einkorn and emmer) and the second, a more large-scale extensive husbandry regime associated with barley. Integrating these results within the wider geographical area showed regional and temporal variations in the crops cultivated that are likely linked to personal choice and socio-economic influences rather than environmental constraints.

This study advances our knowledge on farming practices within the Carpathian Basin and demonstrates the importance of archaeobotanical data to debates on socio-economic and technological change in prehistory.

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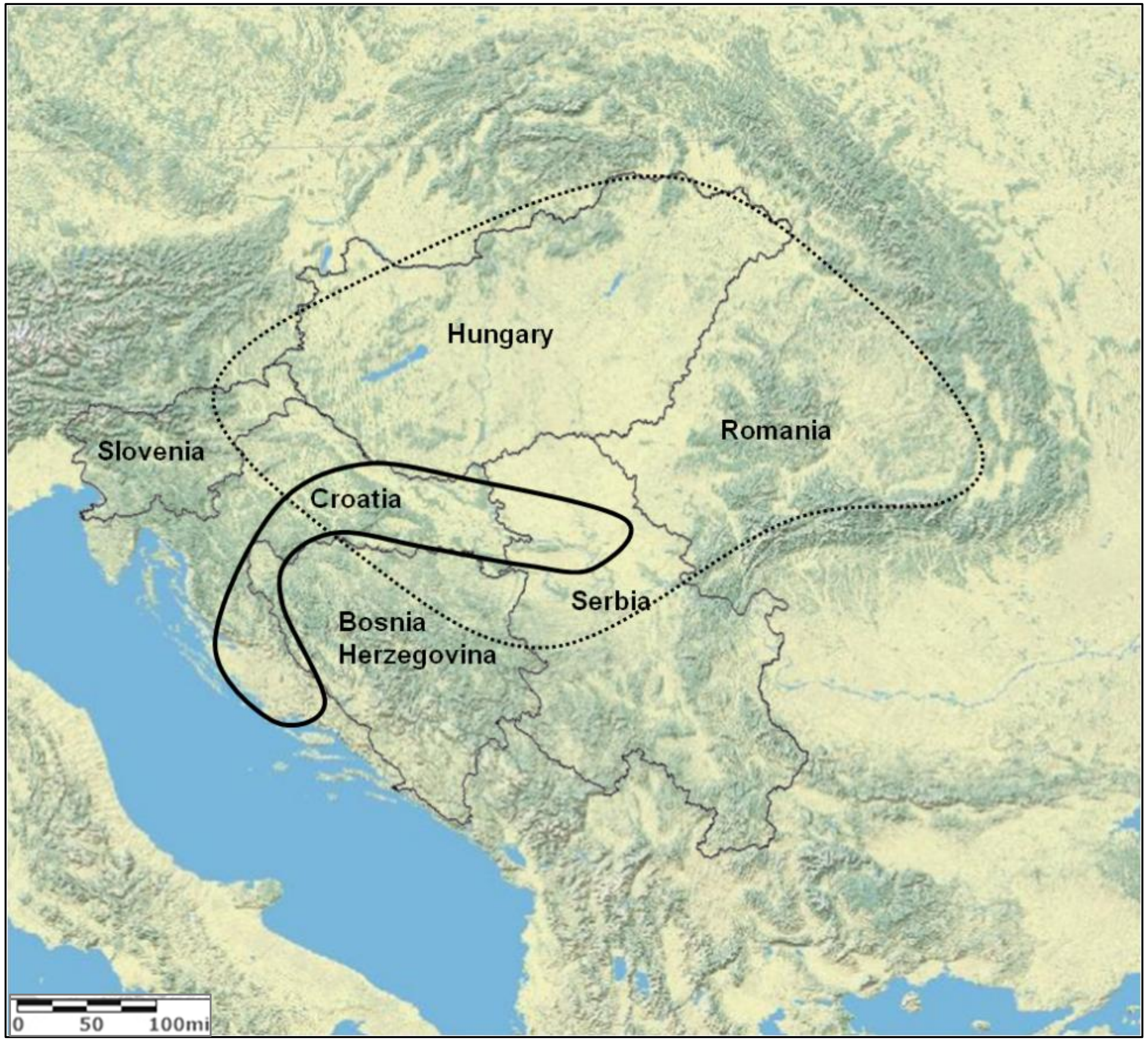


Fig 2.1. Outline of the Carpathian Basin and the core study area within Croatia and northern Serbia. Base map U.S. National Park Service (NPS) 2009

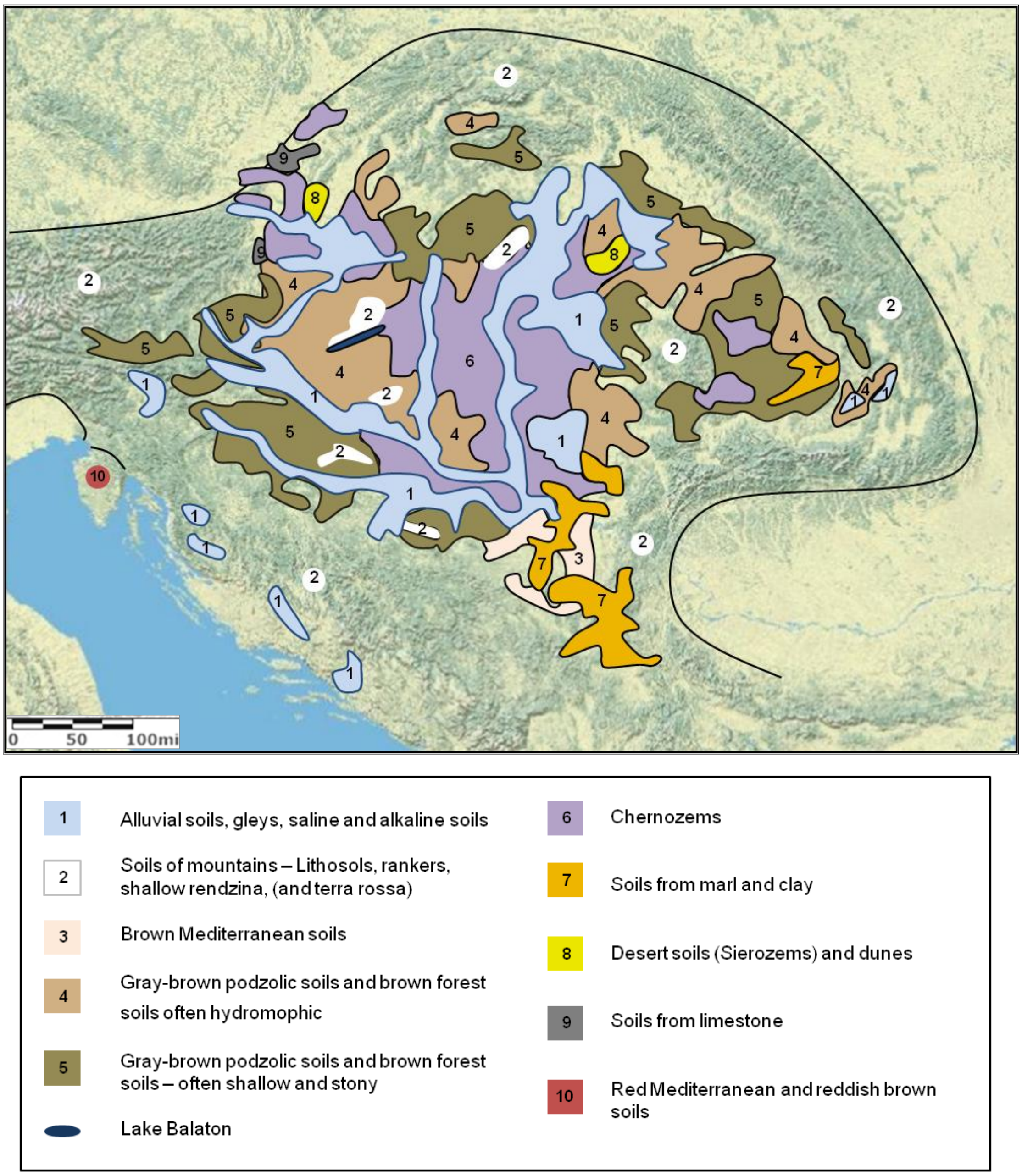


Fig 2.2a. Soil map of the Carpathian Basin. (After European Digital Archive of Soil Maps (EuDASM) 2005)

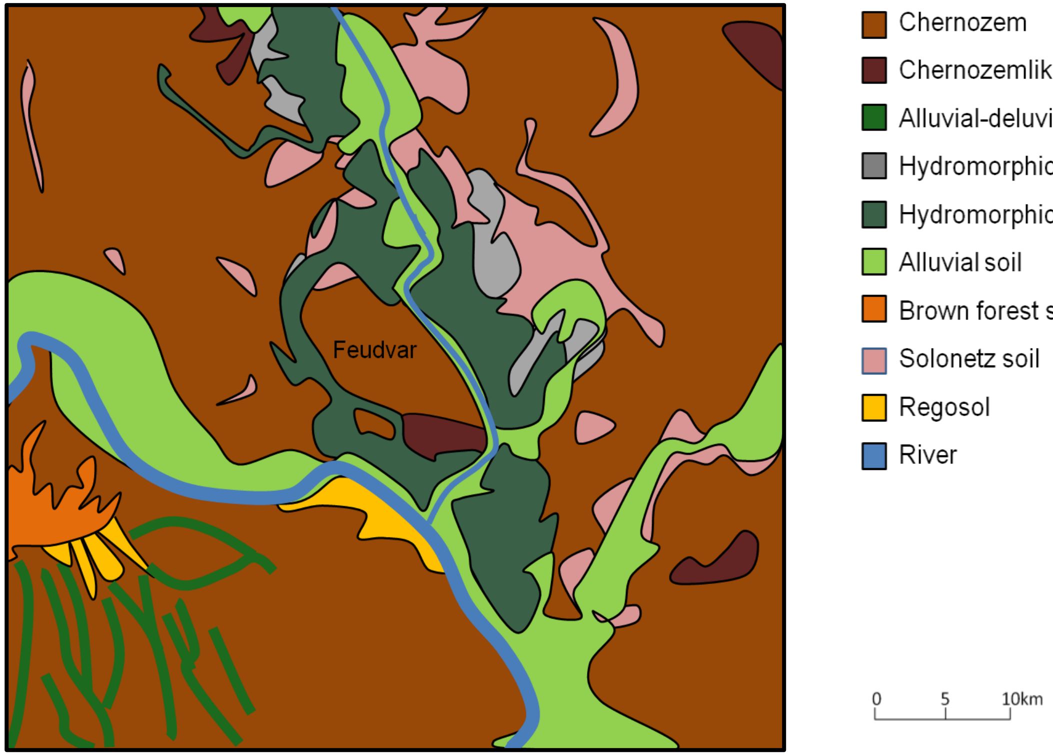


Fig 2.2b. Soil map of the Titel plateau (Feudvar settlement) and the surrounding area. Adapted from (Benka 2006)

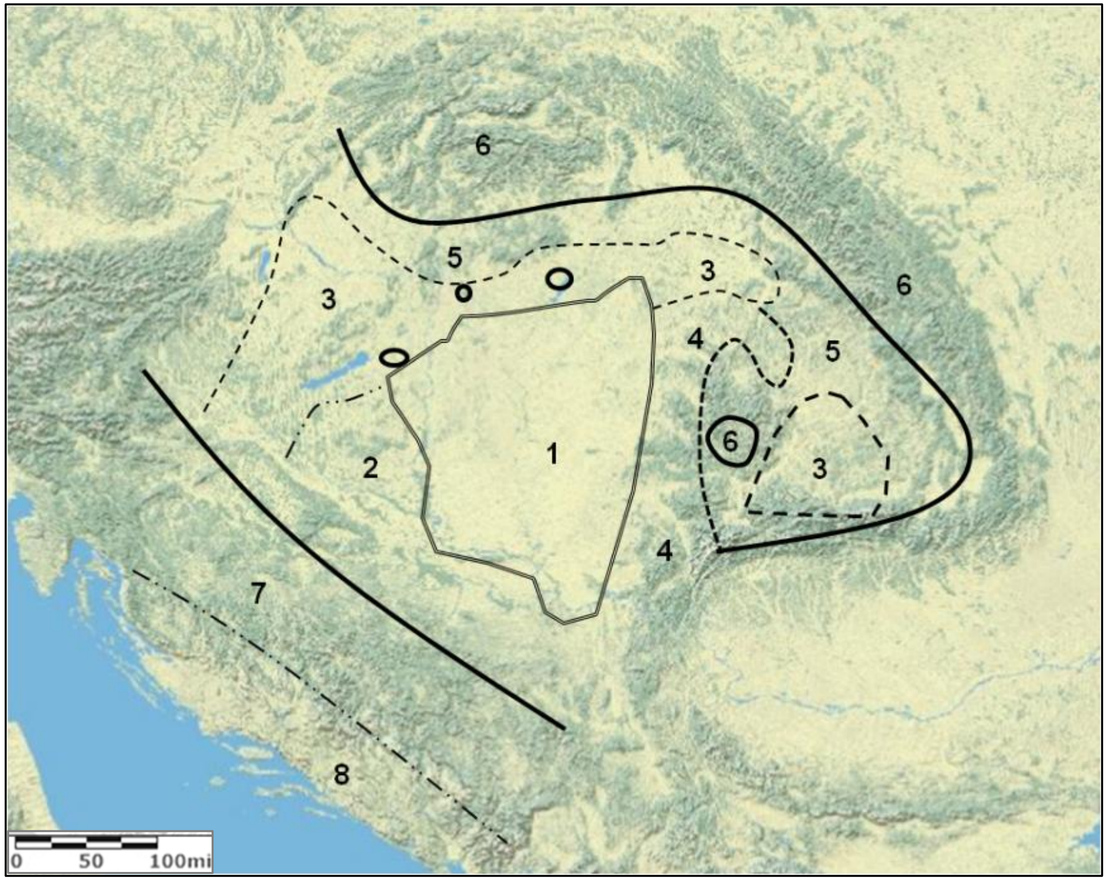


Fig 2.3. Vegetation zones in the Carpathian Basin.

(1) Pannonian forest steppe; (2) Sub-Mediterranean oak forest; (3) Central European and sub-Mediterranean mixed oak forest; (4) Balcanic oak forest; (5) Central European oak forest; (6) Sub alpine and alpine, beech and needle-leaved forest; (7) Pine and beech forest; (8) Pine and oak forest (adapted from Rudner and Sümegi 2001:180 Fig. 4)

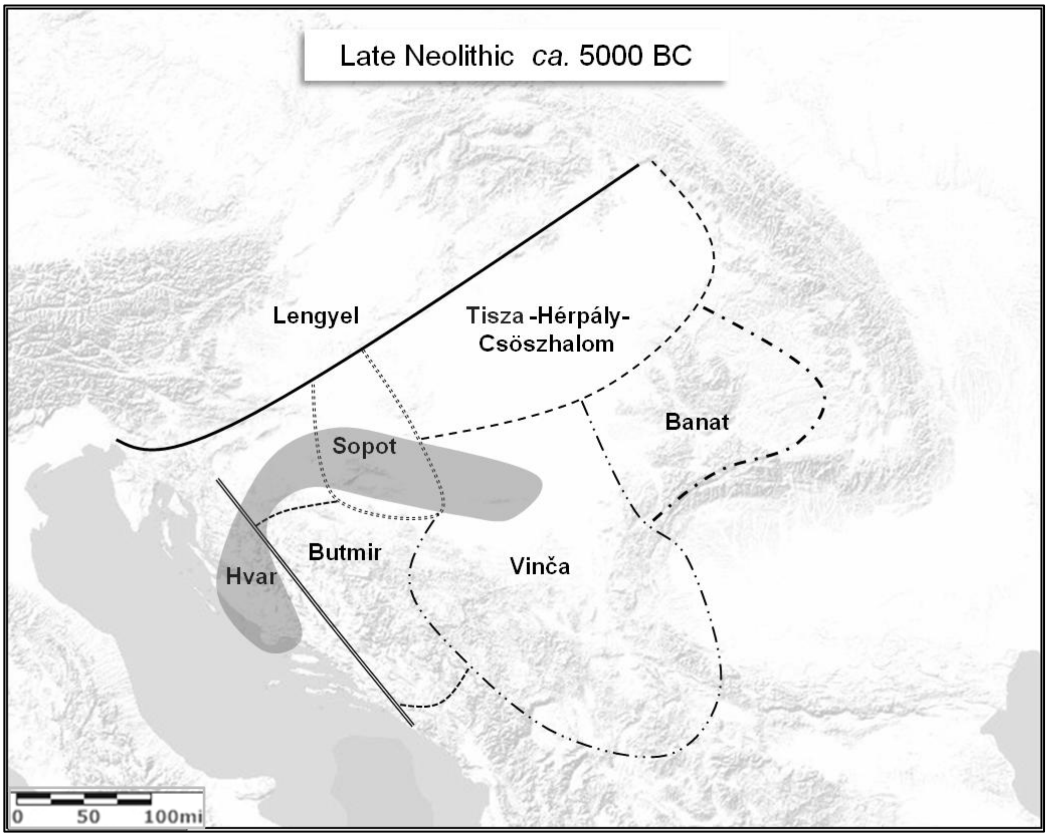


Fig 2.4. Outline of cultural groups present in the Carpathian Basin *ca.* 5000 BC. Core study area is shaded.

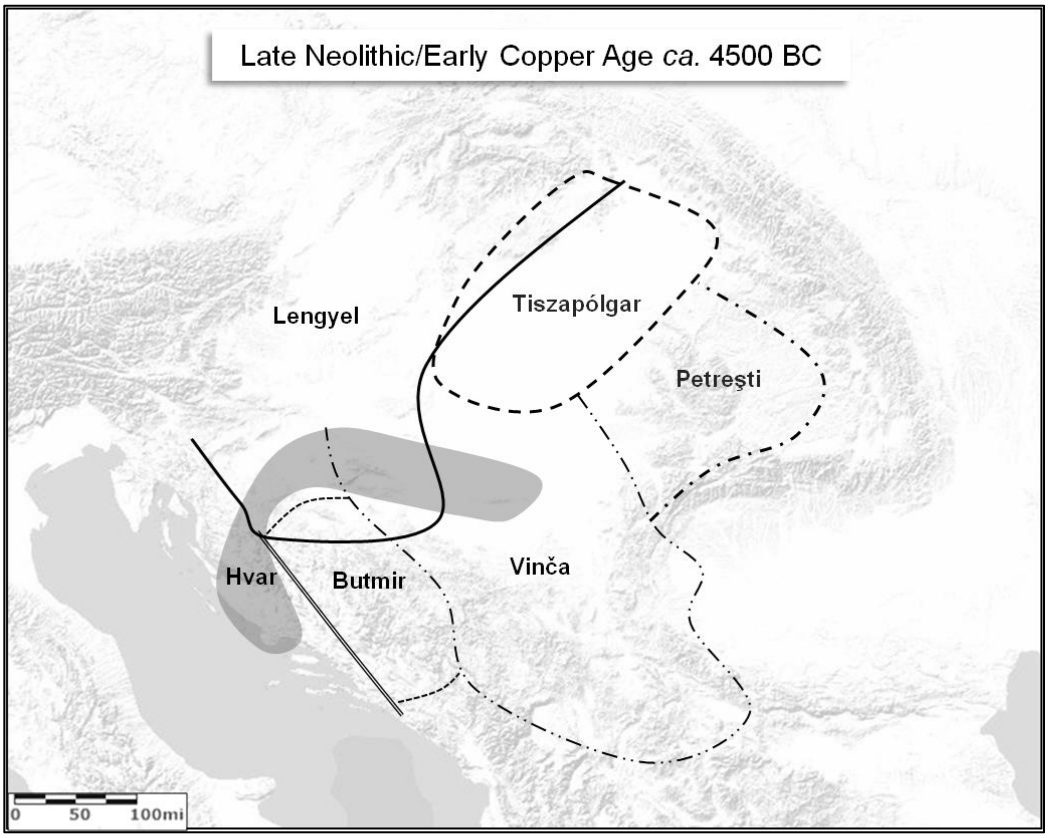


Fig 2.5. Outline of cultural groups present *ca.* 4500 BC. Core study area is shaded.

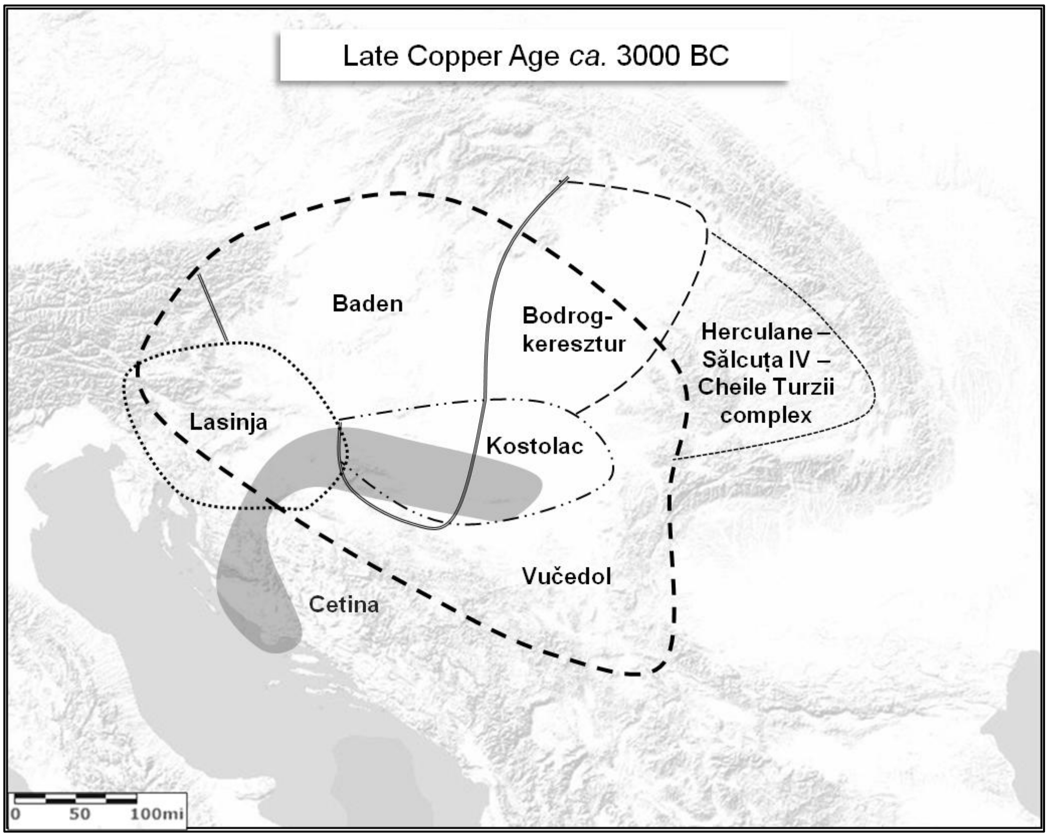


Fig 2.6. Outline of cultural groups present *ca.* 3000 BC. Core study area is shaded.

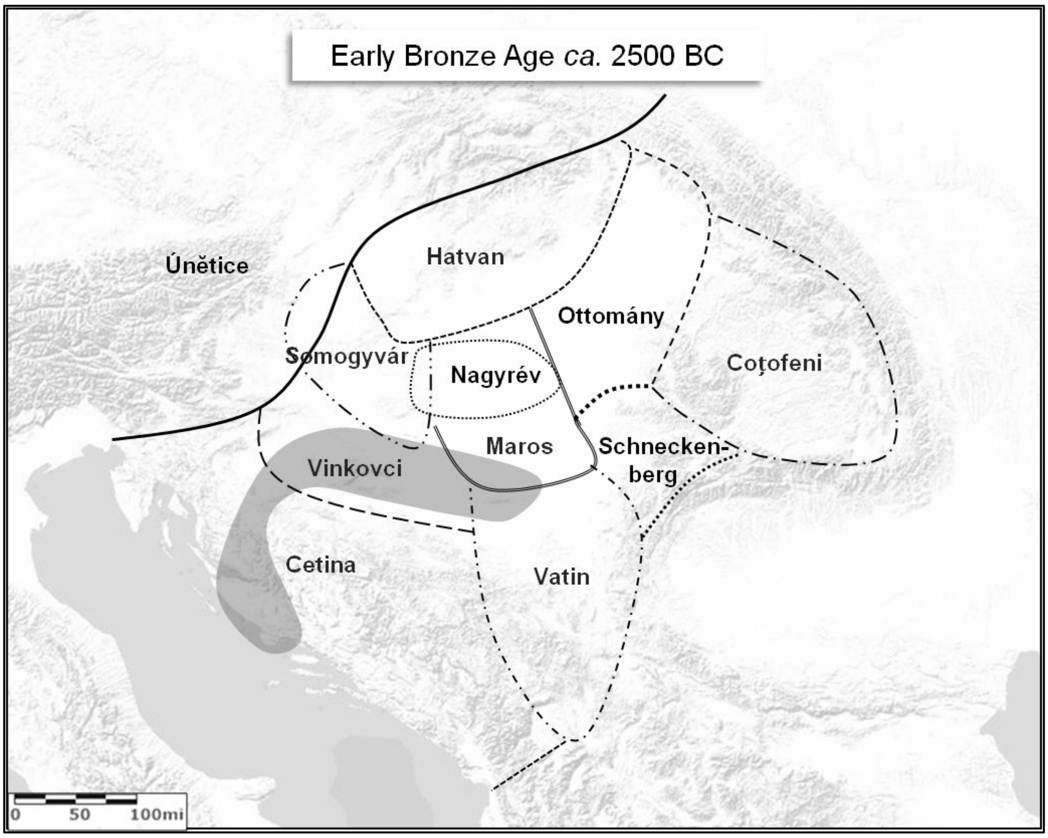


Fig 2.7. Outline of cultural groups present *ca.* 2500 BC. Core study area is shaded.

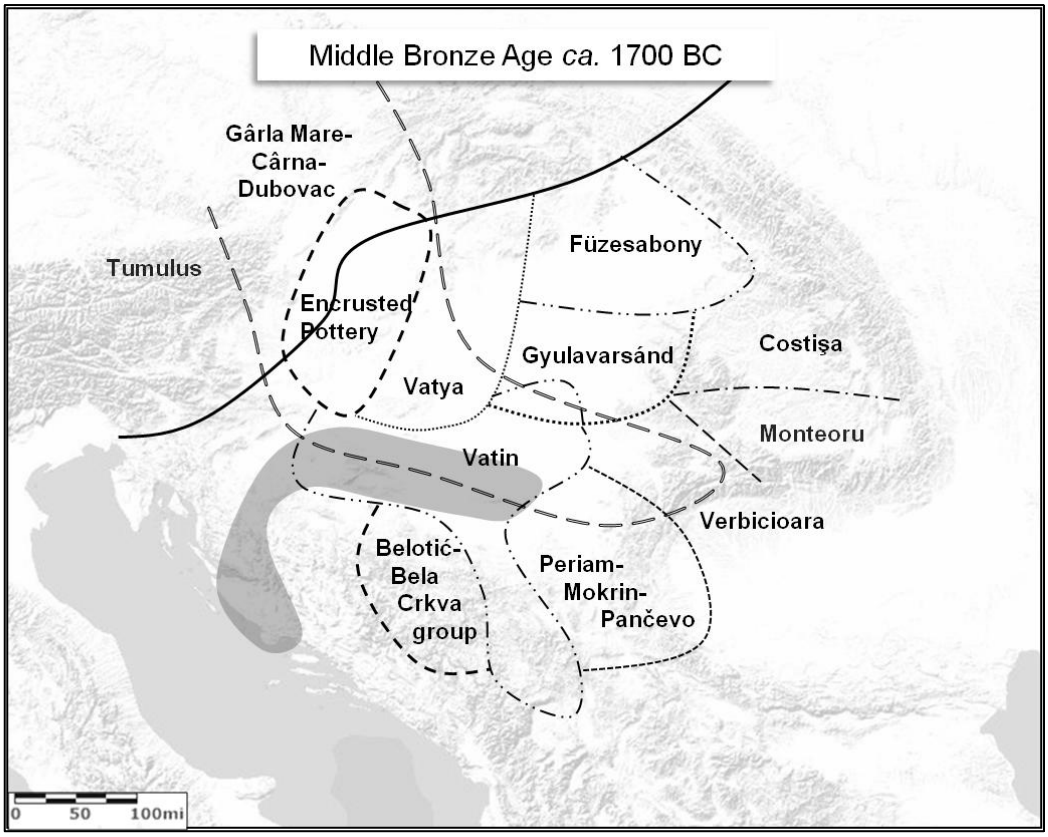


Fig 2.8. Outline of cultural groups present *ca.* 1700 BC. Core study area is shaded.

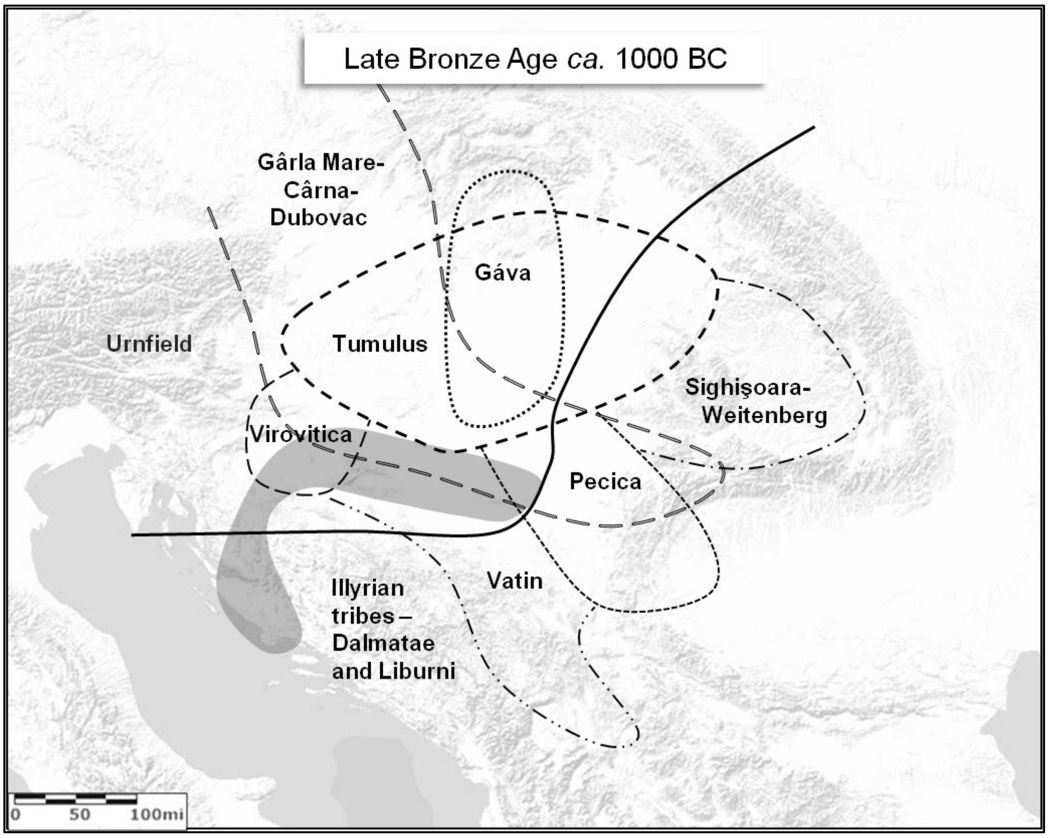


Fig 2.9. Outline of cultural groups present *ca.* 1000 BC. Core study area is shaded.

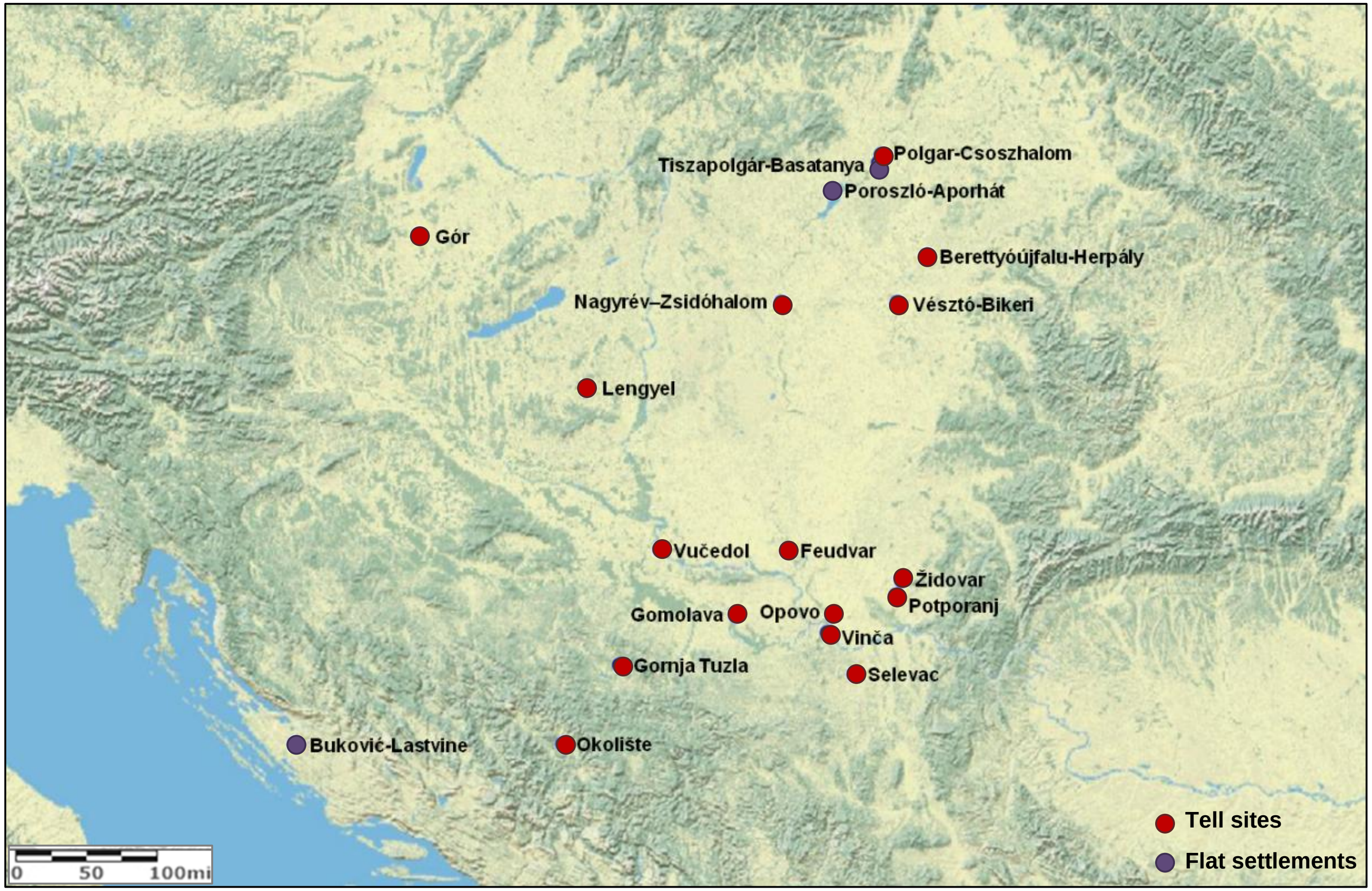


Fig 2.10. Map of the main tell and flat sites within the Carpathian Basin discussed in Chapter 2

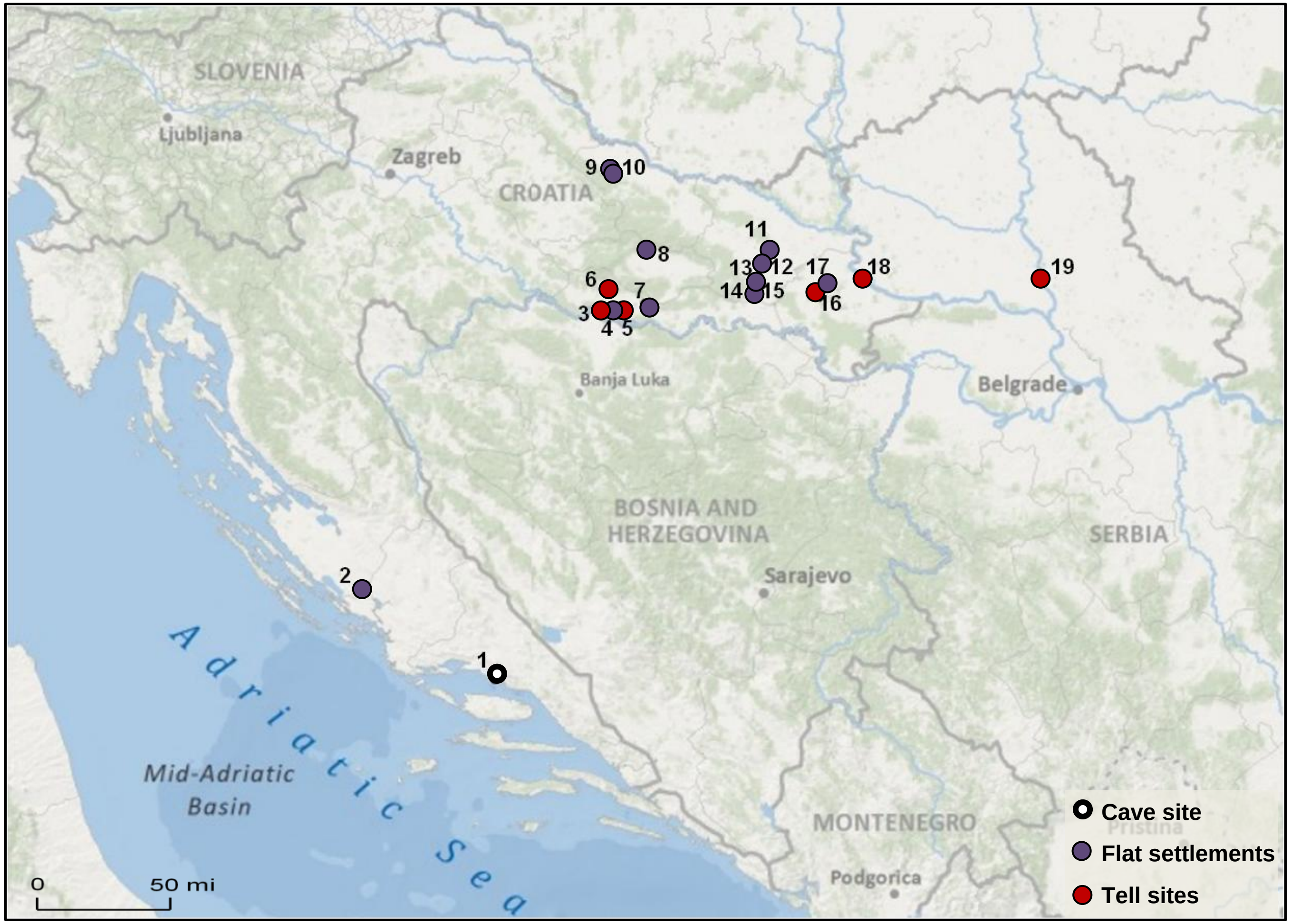


Fig 4.1. Locations of the study sites. Base map GEBCO, NOAA, National Geographic, DeLorme, and Esri Ocean Basemap 2008.
1. Turska Peć, 2. Cista Mala Velištak, 3. Mačkovac Crišnjevi, 4. Crišnjevi – Oštrov, 5. Orubica-Veliki Šeš, 6. Slavča, 7. Ravnjas, 8. Potočani, 9. Virovitica-Batelije, 10. Virovitica-Brekinja, 11. Ivandvor-Gaj, 12. Pajtenica-Velike Livade, 13. Jurjevac-Stara Vodenica, 14. Tomašanci - Palača, 15. Đakovo-Franjevac, 16. Sopot , 17. Vinkovci, 14 Matije Gupca, 18. Vučedol, 19. Feudvar

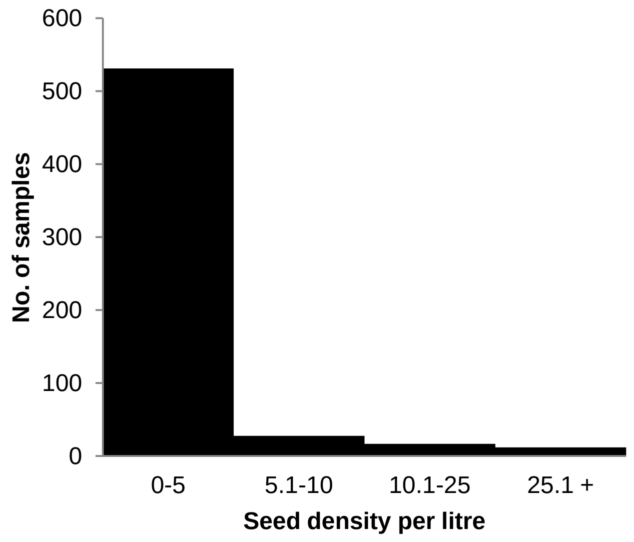


Figure 4.2. Number of samples per density group for the 18 Croatian sites (n=565)

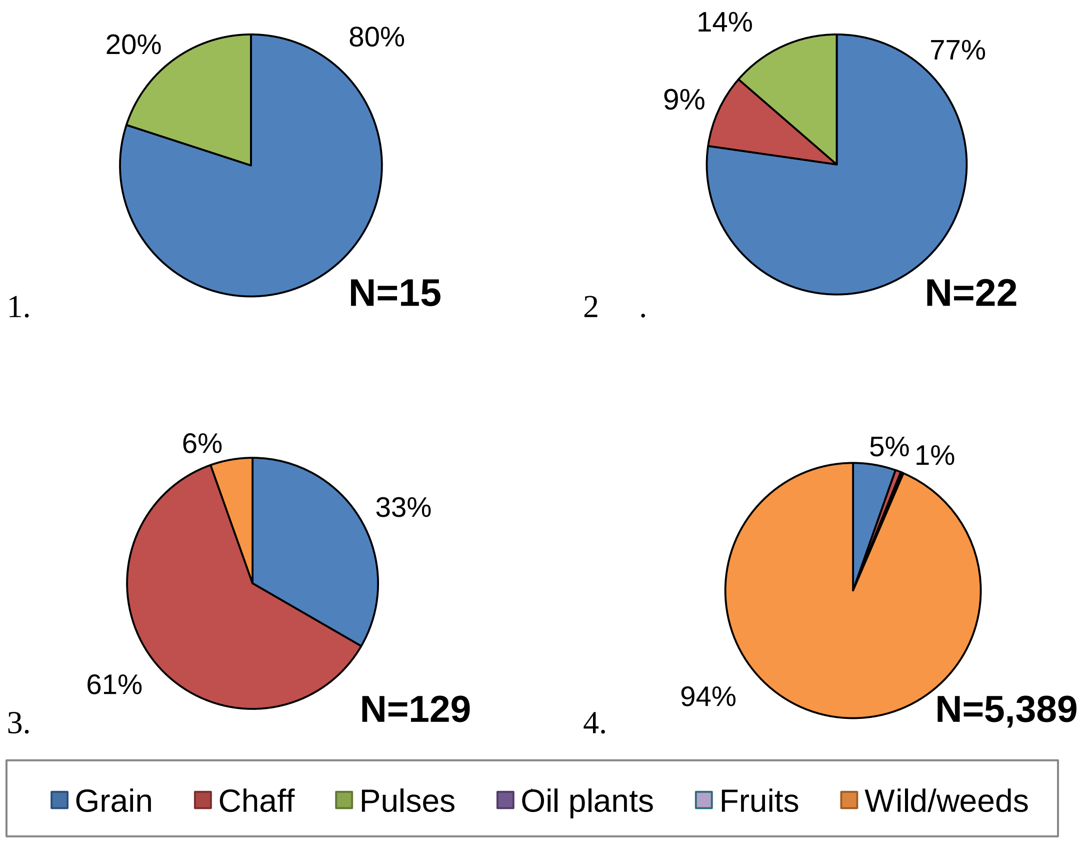


Fig 4.3. Pie charts representing the percentage of seeds allocated to a particular plant category per site: Mid/Late Neolithic.Croatia. 1. Virovitica-Brekinja, 2. Ivandvor-Gaj, 3. Čista Mala Valištak, 4. Turska Peć , 5. Sopot, 6. Slavča, 7. Ravnjaš

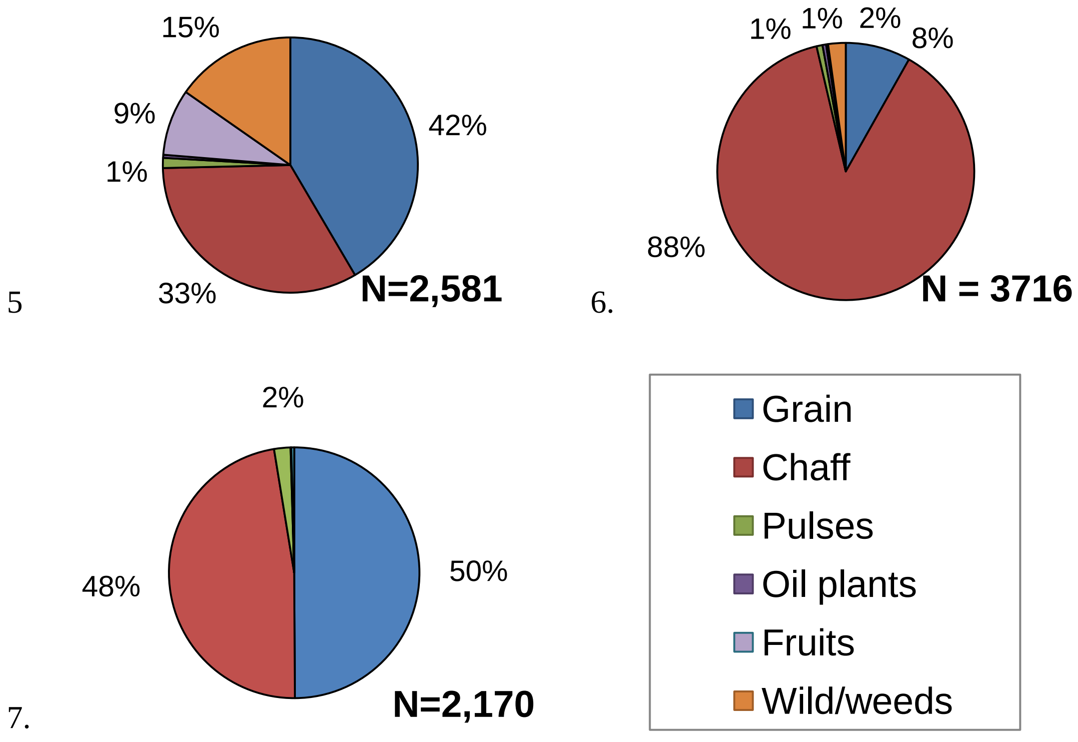


Fig 4.3. (Continued)

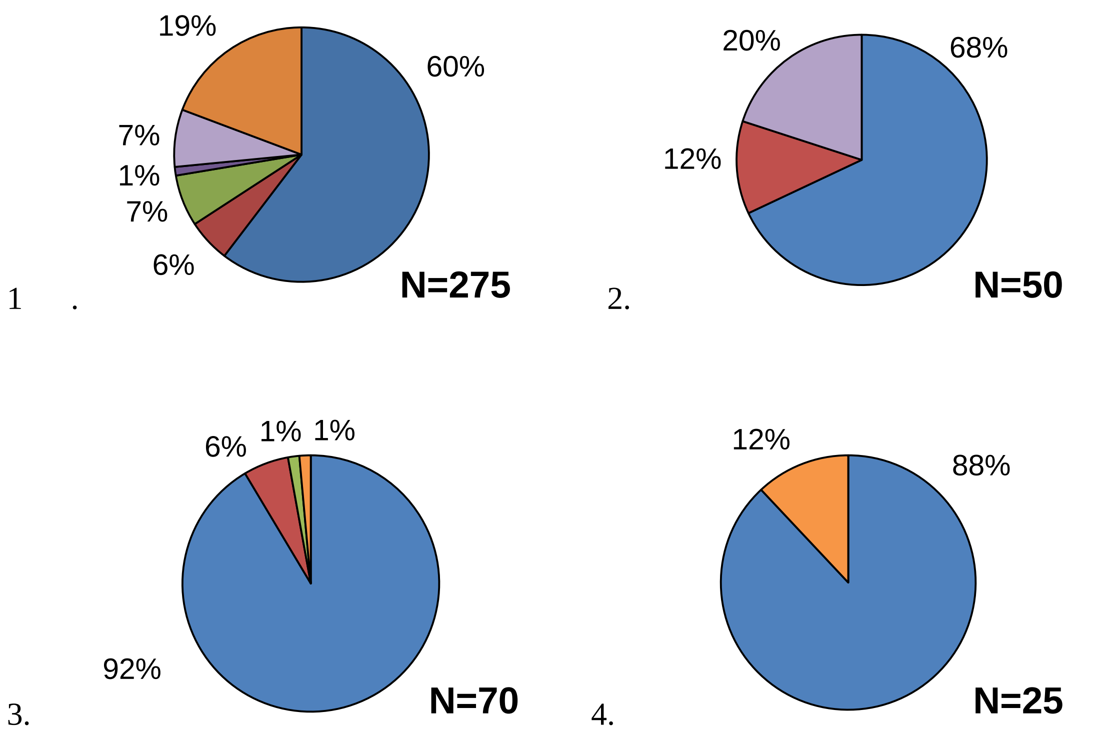


Fig 4.4. Pie charts representing the percentage of seeds allocated to a particular plant category per site: Copper Age Croatia.1. Đakovo-Franjevac, 2. Jurjevac-Stara Vodenica, 3. Potočani, 4. Pajtenica-Velike Livade, 5. Virovitica-Batelije, 6. Vinkovci/ Matije Gupca 14, 7. Vučedol, 8. Tomašanci–Palača, 9. Slavča

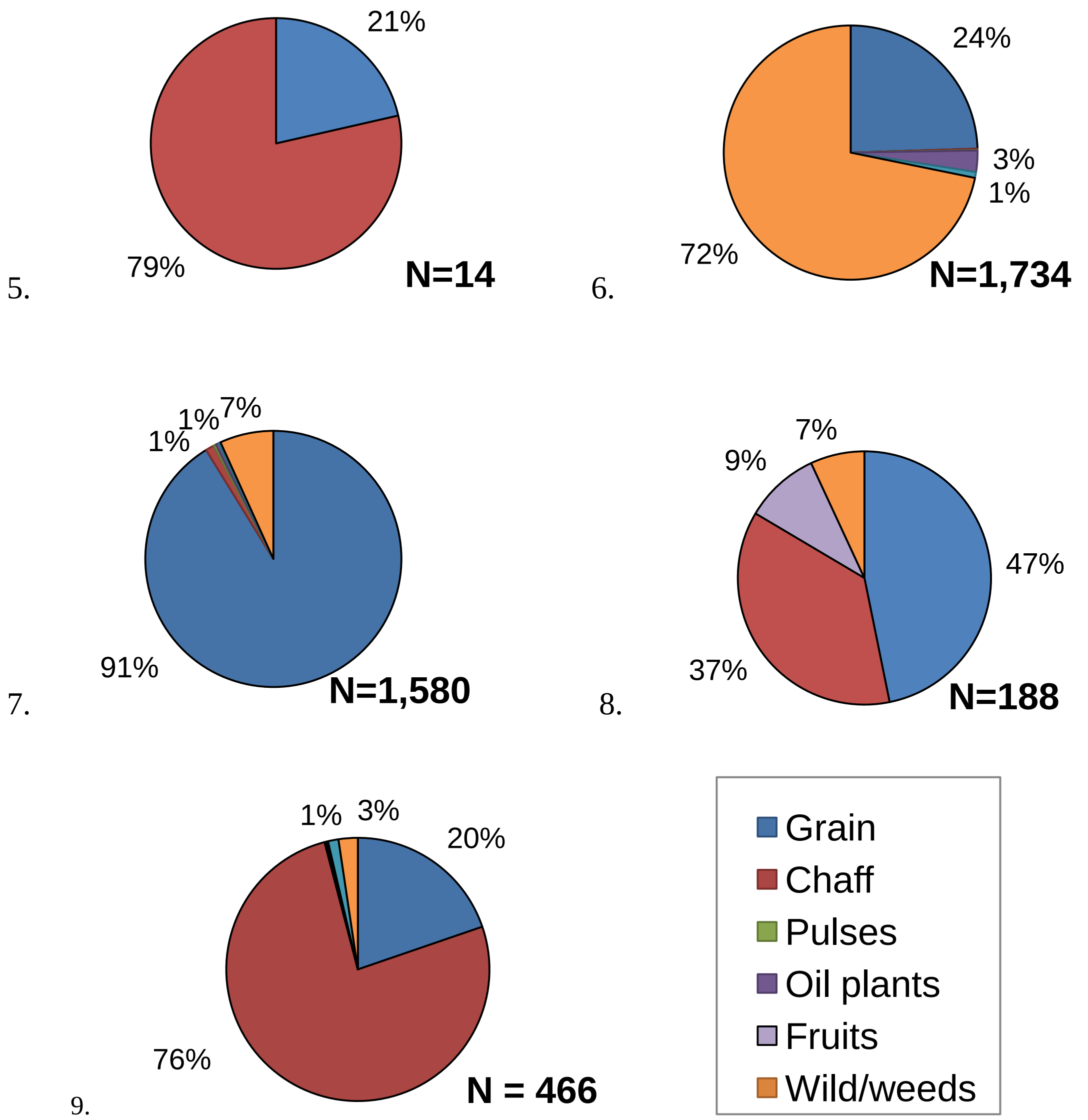


Fig 4.4. (Continued)

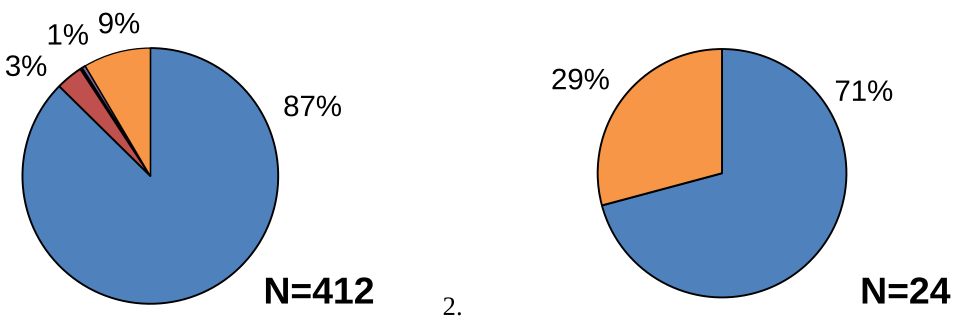


Fig 4.5. Pie charts representing the percentage of seeds allocated to a particular plant category per site: Late Bronze Age Croatia. 1.Mačkovac Crišnjevi, 2. Crišnjevi-Oštrov, 3.Orubica-Veliki Šeš, 4. Tomašanci – Palača

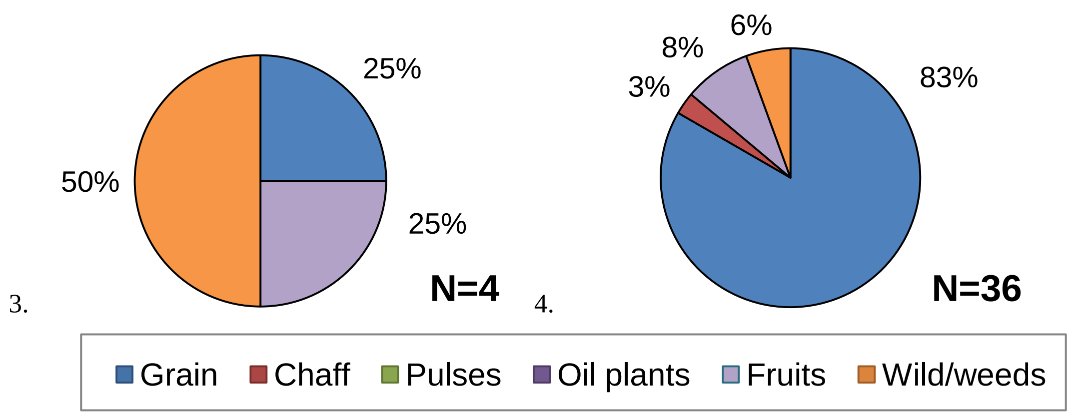


Fig 4.5. (Continued)

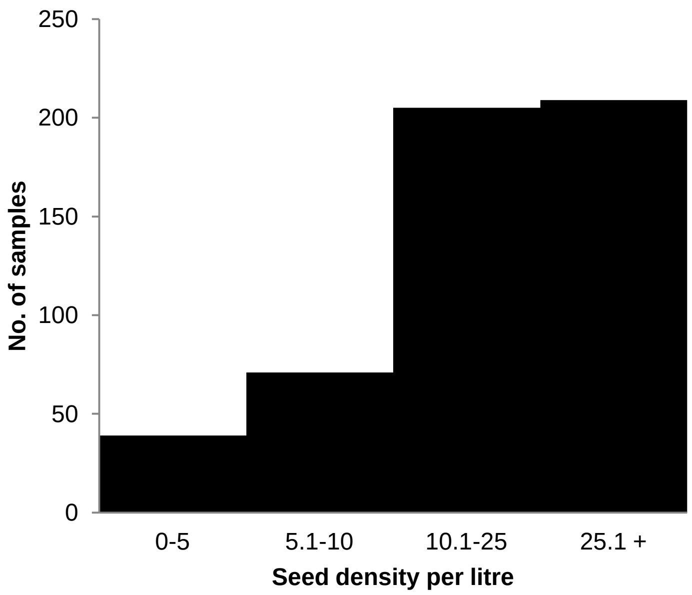


Fig 5.1. Number of samples per density group: Late Bronze Age Feudvar (n=524)

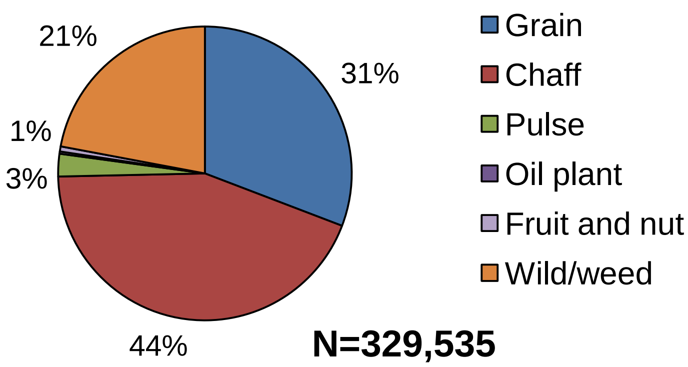


Fig 5.2. Pie chart representing the percentage of seeds allocated to a particular plant category: Late Bronze Age Feudvar

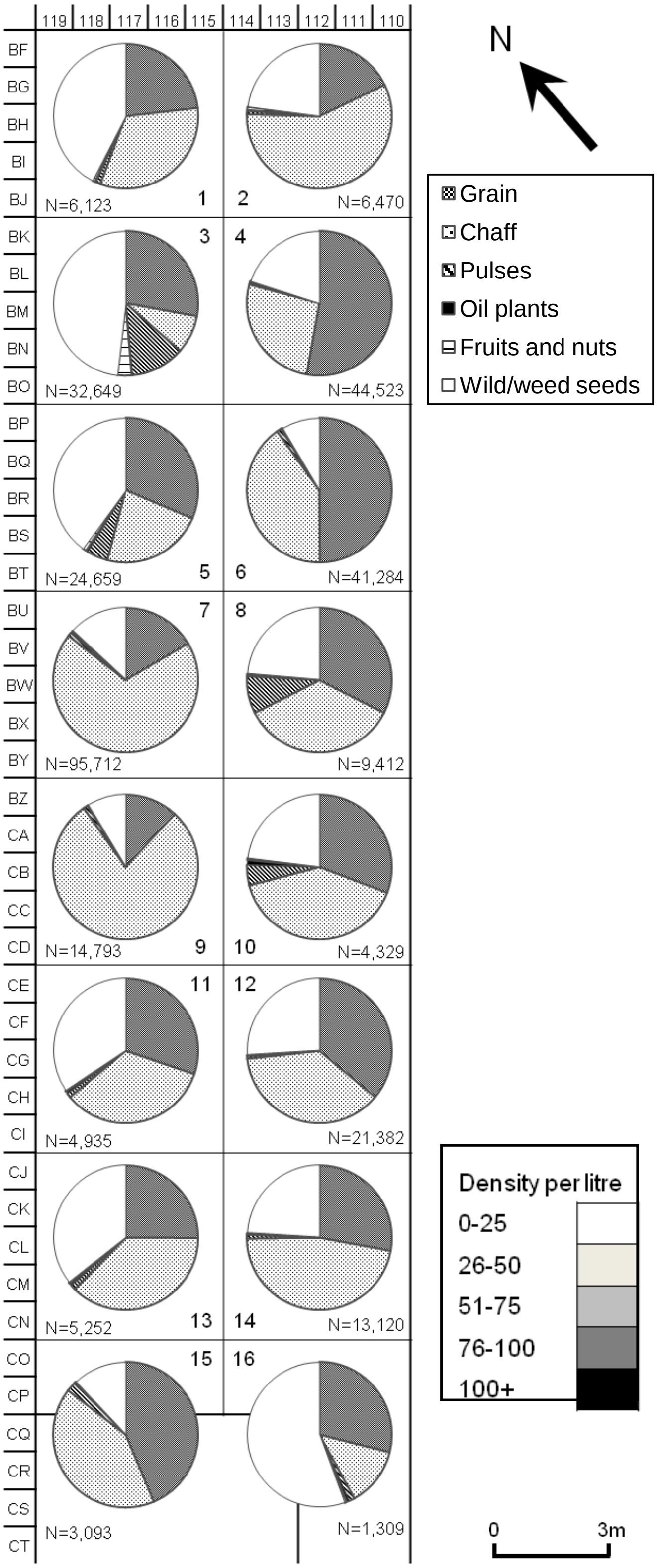


Fig 5.3. Pie charts representing the percentage of seeds allocated to a particular plant category per block: Late Bronze Age Feudvar

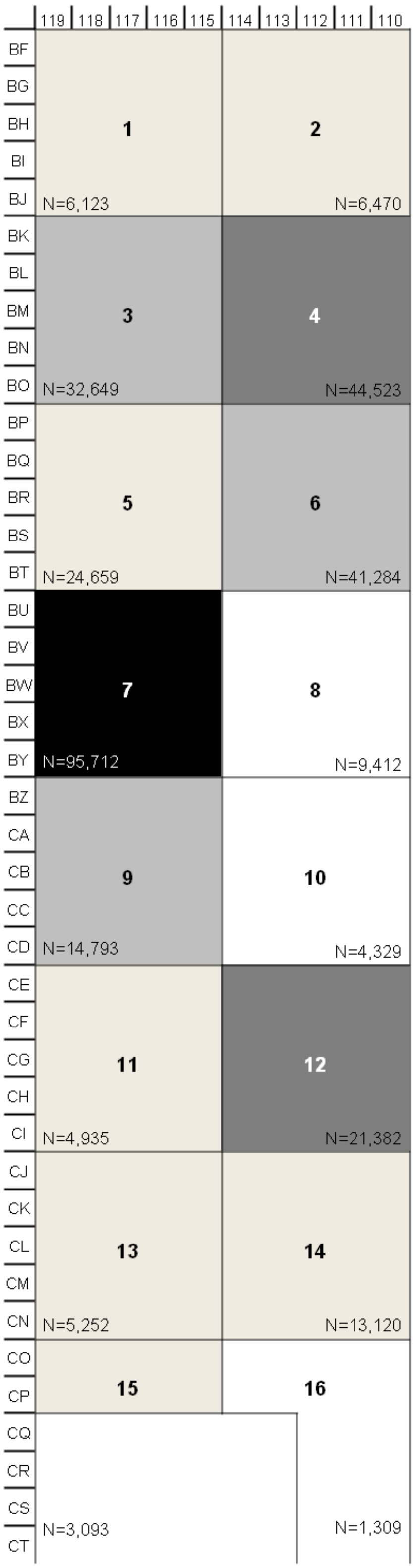


Fig 5.4. Average seed density per litre of sediment per block: Late Bronze Age Feudvar

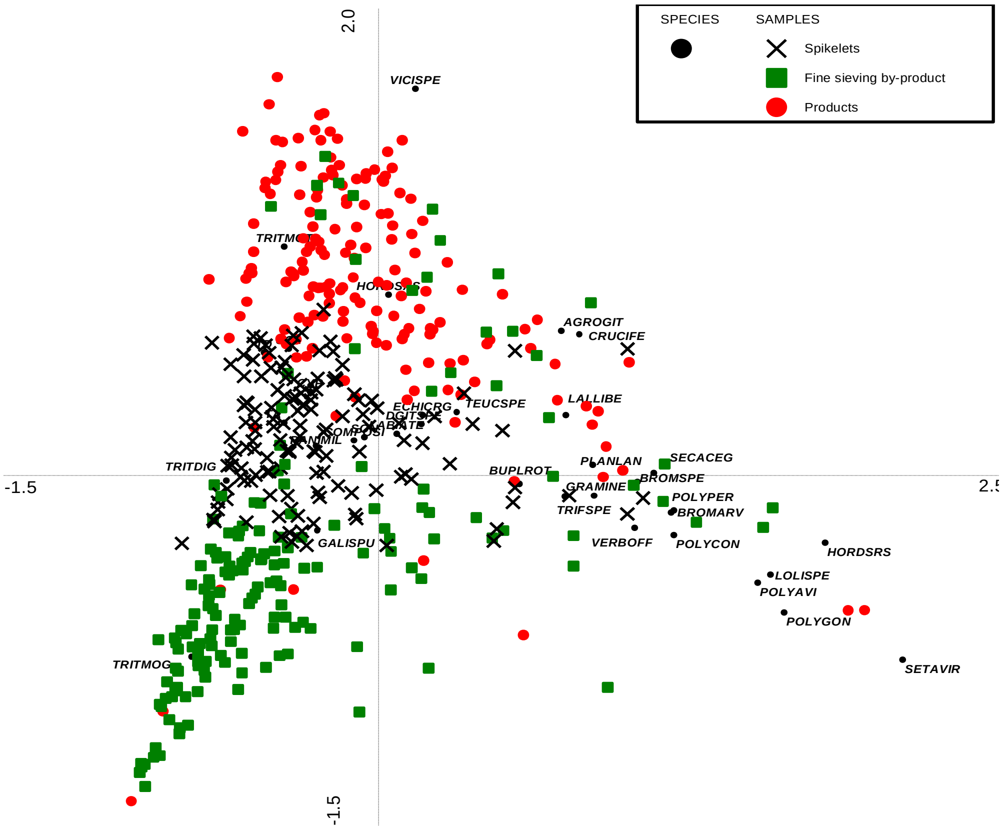


Fig 6.1. Correspondence analysis of the Feudvar samples (> 50 identifications and > 10% weed species) classified by the crop processing stage, as identified by the ratio analysis, on the first two principal axes (axis 1 horizontal, axis 2 vertical): LBA Feudvar

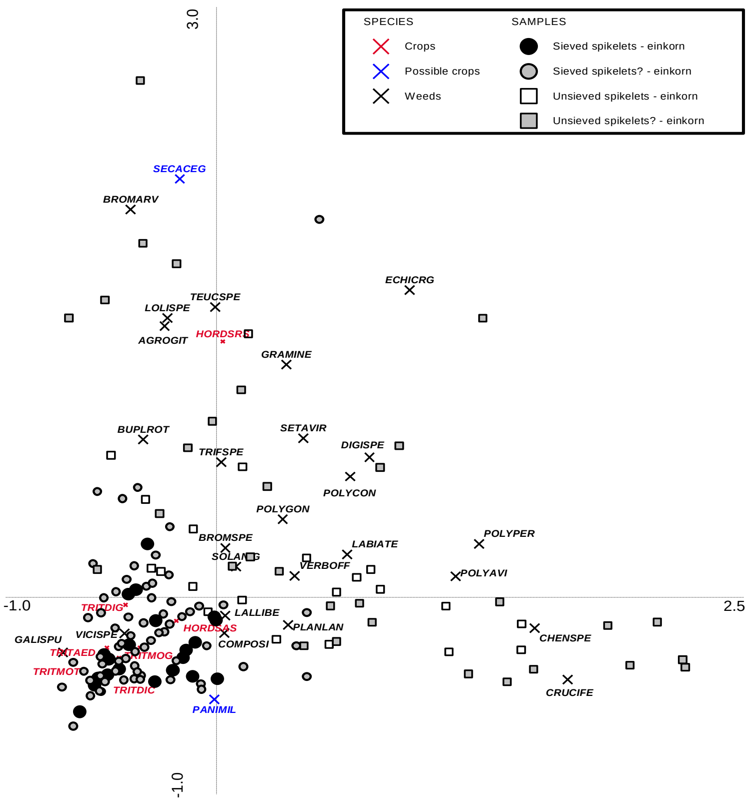


Fig 6.2. Correspondence analysis of samples identified as sieved and unsieved einkorn spikelets: LBA Feudvar

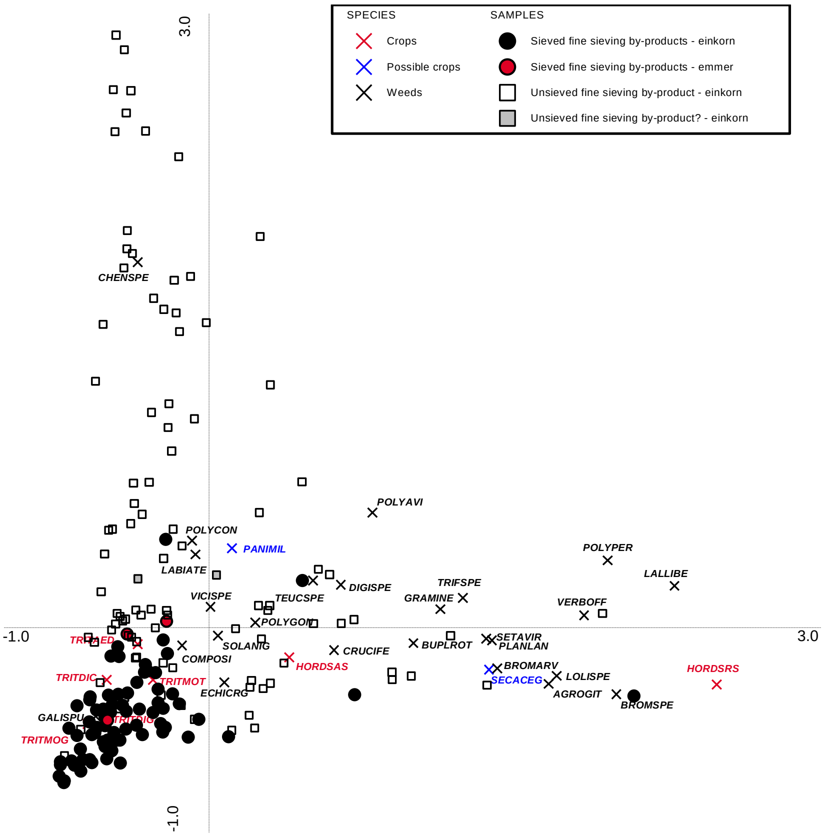


Fig 6.3. Correspondence analysis of samples identified as sieved and unsieved fine sieving by-products: LBA Feudvar

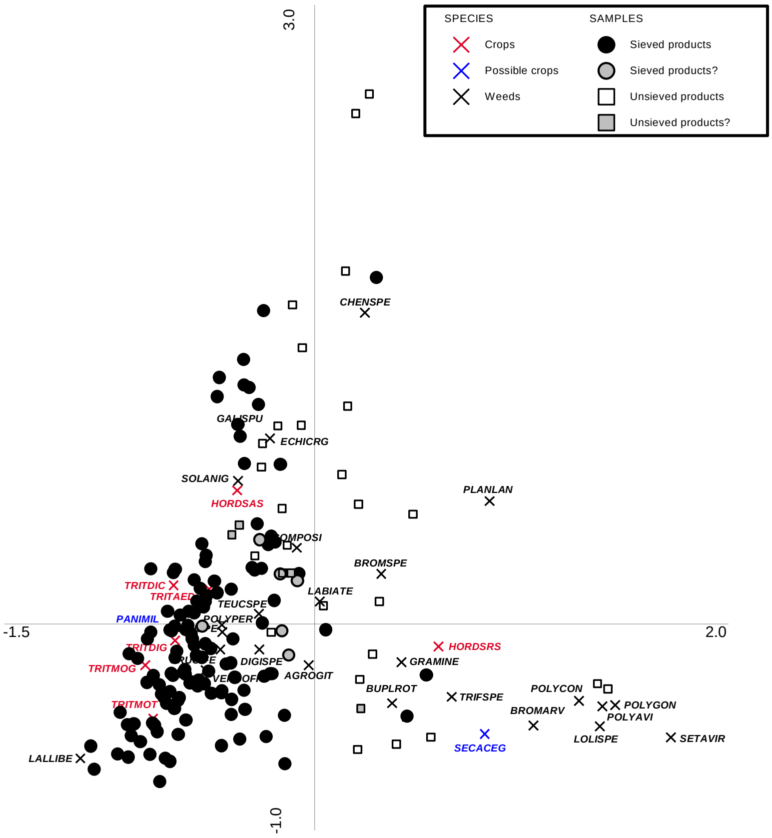


Fig 6.4. Correspondence analysis of samples identified as sieved and unsieved products: LBA Feudvar

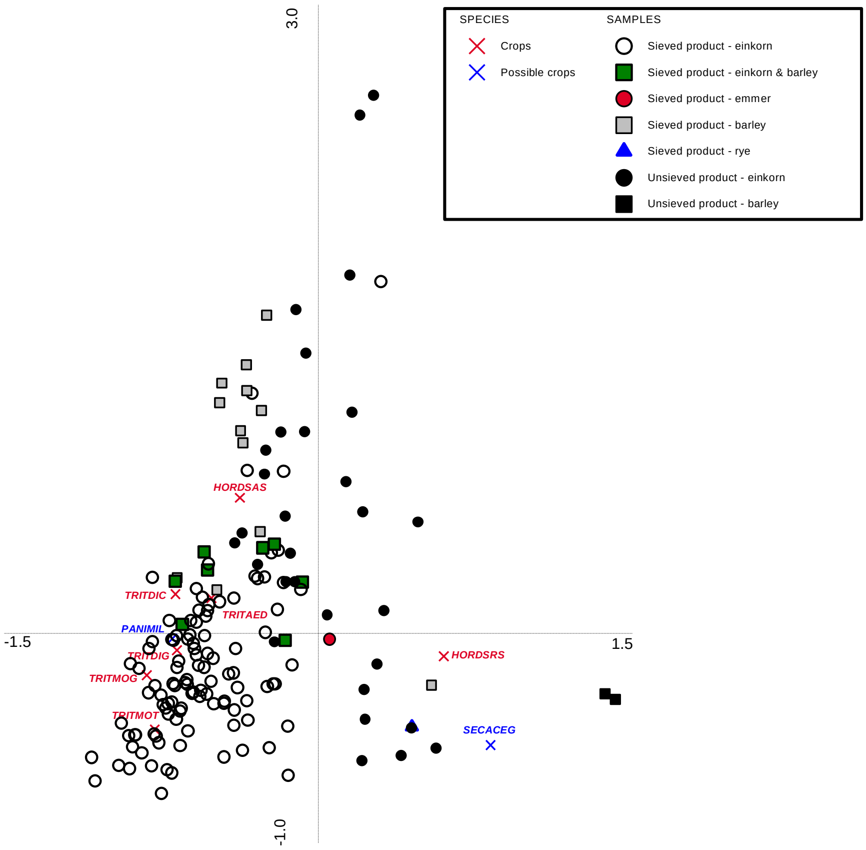


Fig 6.5. Correspondence analysis of samples identified to specific crop products: LBA Feudvar

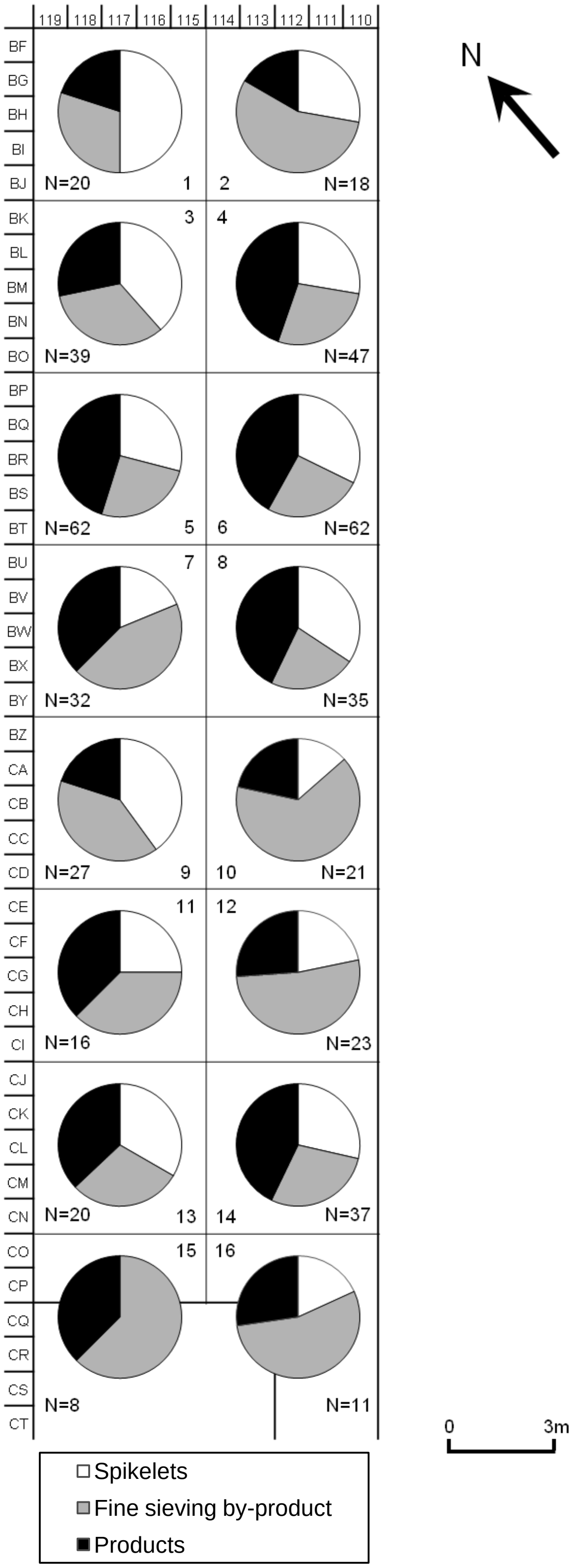


Fig. 6.6. Pie charts representing the percentage of samples identified as spikelets, fine sieving by-products and products per 5x5m area: LBA Feudvar

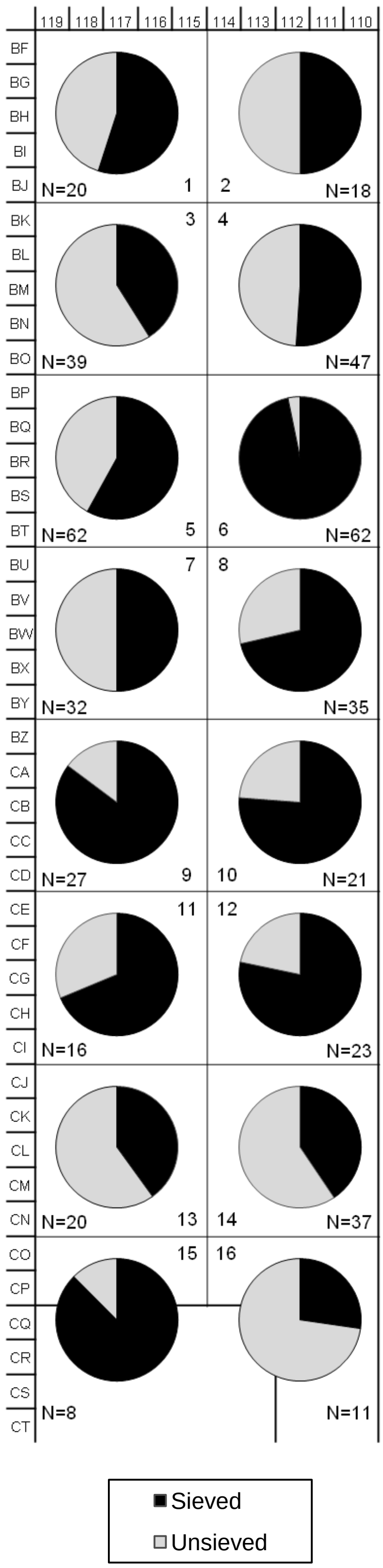


Fig 6.7. Pie charts representing the percentage of samples identified as sieved and unsieved (regardless of crop processing stage) per 5x5m area: LBA Feudvar

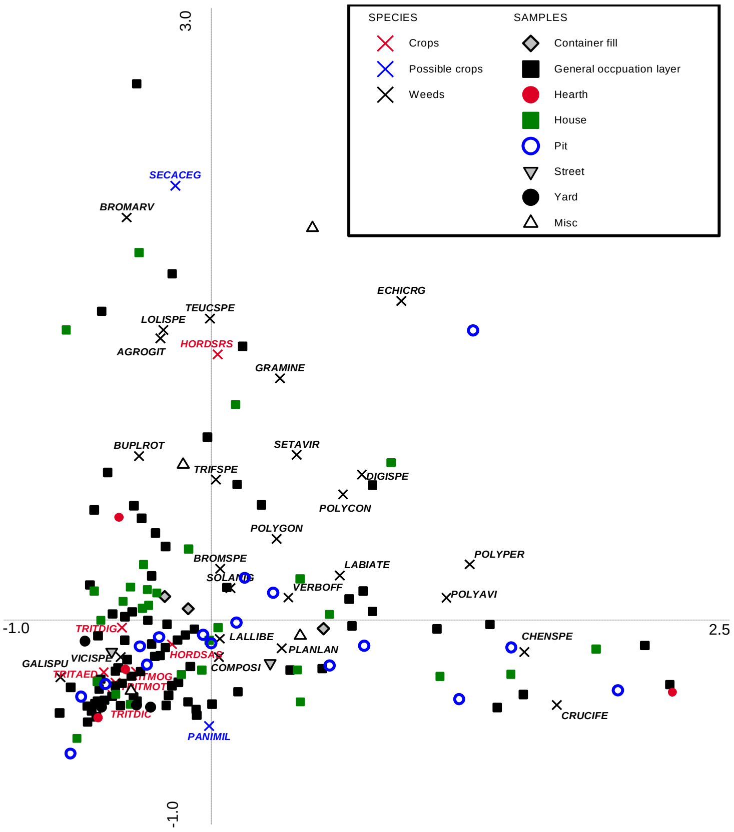


Fig 6.8. Correspondence analysis of samples identified as spikelets per feature type: LBA Feudvar

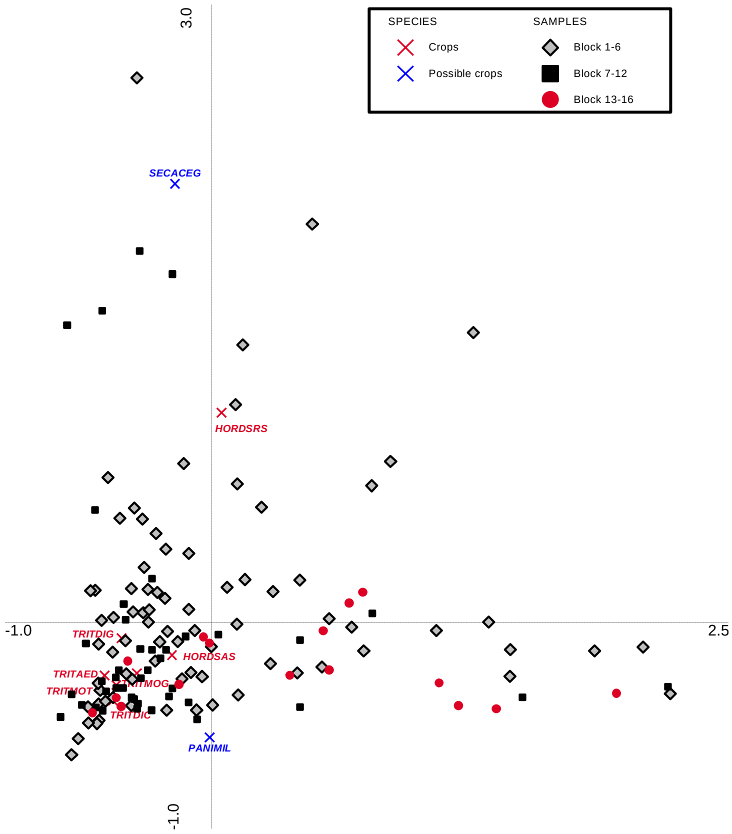


Fig 6.9. Correspondence analysis of samples identified as spikelets per area/block within the trench: LBA Feudvar

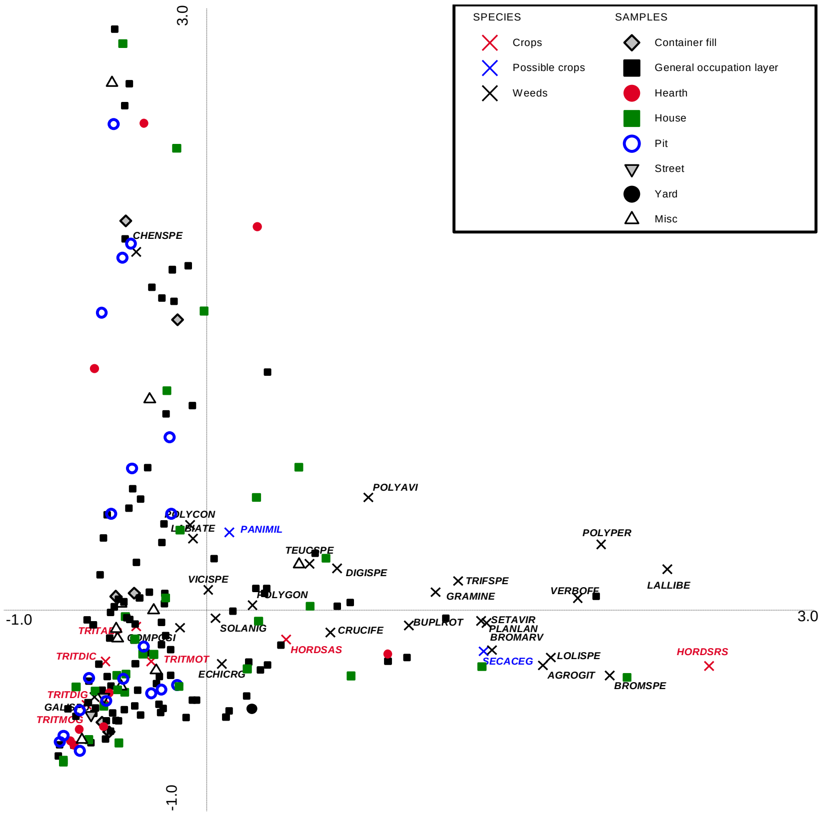


Fig 6.10. Correspondence analysis of samples identified as fine sieving by-products per feature type: LBA Feudvar

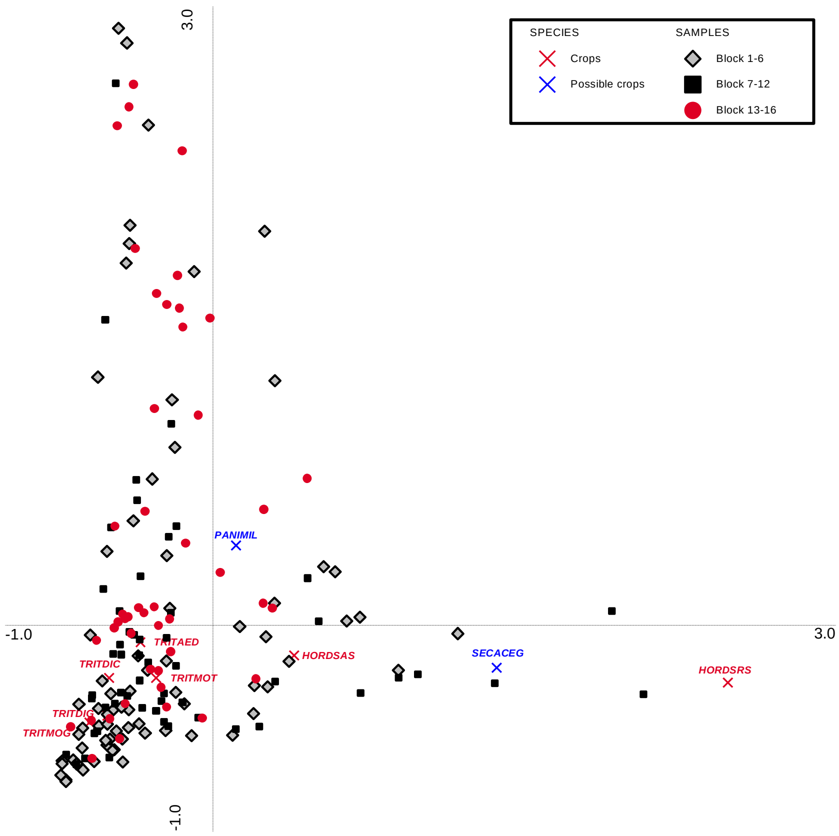


Fig 6.11. Correspondence analysis of samples identified as fine sieving by-products per area/block within the trench: LBA Feudvar

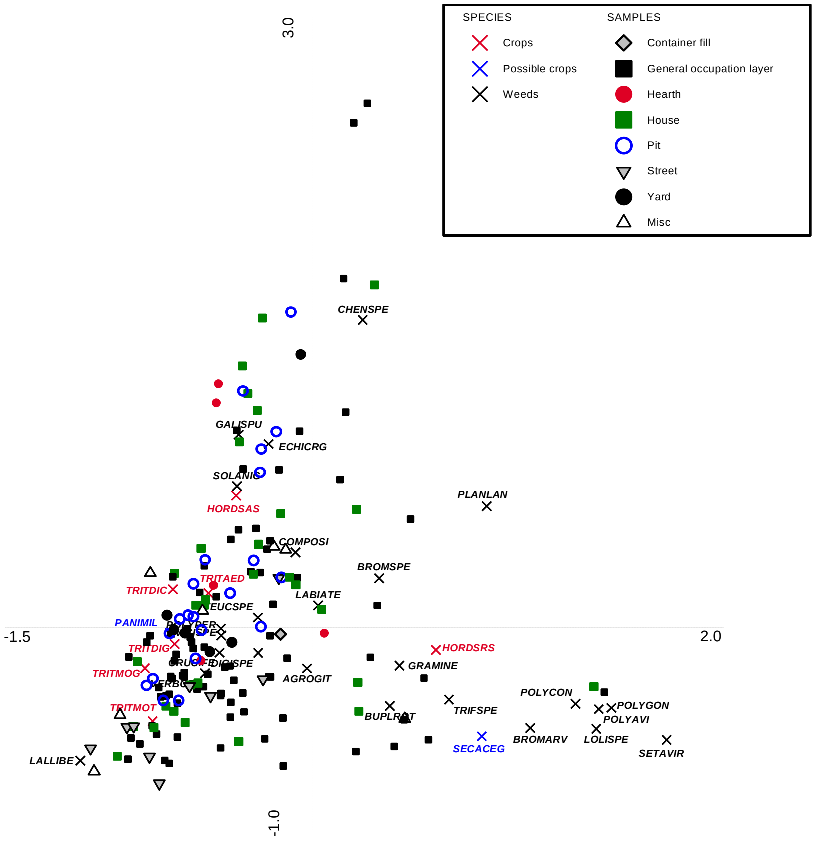


Fig 6.12. Correspondence analysis of samples identified as products per feature type: LBA Feudvar

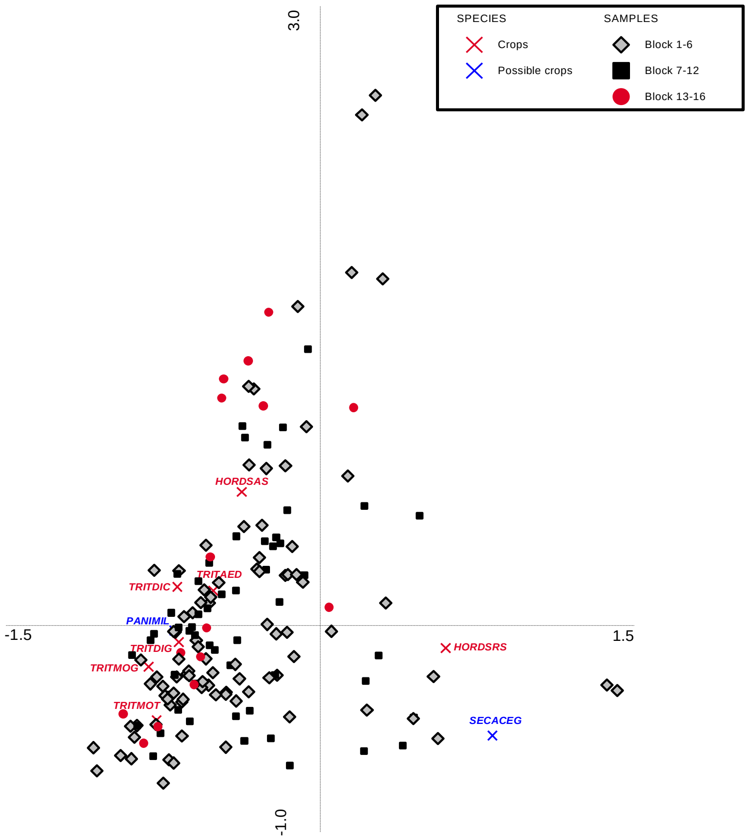


Fig 6.13. Correspondence analysis of samples identified as products per area/block within the trench: LBA Feudvar

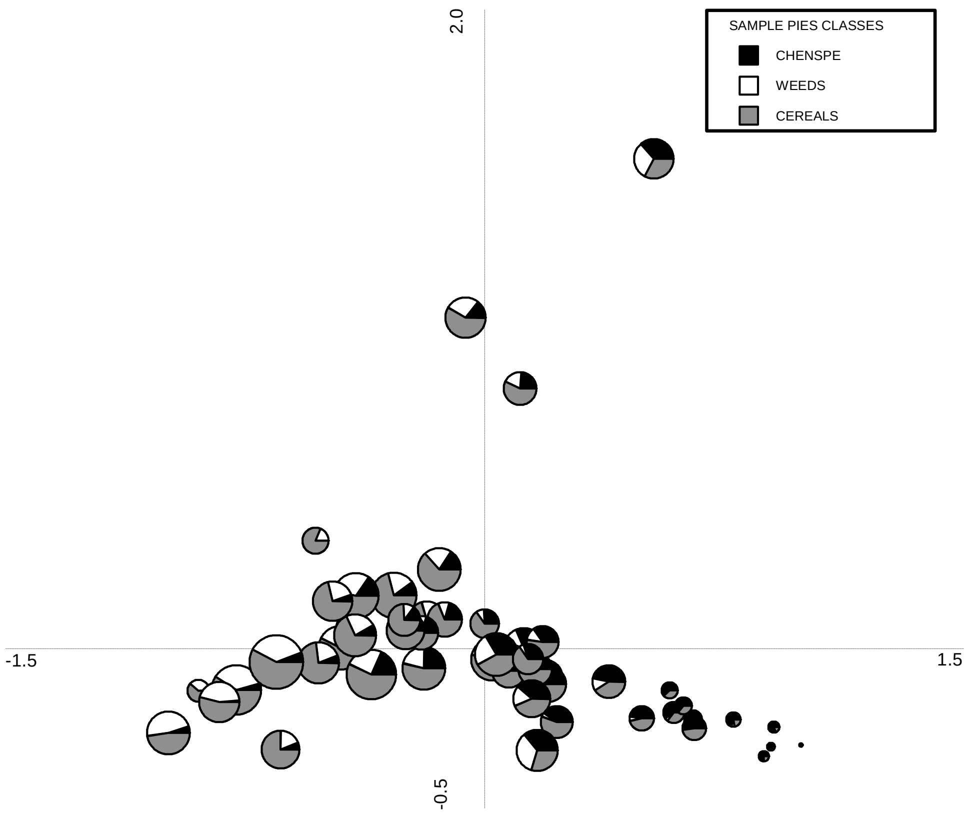


Fig 7.1. Unsieved spikelets - Shannon diversity examining the impact of Chenopodium on sample composition: LBA Feudvar.

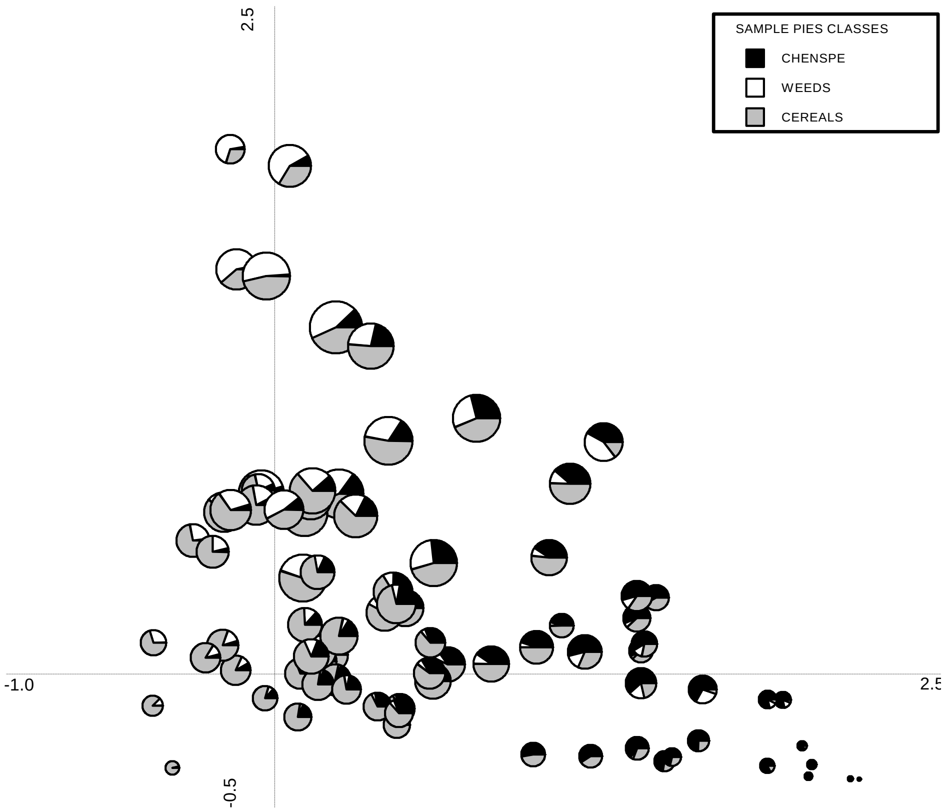


Fig 7.2. Unsieved fine sieving by-produces - Shannon diversity examining the impact of Chenopodium on sample composition: LBA Feudvar.

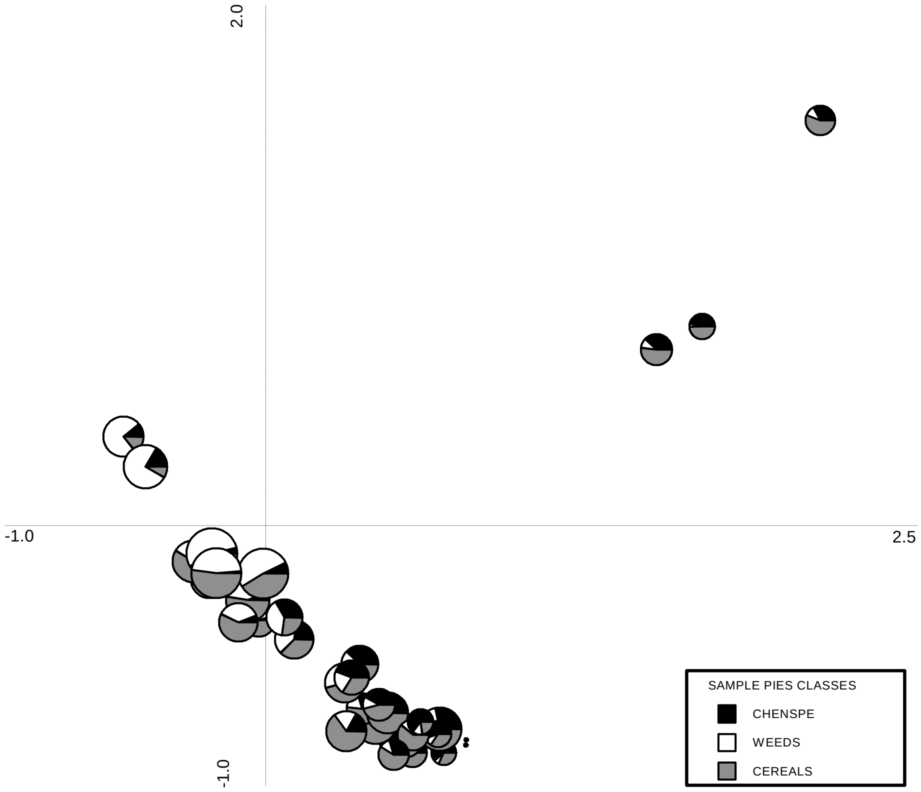


Fig 7.3. Unsieved products - Shannon diversity examining the impact of Chenopodium on sample composition: LBA Feudvar.

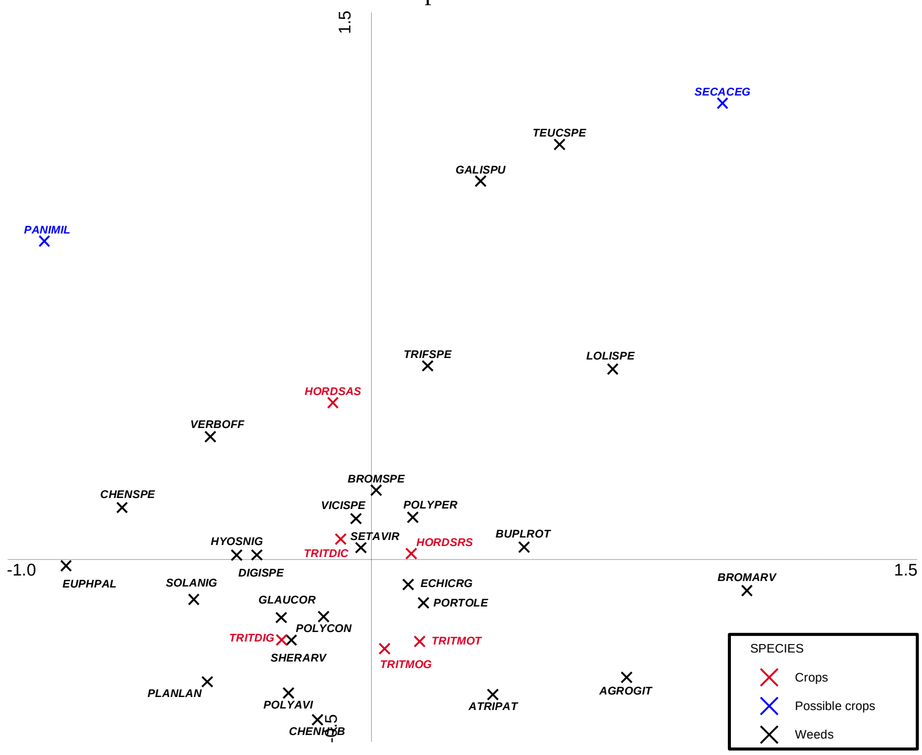


Fig 7.4. Correspondence analysis of crops, possible crops and weed species for samples identified as unsieved spikelets on the first two principal axes (axis 1 horizontal, axis 2 vertical): LBA Feudvar

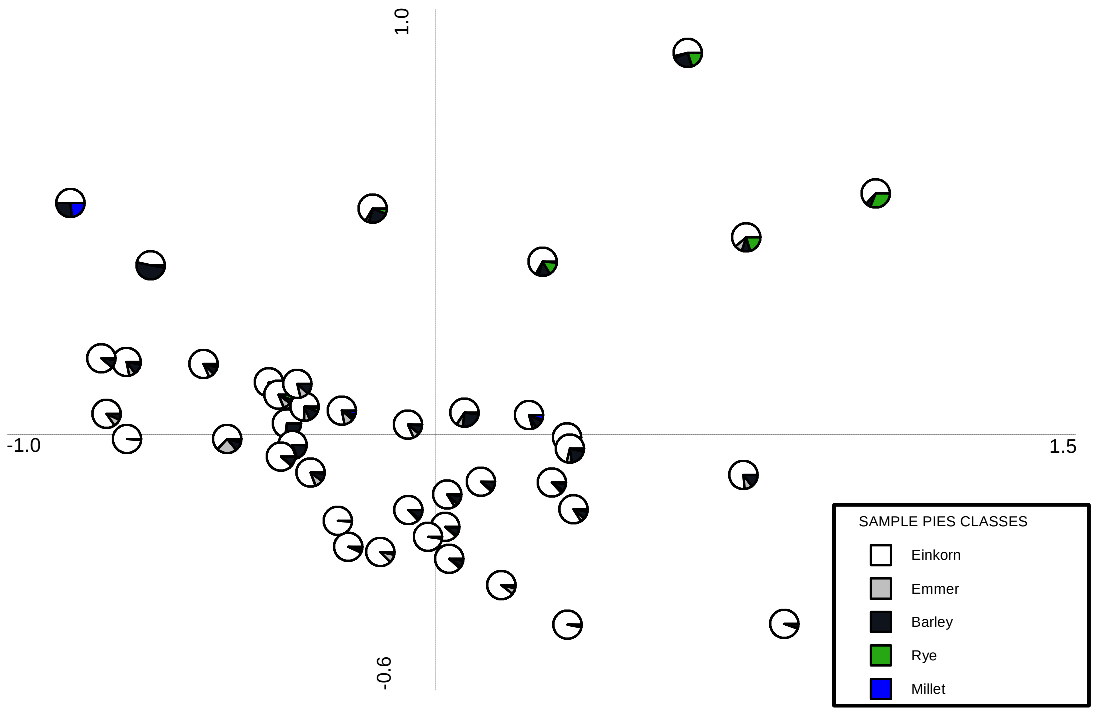


Fig 7.5. Correspondence analysis of the proportion of cereals per sample identified as unsieved spikelets: LBA Feudvar

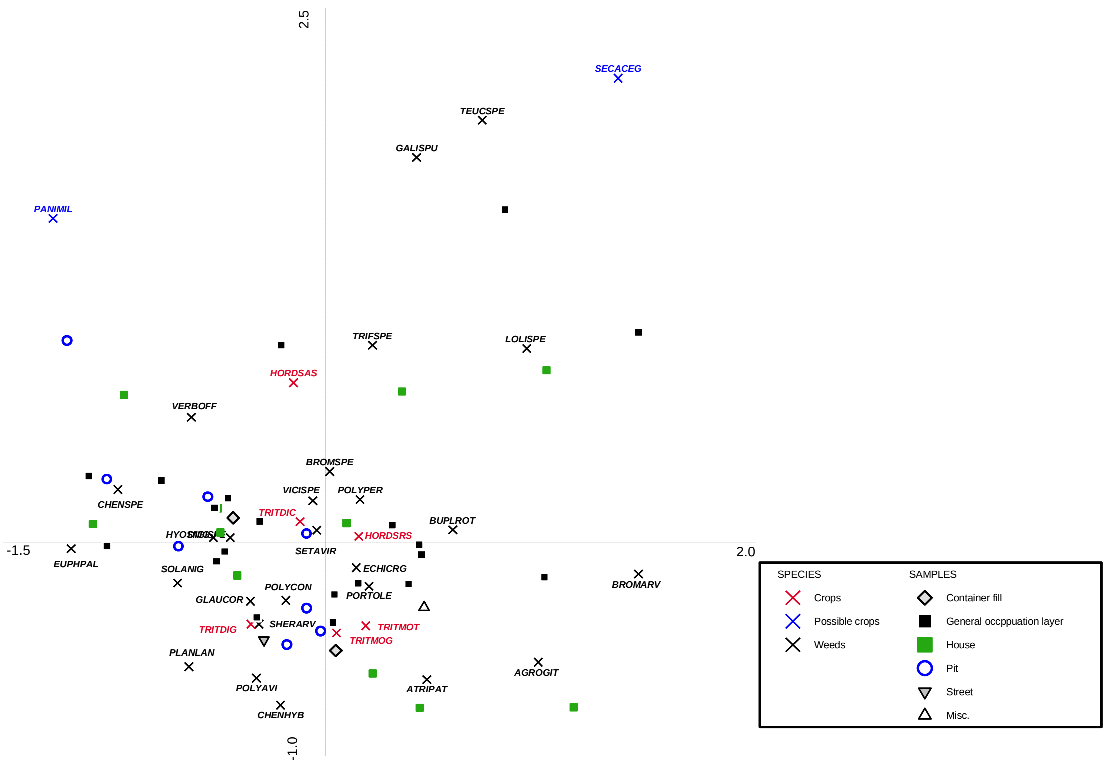


Fig 7.6. Correspondence analysis of crops, possible crops and weed species for samples identified as unsieved spikelets per feature type: LBA Feudvar

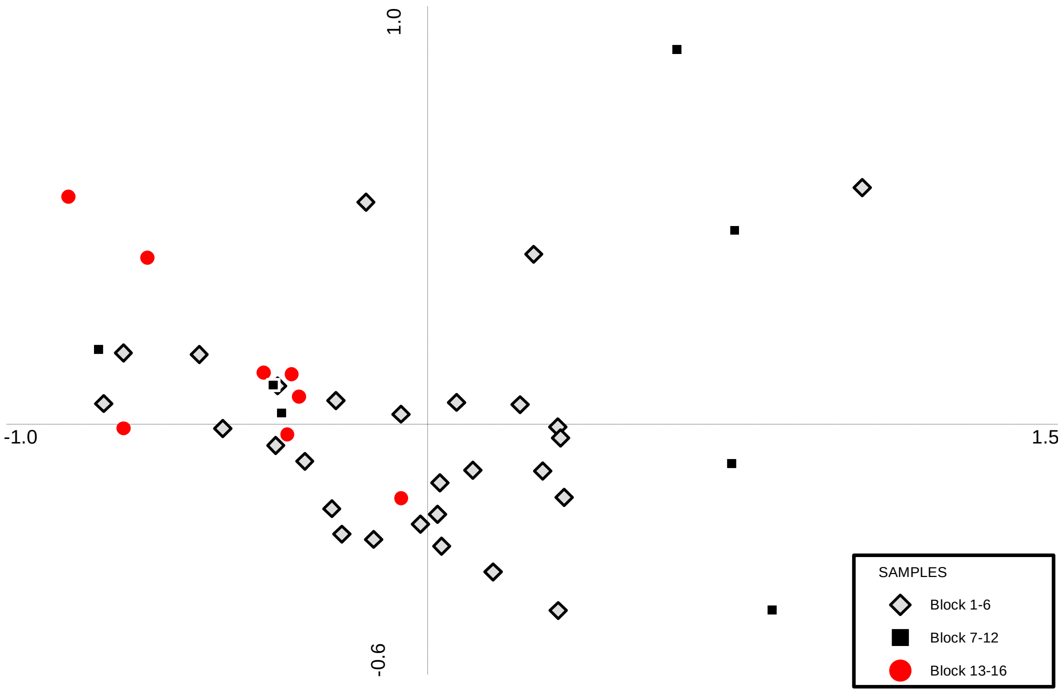


Fig 7.7. Correspondence analysis of each sample identified as unsieved spikelets per block group: LBA Feudvar

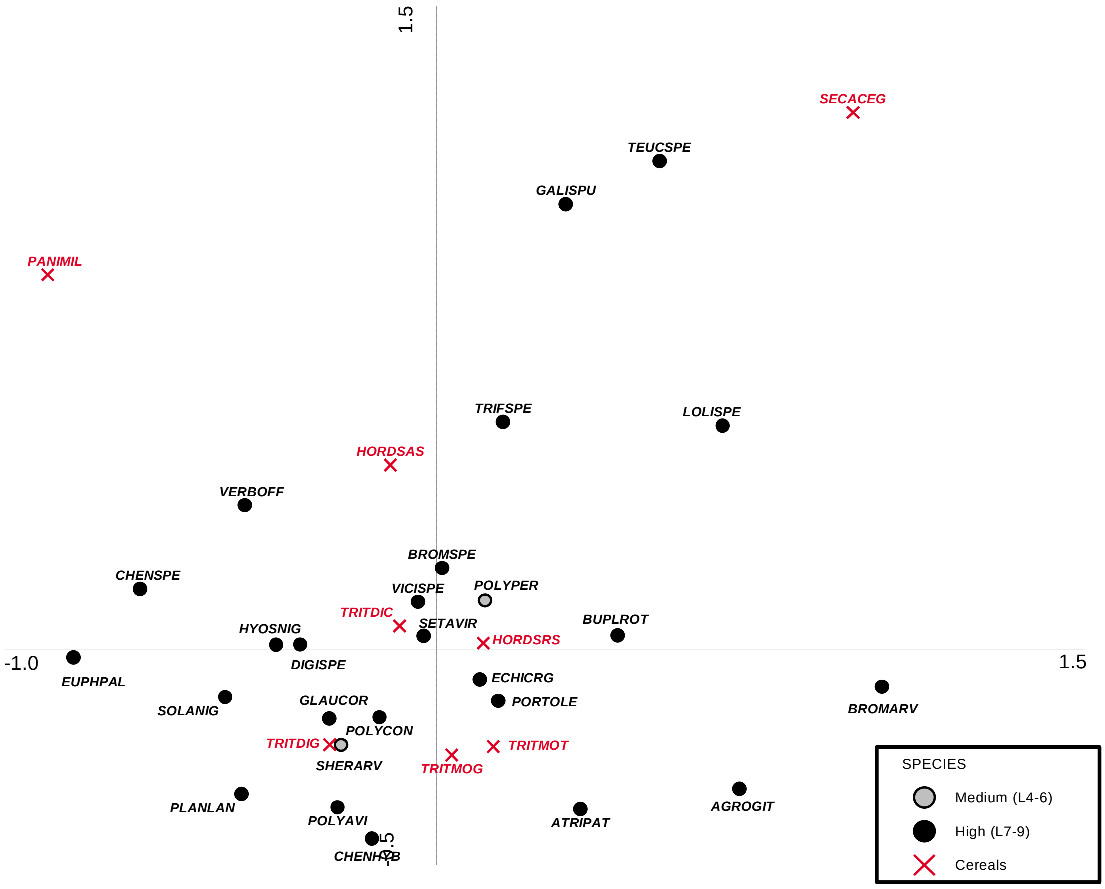


Fig 7.8. Correspondence analysis of crops and weed species for samples identified as unsieved spikelets showing the ecological indicator values for light (after Borhidi 1995): LBA Feudvar

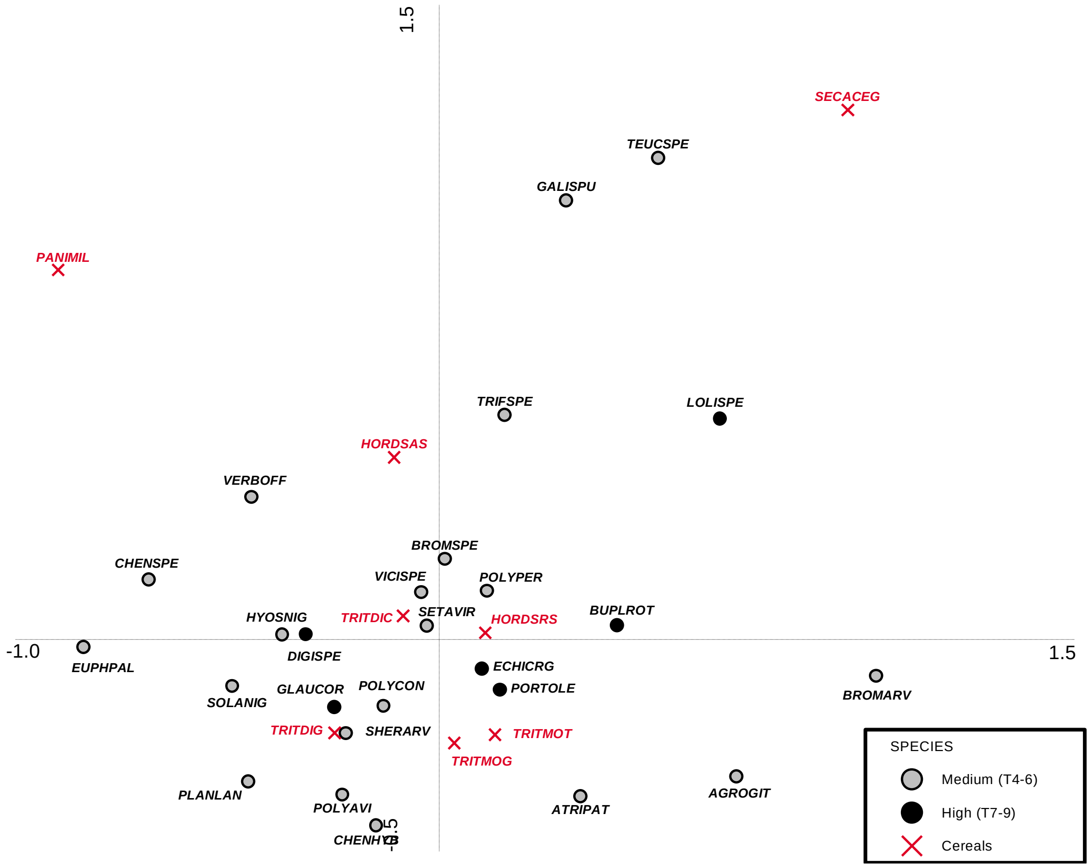


Fig 7.9. Correspondence analysis of crops and weed species for samples identified as unsieved spikelets showing the ecological indicator values for temperature (after Borhidi 1995): LBA Feudvar

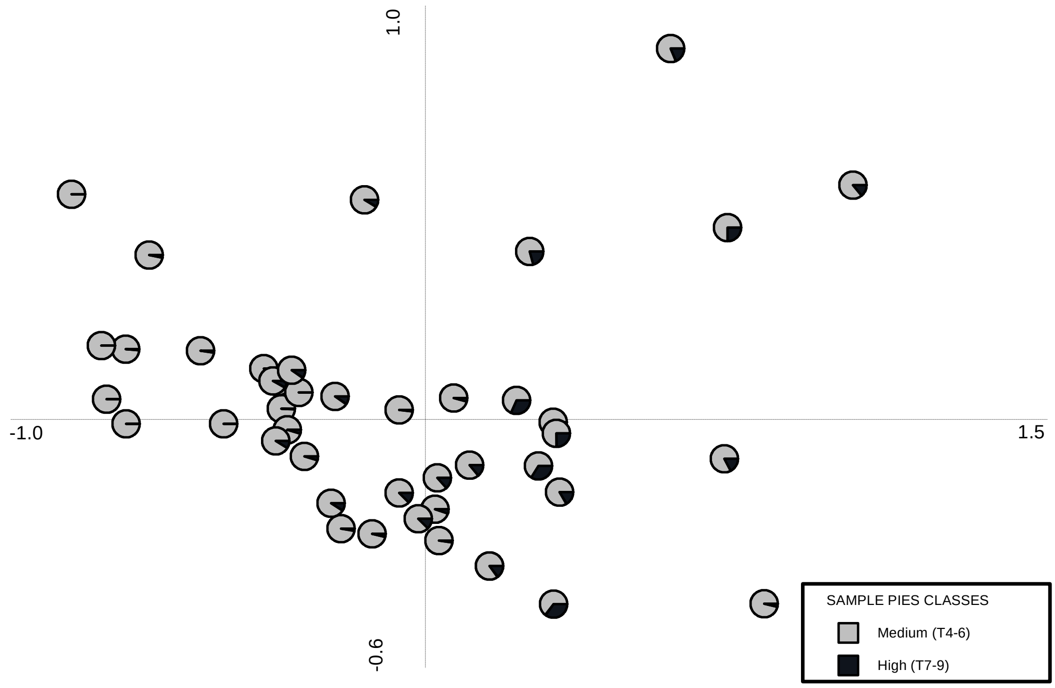


Fig 7.10. Correspondence analysis of the proportion of weed species according to their temperature indicator value for samples identified as unsieved spikelets (after Borhidi 1995): LBA Feudvar

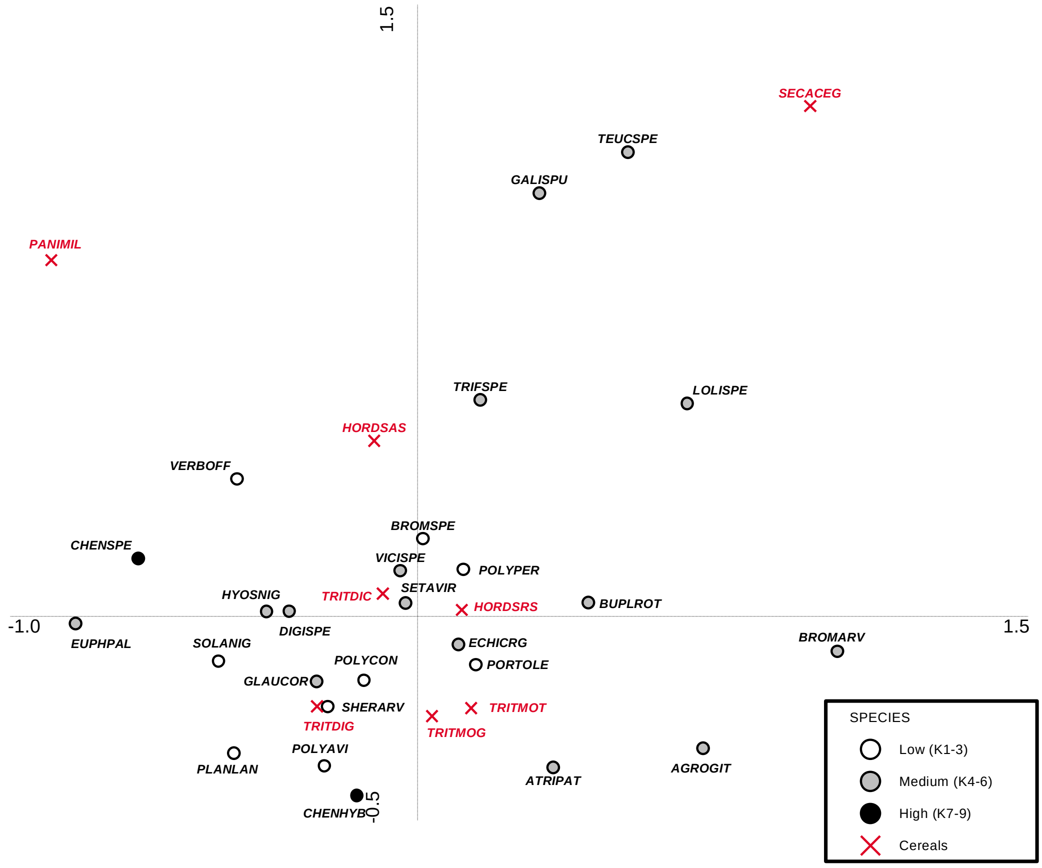


Fig 7.11. Correspondence analysis of crops and weed species for samples identified as unsieved spikelets showing the ecological indicator values for continentality (after Borhidi 1995): LBA Feudvar

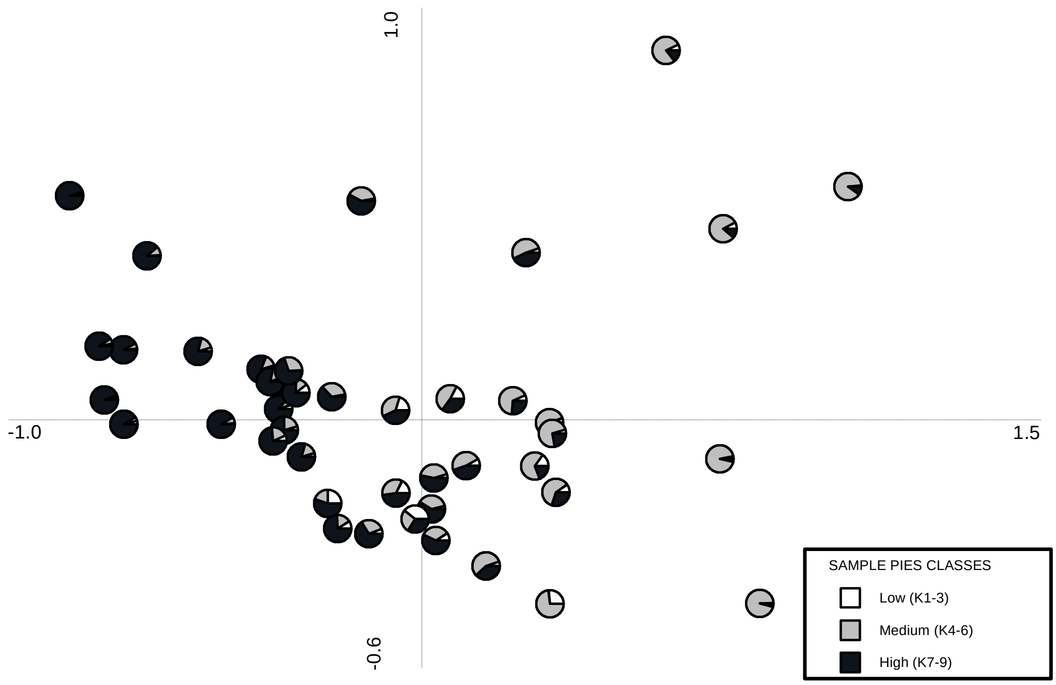


Fig 7.12. Correspondence analysis of the proportion of weed species according to their continentality indicator value for samples identified as unsieved spikelets (after Borhidi 1995): LBA Feudvar

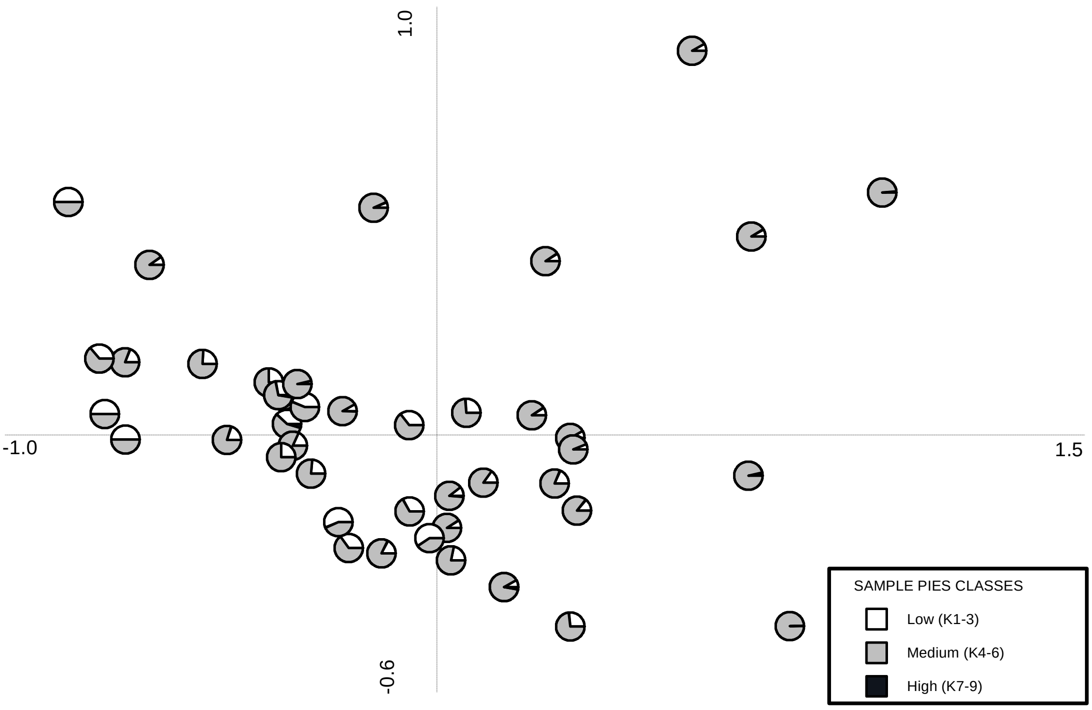


Fig 7.13. Correspondence analysis of the proportion of weed species without CHENSPE according to their continentality indicator value for samples identified as unsieved spikelets (after Borhidi 1995): LBA Feudvar

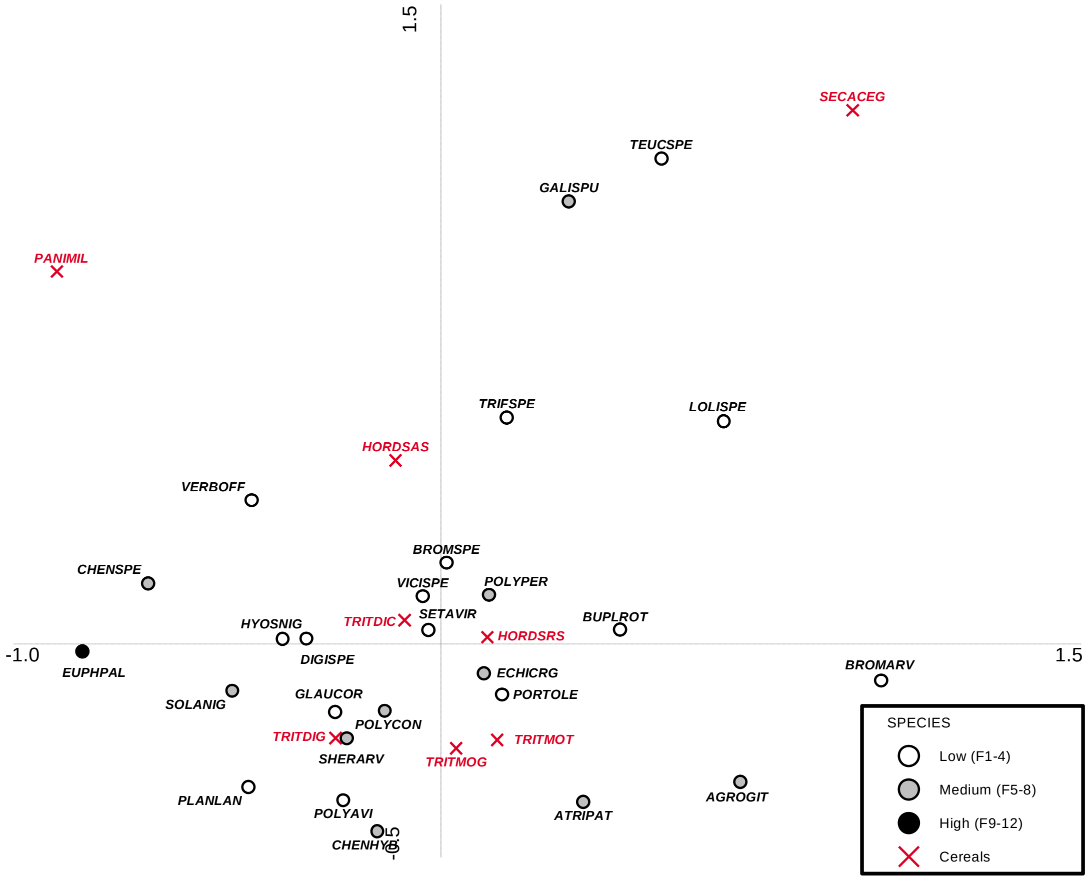


Fig 7.14. Correspondence analysis of crops and weed species for samples identified as unsieved spikelets showing the ecological indicator values for moisture (after Borhidi 1995): LBA Feudvar

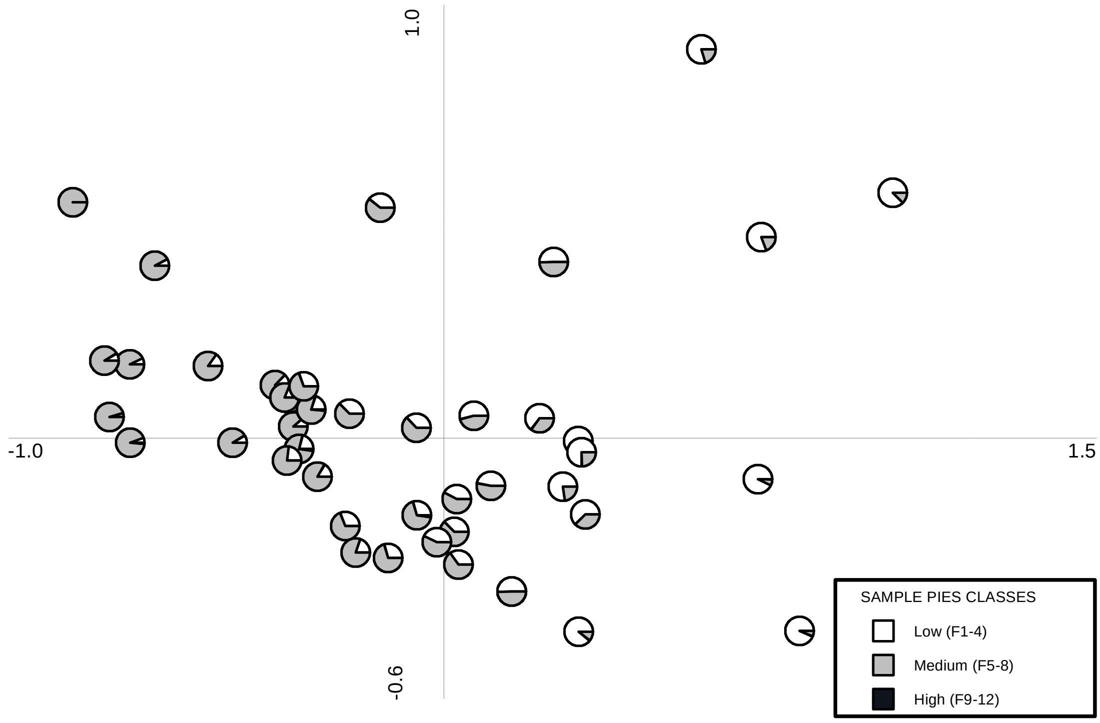


Fig 7.15. Correspondence analysis of the proportion of weed species according to their moisture indicator value for samples identified as unsieved spikelets (after Borhidi 1995): LBA Feudvar

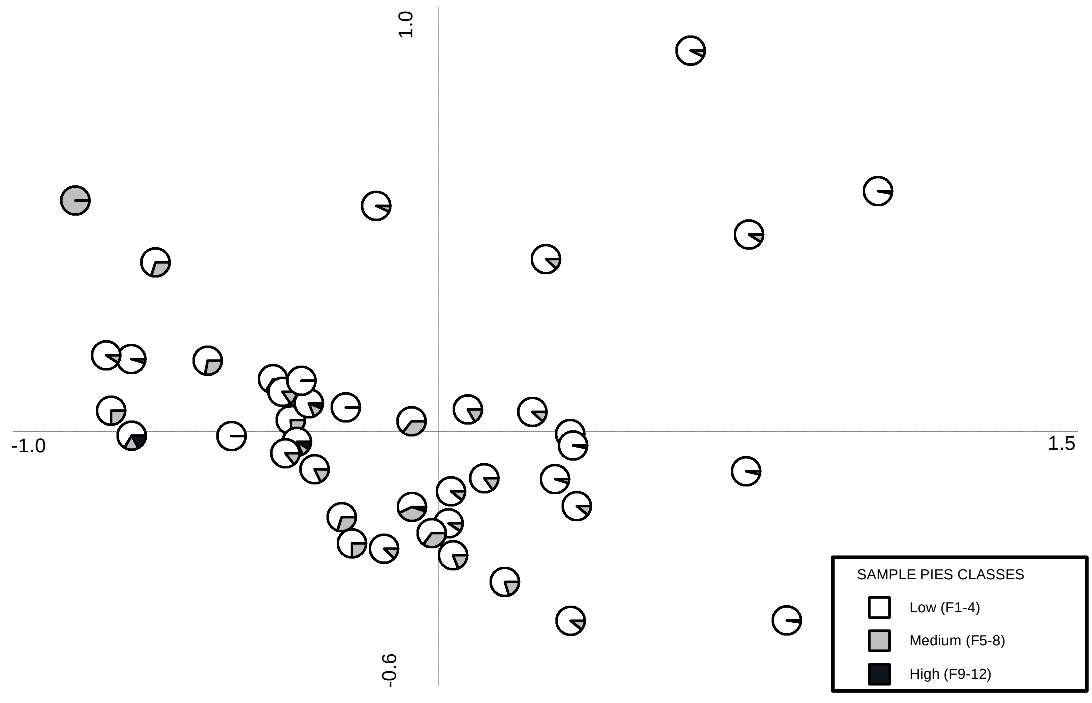


Fig 7.16. Correspondence analysis of the proportion of weed species without CHENSPE according to their moisture indicator value for samples identified as unsieved spikelets (after Borhidi 1995): LBA Feudvar

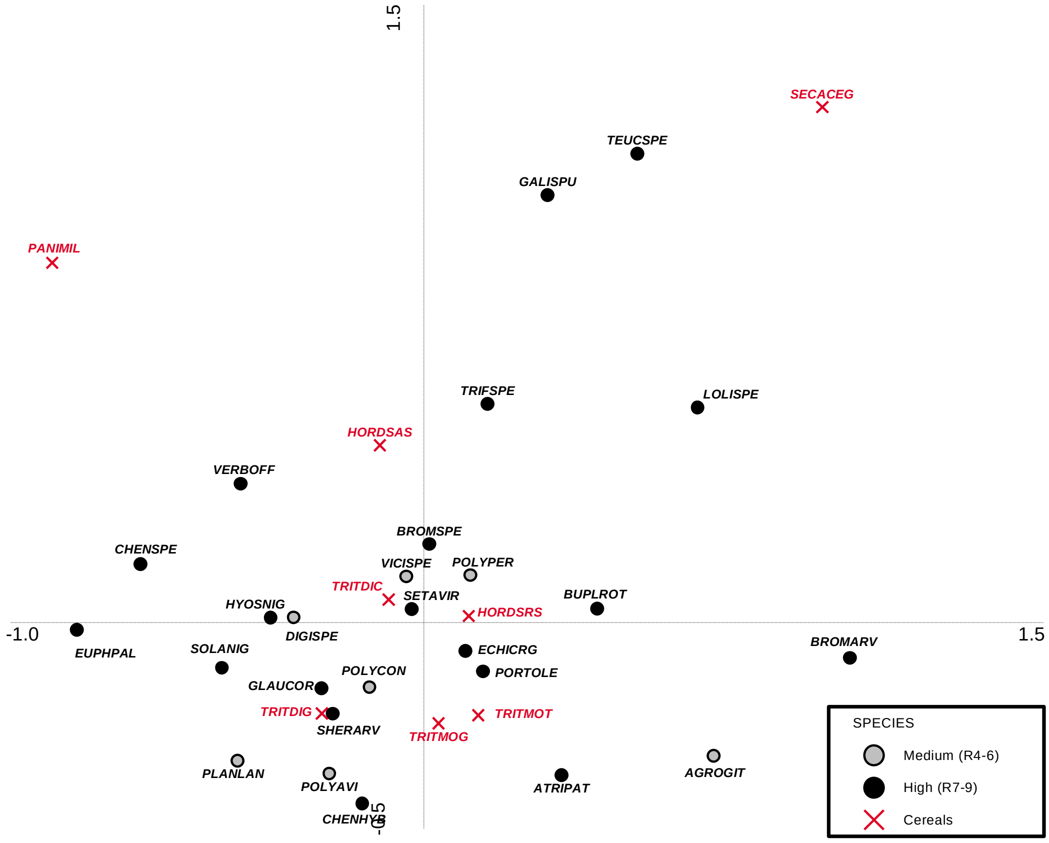


Fig 7.17. Correspondence analysis of crops and weed species for samples identified as unsieved spikelets showing the ecological indicator values for reaction (after Borhidi 1995): LBA Feudvar

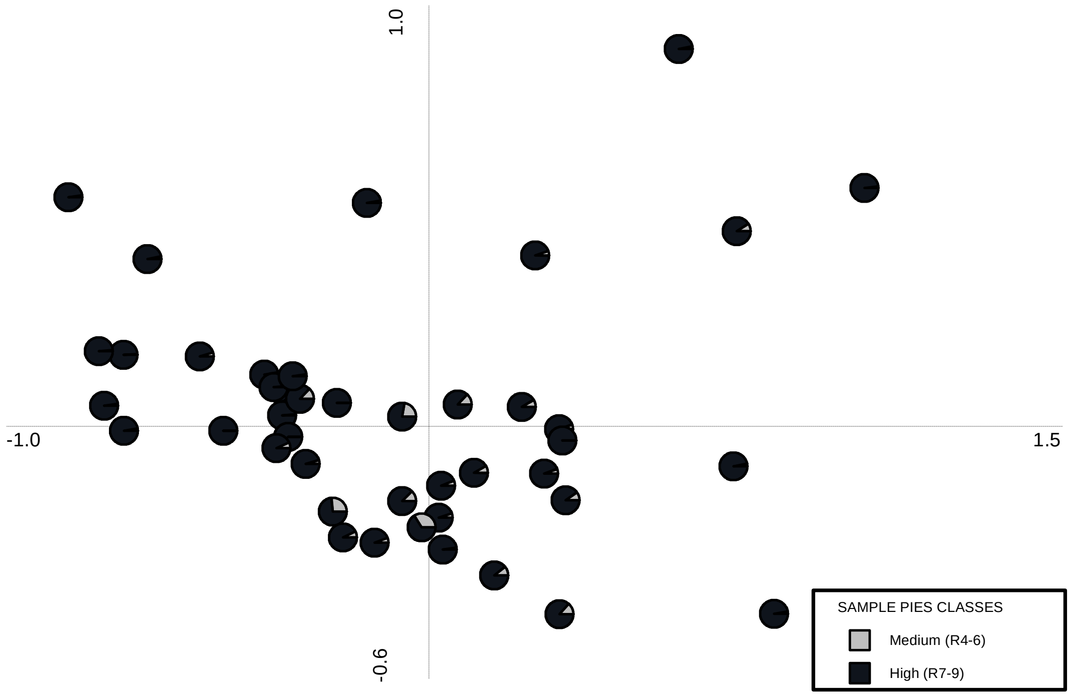


Fig 7.18. Correspondence analysis of the proportion of weed species according to their reaction indicator value for samples identified as unsieved spikelets (after Borhidi 1995): LBA Feudvar

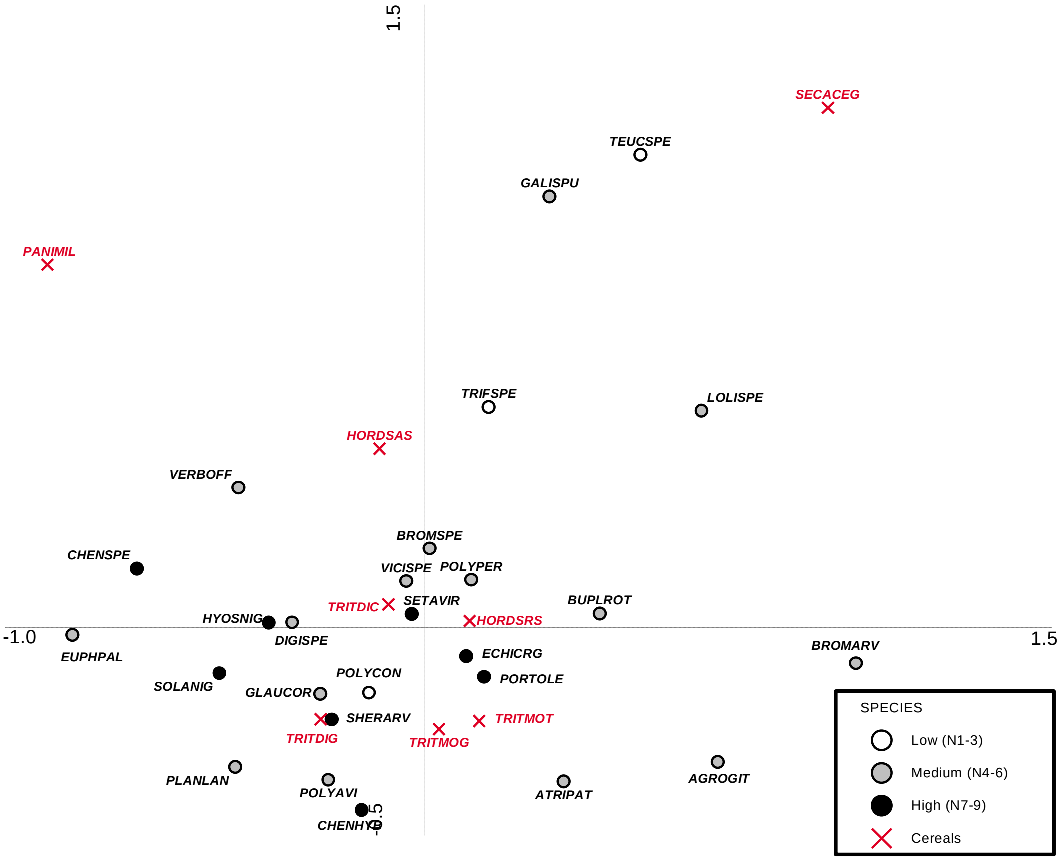


Fig 7.19. Correspondence analysis of crops and weed species for samples identified as unsieved spikelets showing the ecological indicator values for nitrogen (after Borhidi 1995): LBA Feudvar

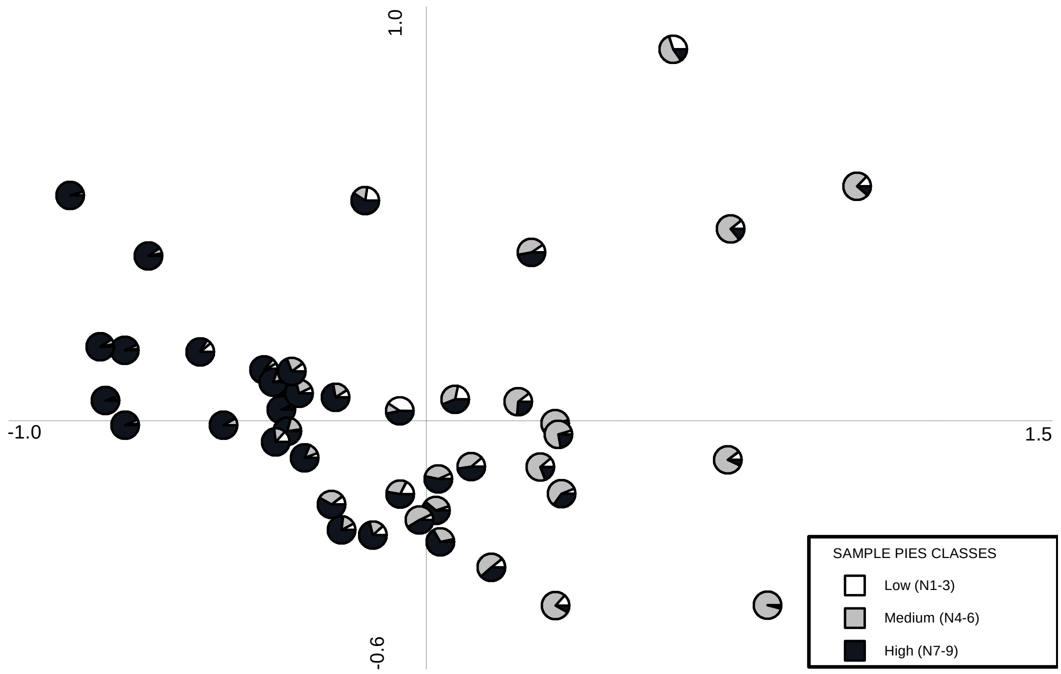


Fig 7.20. Correspondence analysis of the proportion of weed species according to their nitrogen indicator value for samples identified as unsieved spikelets (after Borhidi 1995): LBA Feudvar

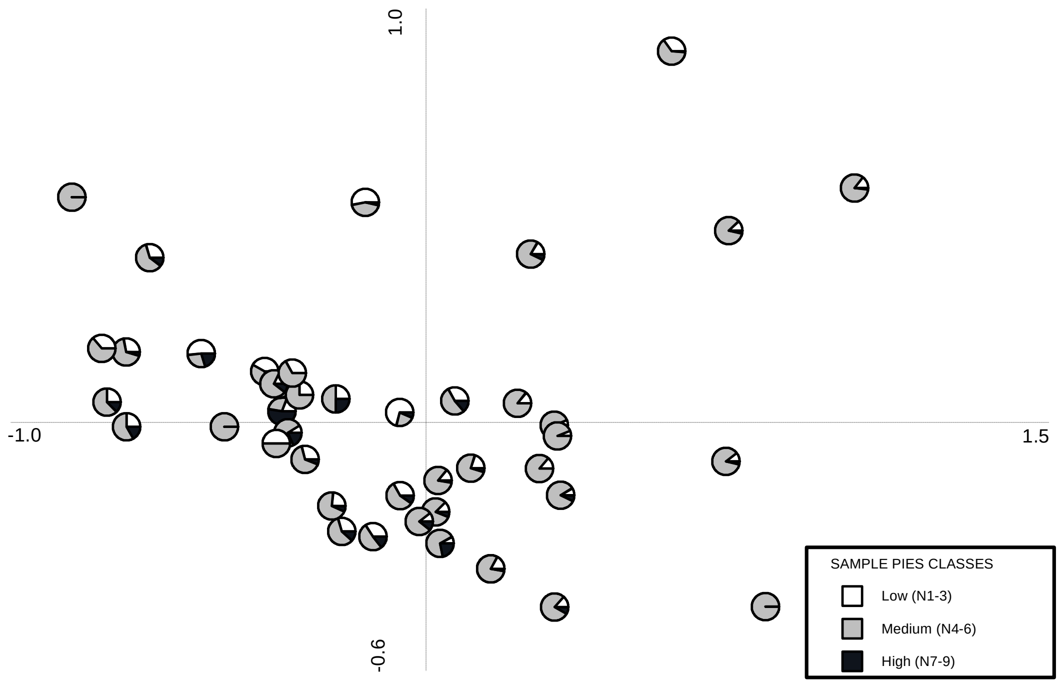


Fig 7.21. Correspondence analysis of the proportion of weed species without CHENSPE according to their nitrogen indicator value for samples identified as unsieved spikelets (after Borhidi 1995): LBA Feudvar

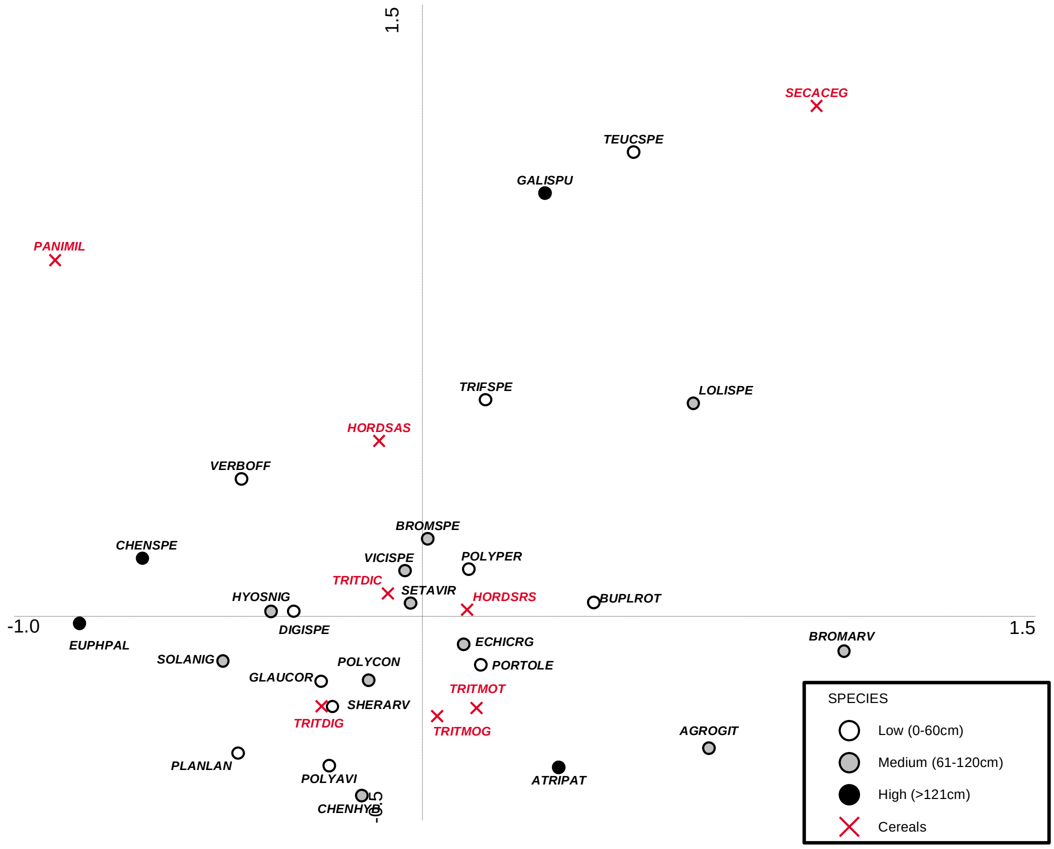


Fig 7.22. Correspondence analysis of crops and weed species for samples identified as unsieved spikelets showing the maximum flowering height for each weed (after Bojňanský and Fargašová 2007): LBA Feudvar

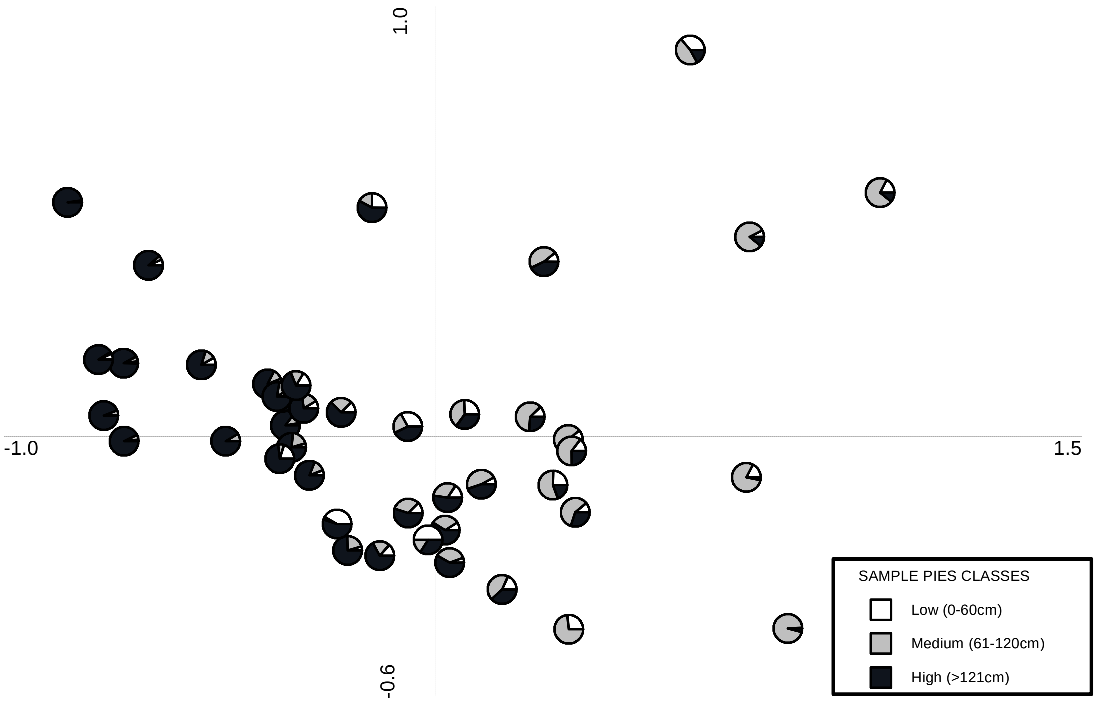


Fig 7.23. Correspondence analysis showing the proportions of weed species according to their maximum flowering height for samples identified as unsieved spikelets (after Bojňanský and Fargašová 2007): LBA Feudvar

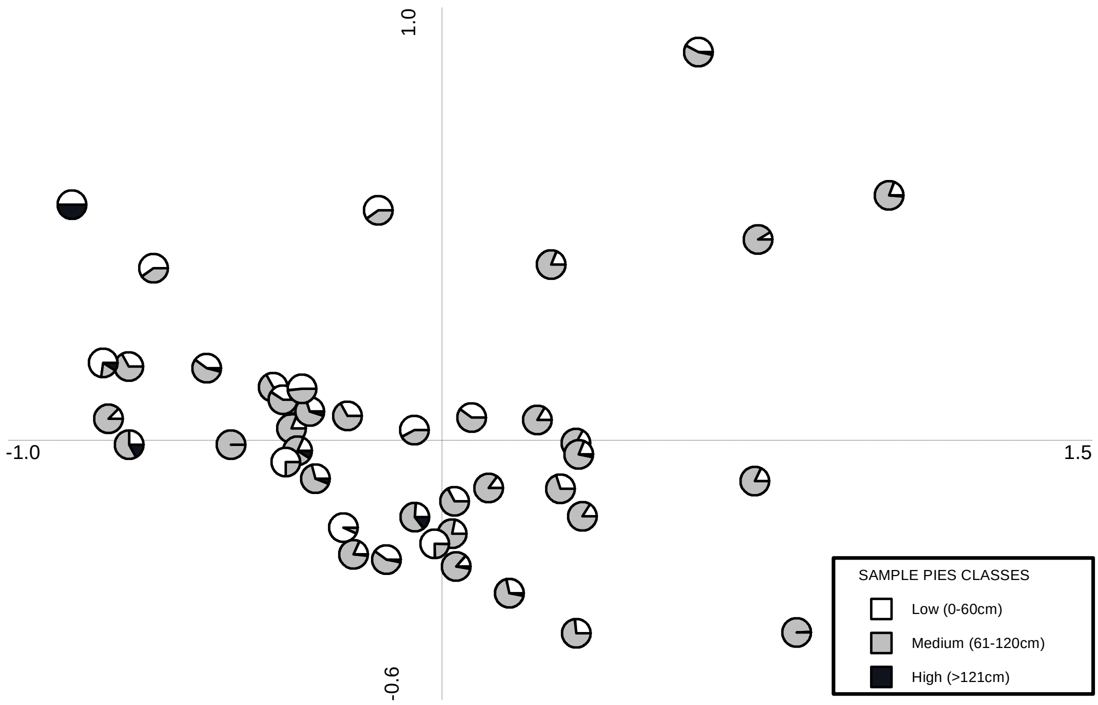


Fig 7.24. Correspondence analysis showing the proportions of weed species without CHENSPE according to their maximum flowering height for samples identified as unsieved spikelets (after Bojňanský and Fargašová 2007): LBA Feudvar

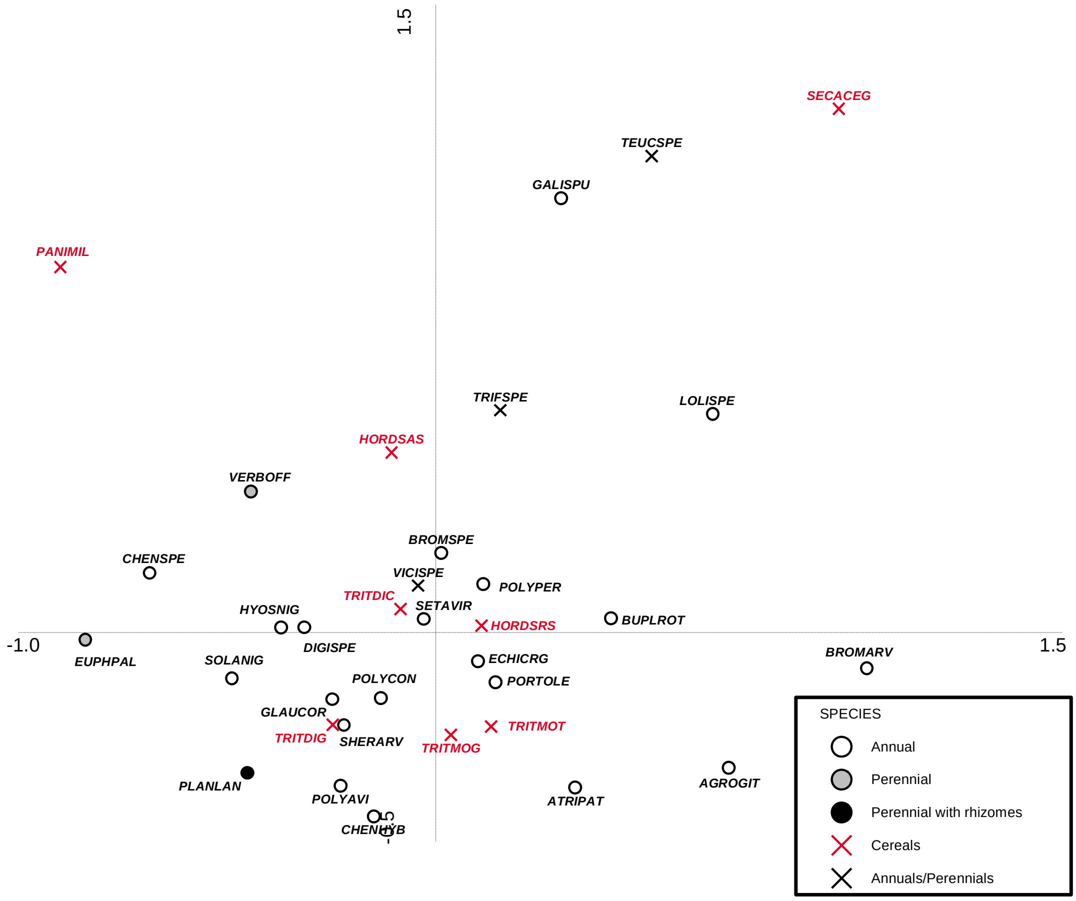


Fig 7.25. Correspondence analysis of crops and weed species for samples identified as unsieved spikelets showing the life cycle of each weed i.e. whether they are an annual, perennial with or without rhizomes (after Bojňanský and Fargašová 2007): LBA Feudvar

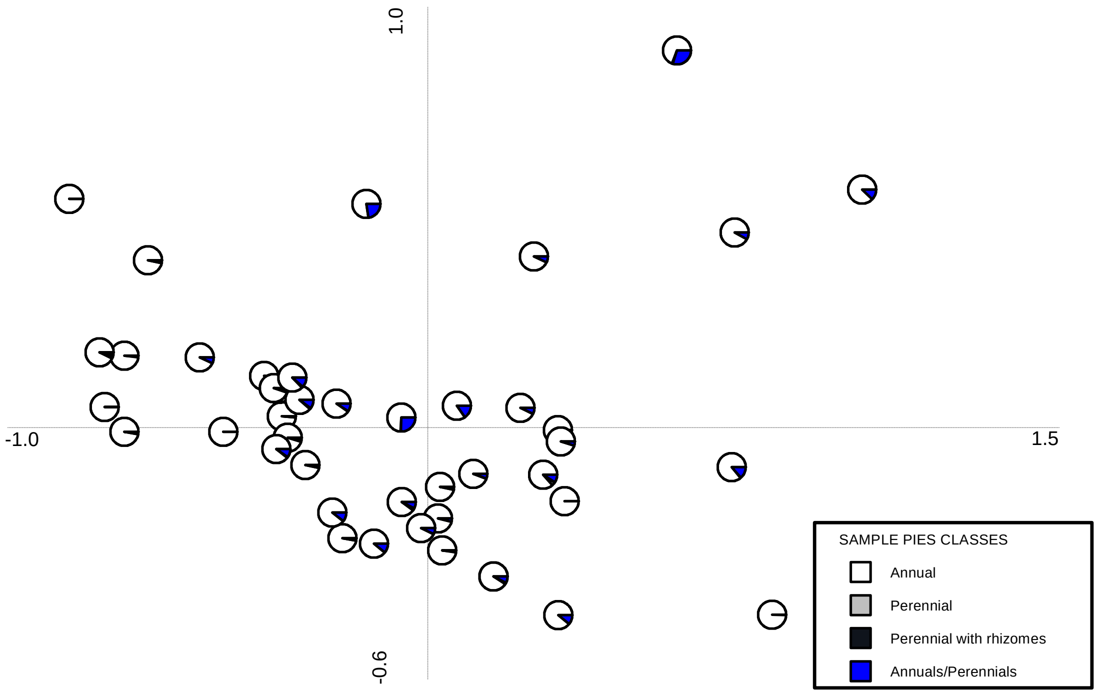


Fig 7.26. Correspondence analysis showing proportions of annuals and perennials for samples identified as unsieved spikelets spikelets (after Bojňanský and Fargašová 2007): LBA Feudvar

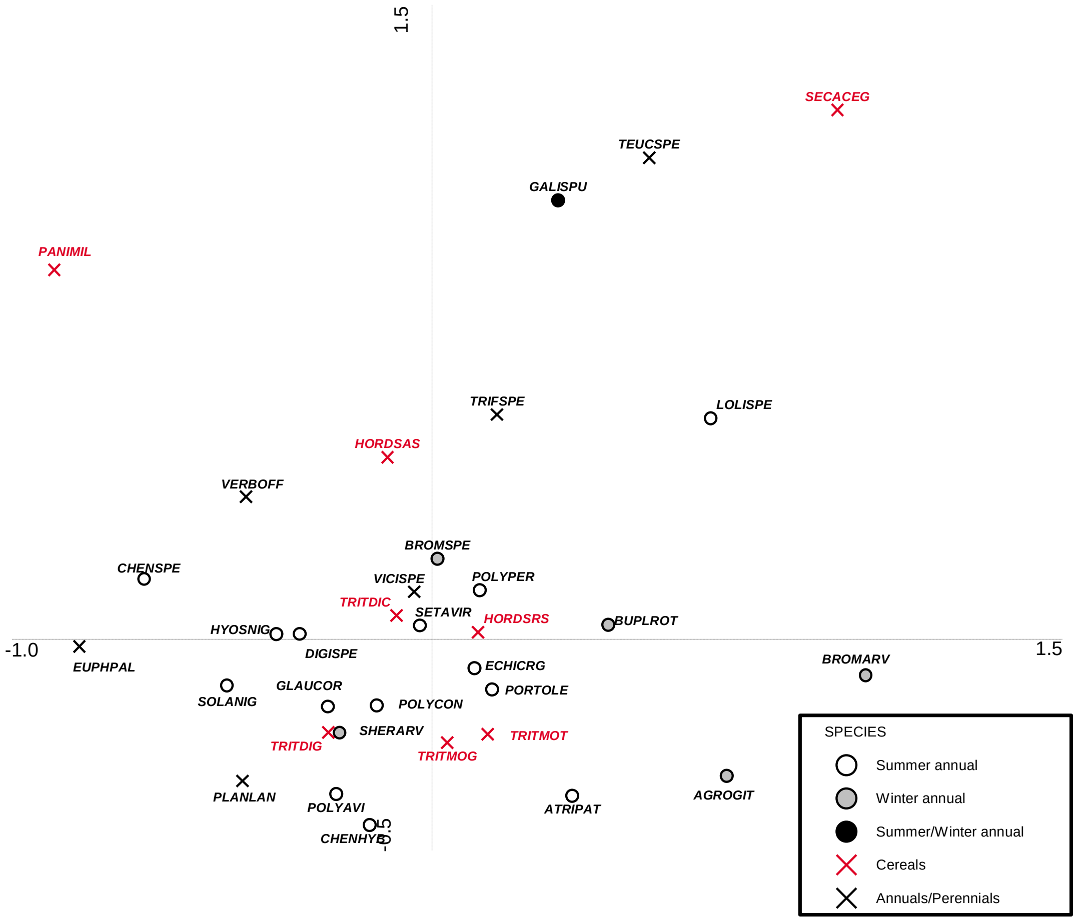


Fig 7.27. Correspondence analysis of crops and weed species for samples identified as unsieved spikelets showing the germination time of each weed (after Bojňanský and Fargašová 2007): LBA Feudvar

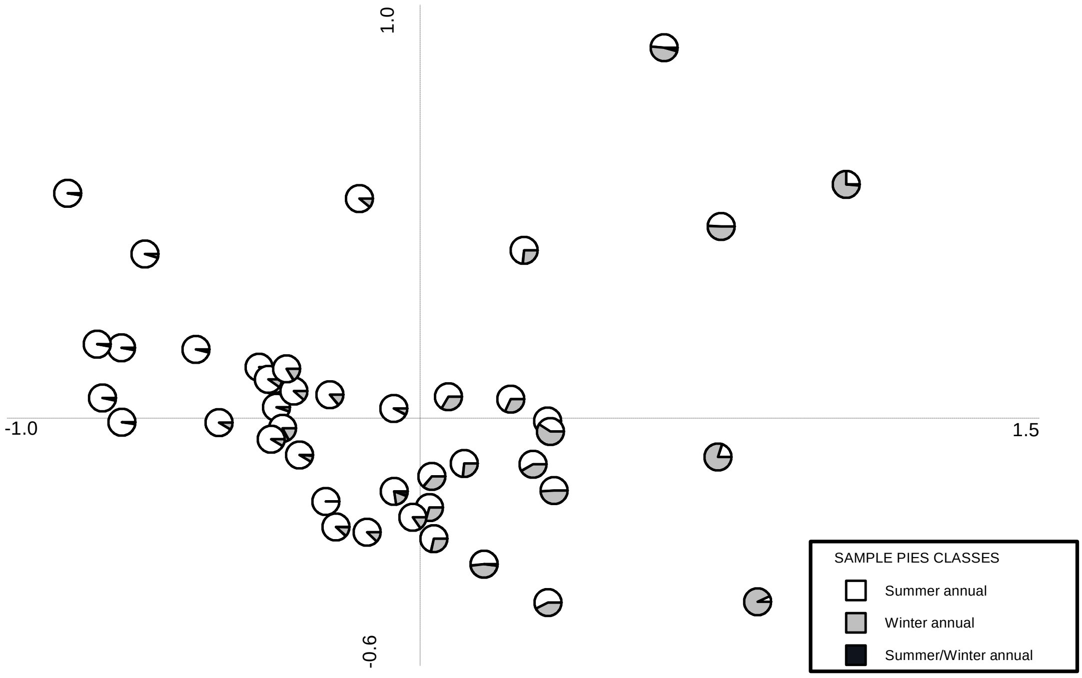


Fig 7.28. Correspondence analysis showing proportions of summer and winter annuals for samples identified as unsieved spikelets (after Bojňanský and Fargašová 2007): LBA Feudvar

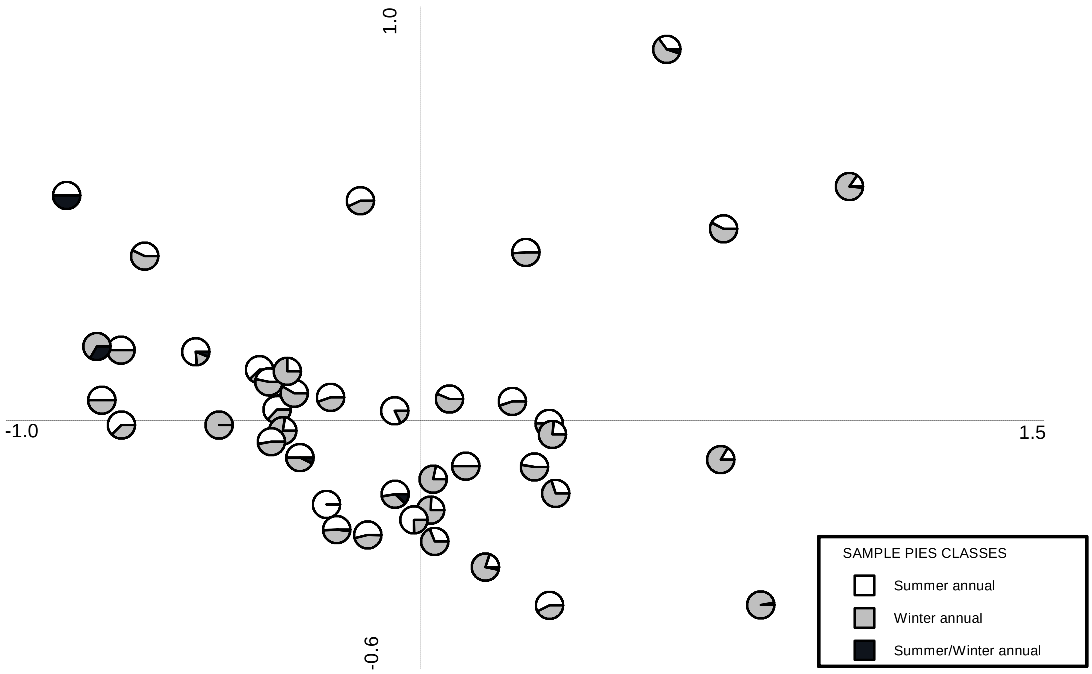


Fig 7.29. Correspondence analysis showing proportions of summer and winter annuals without CHENSPE for samples identified as unsieved spikelets (after Bojňanský and Fargašová 2007): LBA Feudvar

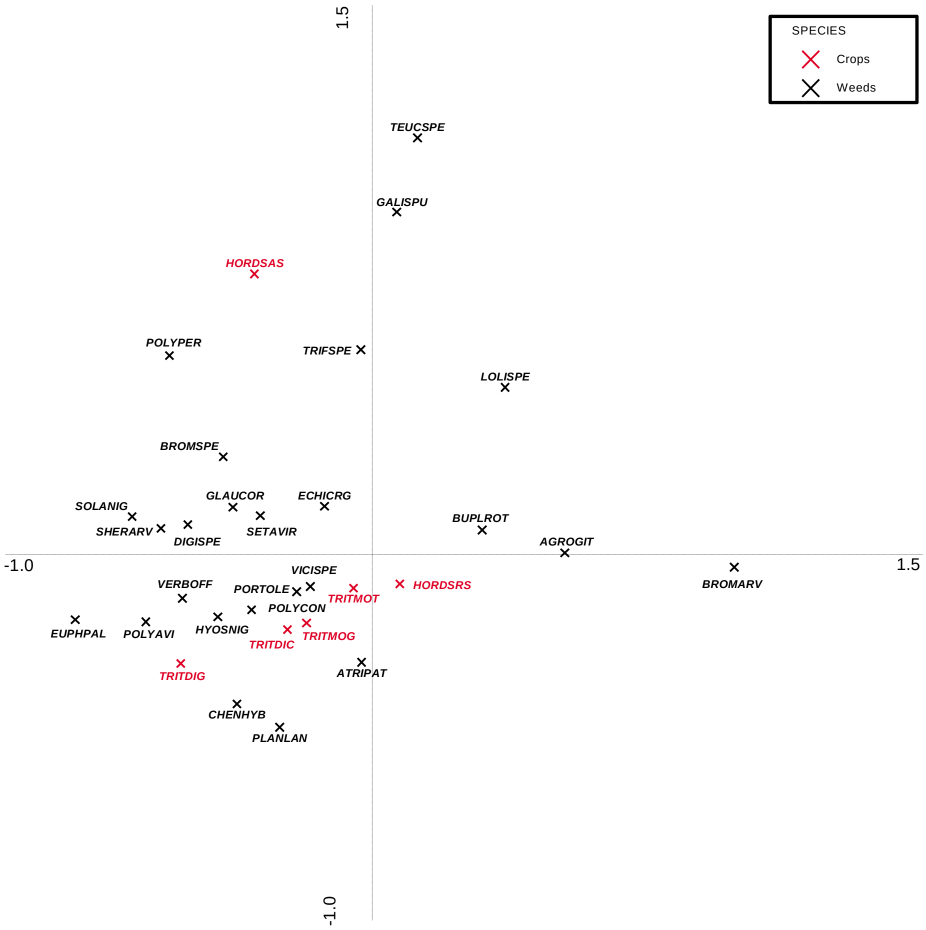


Fig 7.30. Correspondence analysis of crops, possible crops and weed species, without CHENSPE, SECACEG AND PANMIL, for samples identified as unsieved spikelets: LBA Feudvar

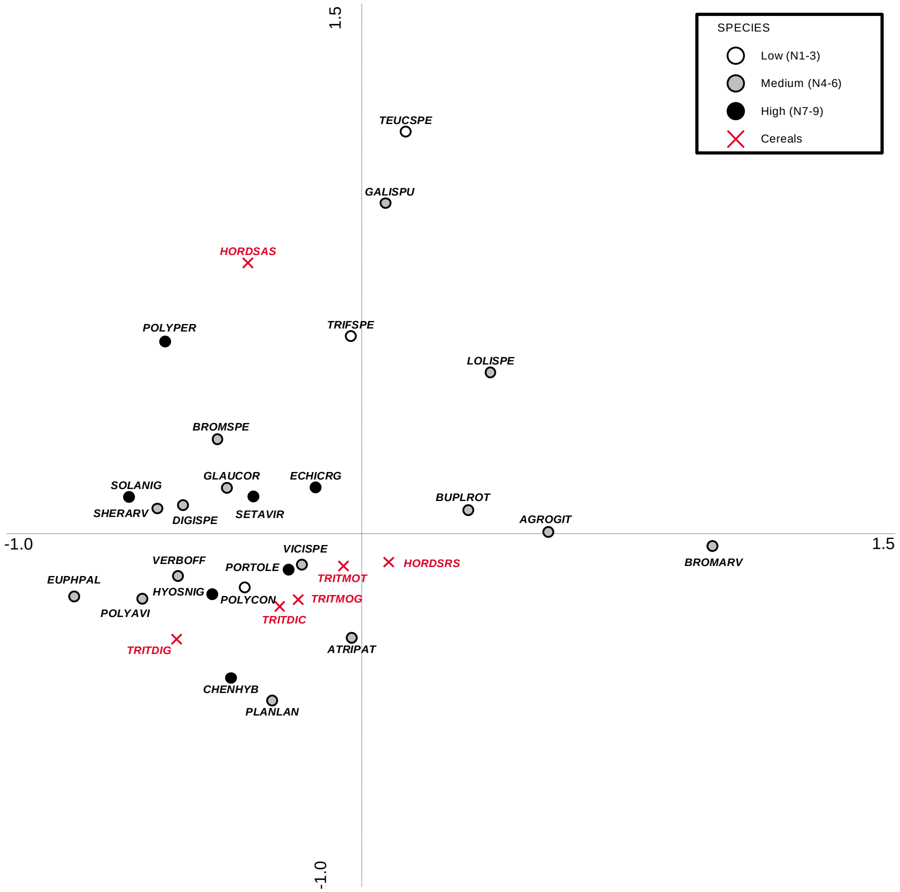


Fig 7.31. Correspondence analysis of crops and weed species, without CHENSPE, SECACEG AND PANMIL, for samples identified as unsieved spikelets showing the ecological indicator values for nitrogen (after Borhidi 1995): LBA Feudvar

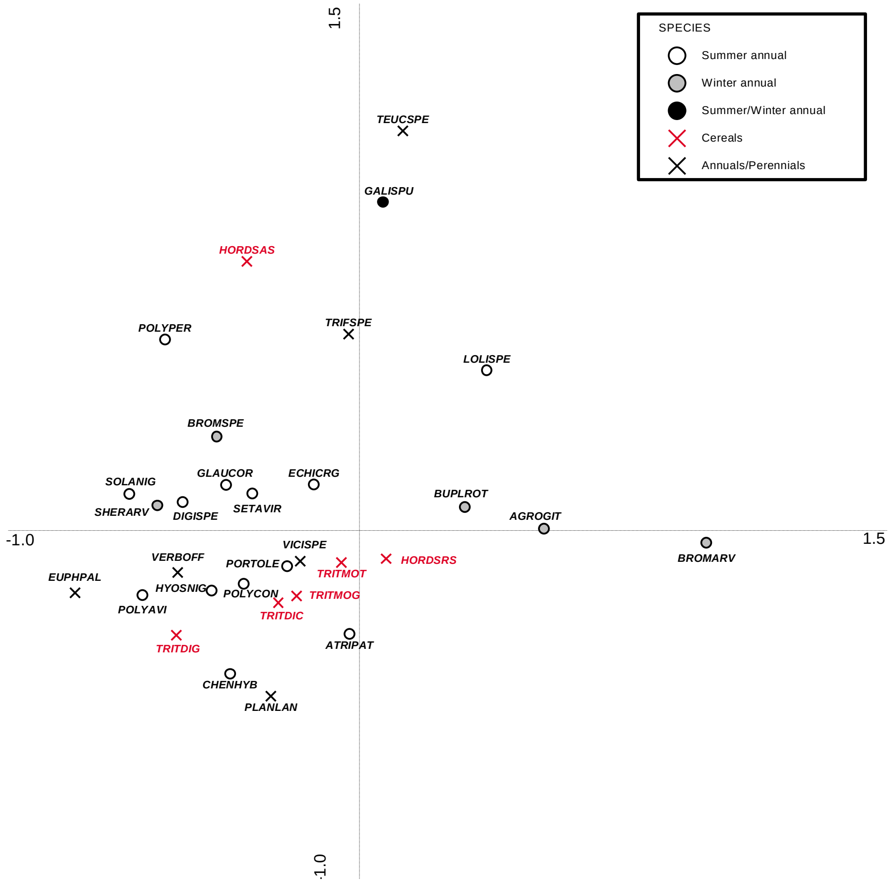


Fig 7.32. Correspondence analysis of crops and weed species, without CHENSPE, SECACEG AND PANMIL, for samples identified as unsieved spikelets showing the germination time of each weed (after Bojňanský and Fargašová 2007): LBA Feudvar

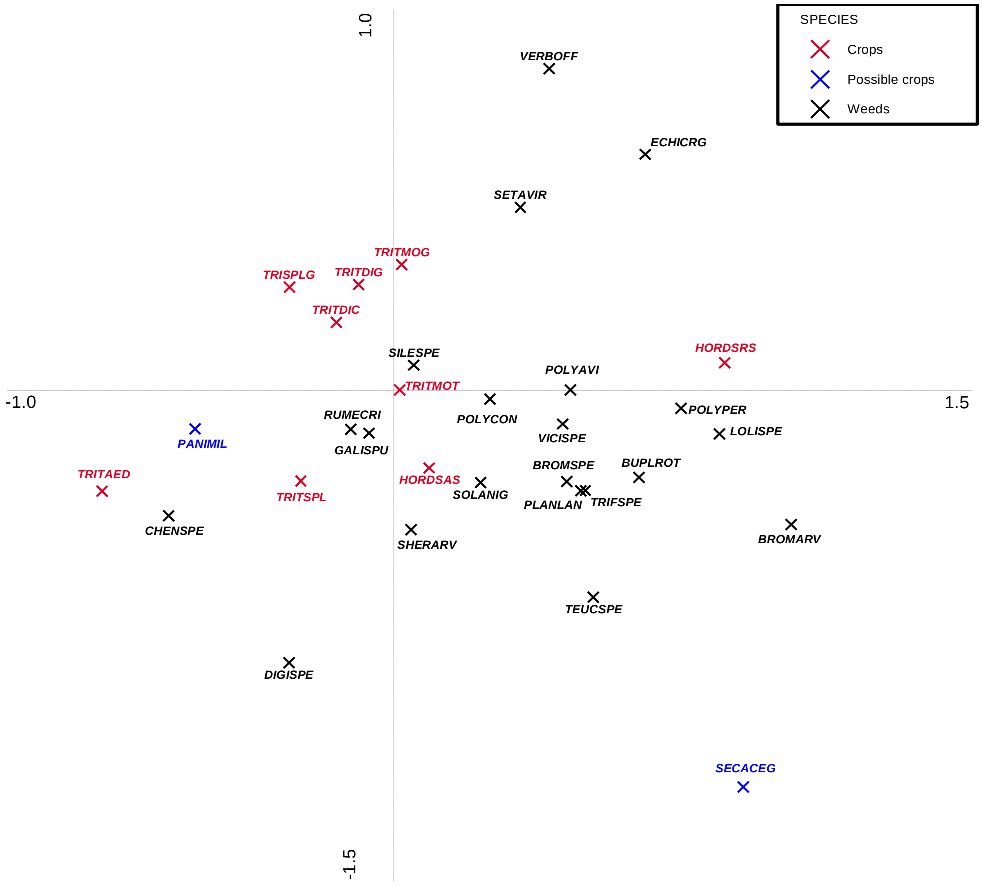
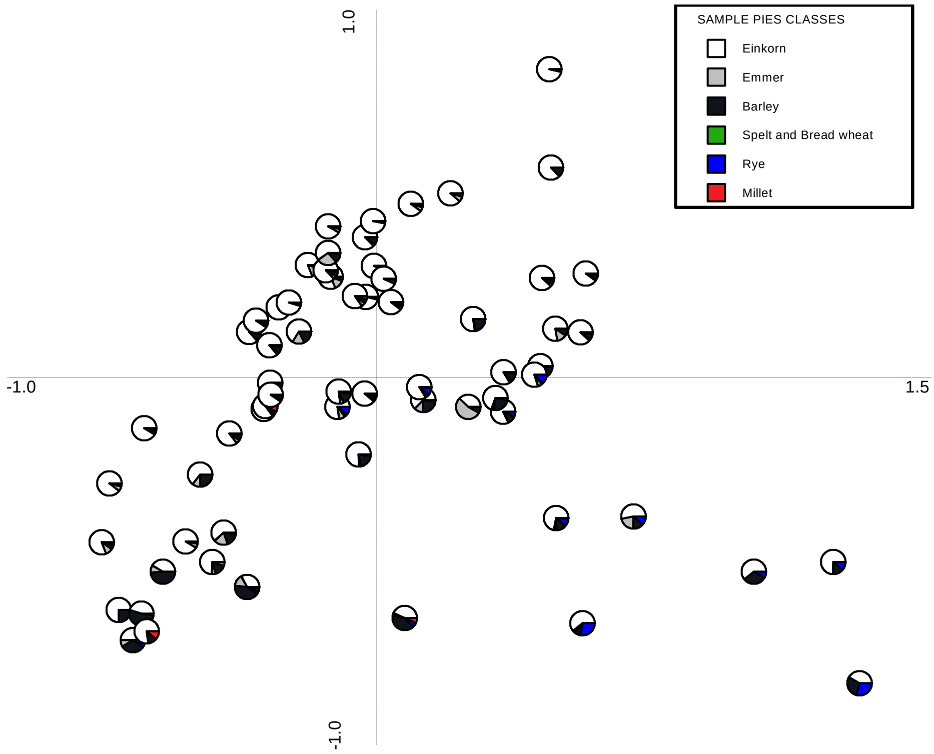


Fig 7.33. Correspondence analysis of crops, possible crops and weed species for samples identified as unsieved fine sieving by-products on the first two principal axes (axis 1 horizontal, axis 2 vertical):



LBA Feudvar

Fig 7.34. Correspondence analysis of the proportion of cereals per sample identified as unsieved fine sieving by-products: LBA Feudvar

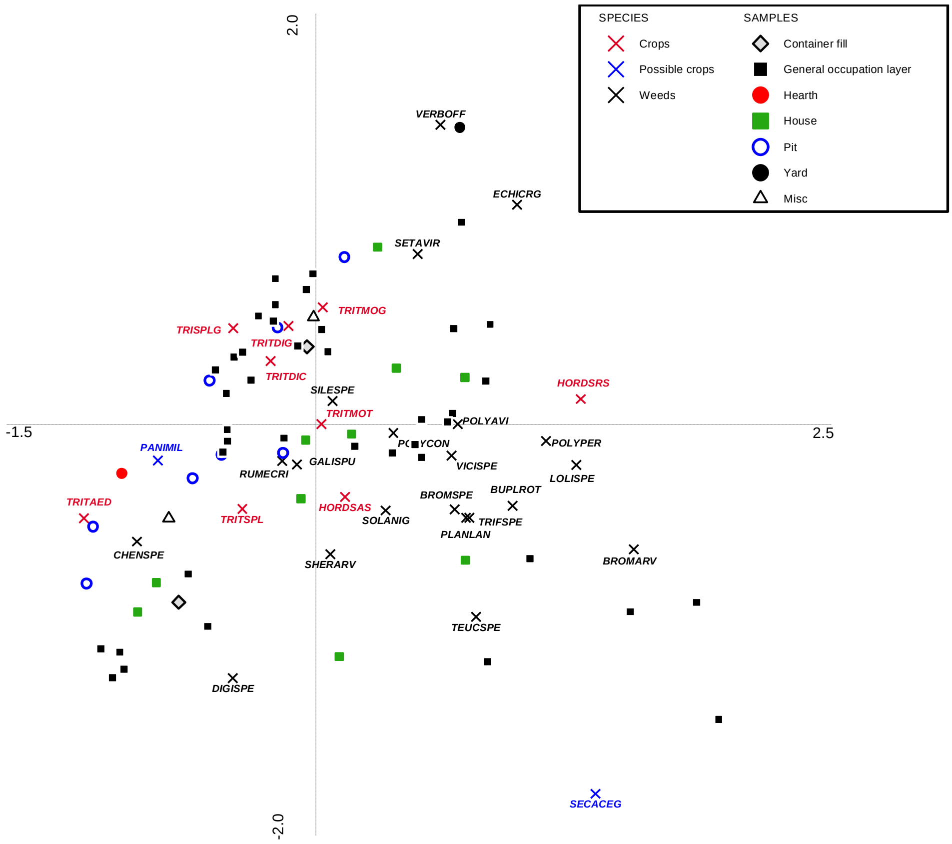


Fig 7.35. Correspondence analysis of crops, possible crops and weed species for samples identified as unsieved fine sieving by-products per feature type: LBA Feudvar

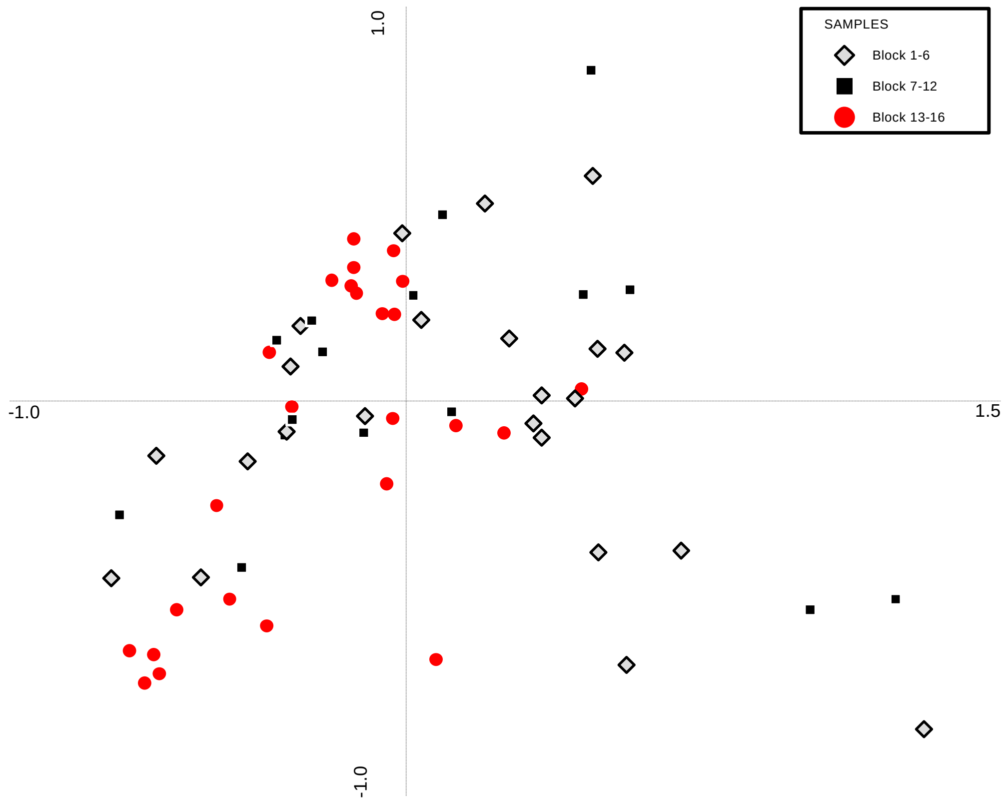


Fig 7.36. Correspondence analysis of each sample identified as unsieved fine sieving by-product per block group: LBA Feudvar

Fig 7.37. Correspondence analysis of crops and weed species for samples identified as unsieved fine sieving by-products showing the ecological indicator values for light (after Borhidi 1995): LBA Feudvar

Fig 7.38. Correspondence analysis of crops and weed species for samples identified as unsieved fine sieving by-products showing the ecological indicator values for temperature (after Borhidi 1995): LBA Feudvar

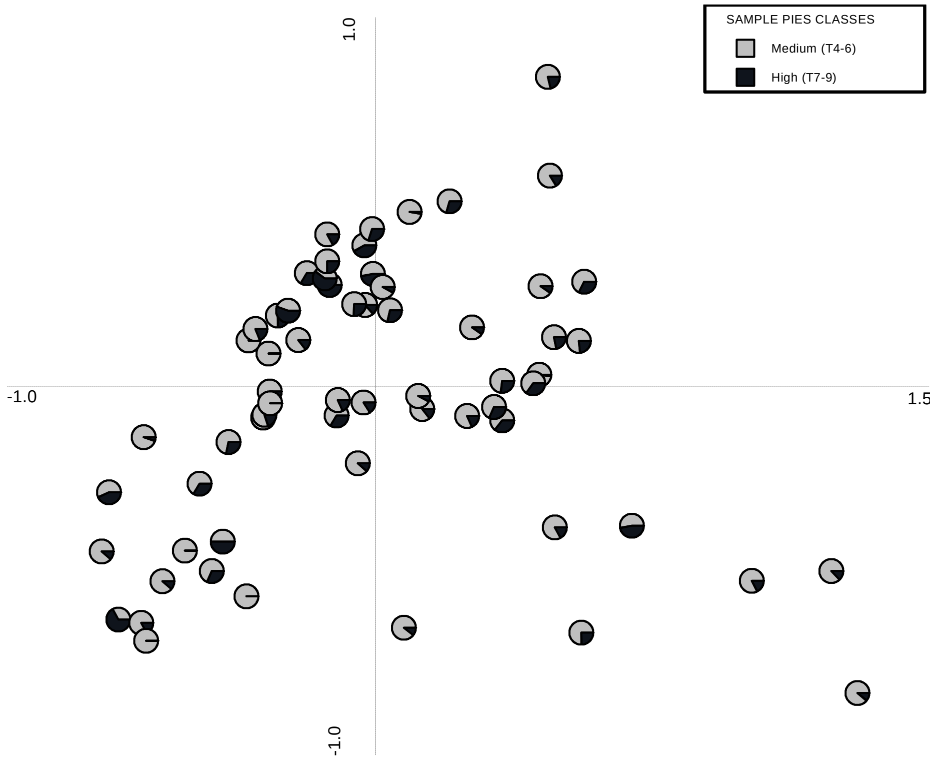


Fig 7.39. Correspondence analysis of crops and weed species without CHENSPE for samples identified as unsieved fine sieving by-products showing the ecological indicator values for temperature (after Borhidi 1995): LBA Feudvar

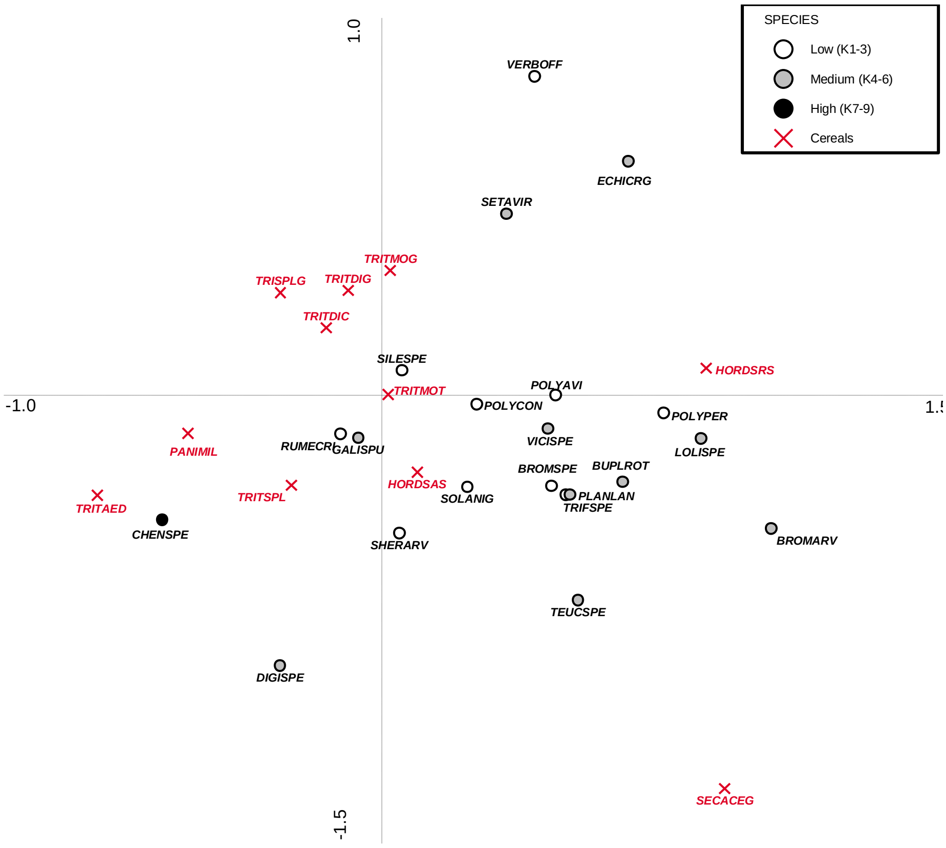


Fig 7.40. Correspondence analysis of crops and weed species for samples identified as unsieved fine sieving by-products showing the ecological indicator values for continentality (after Borhidi 1995): LBA Feudvar

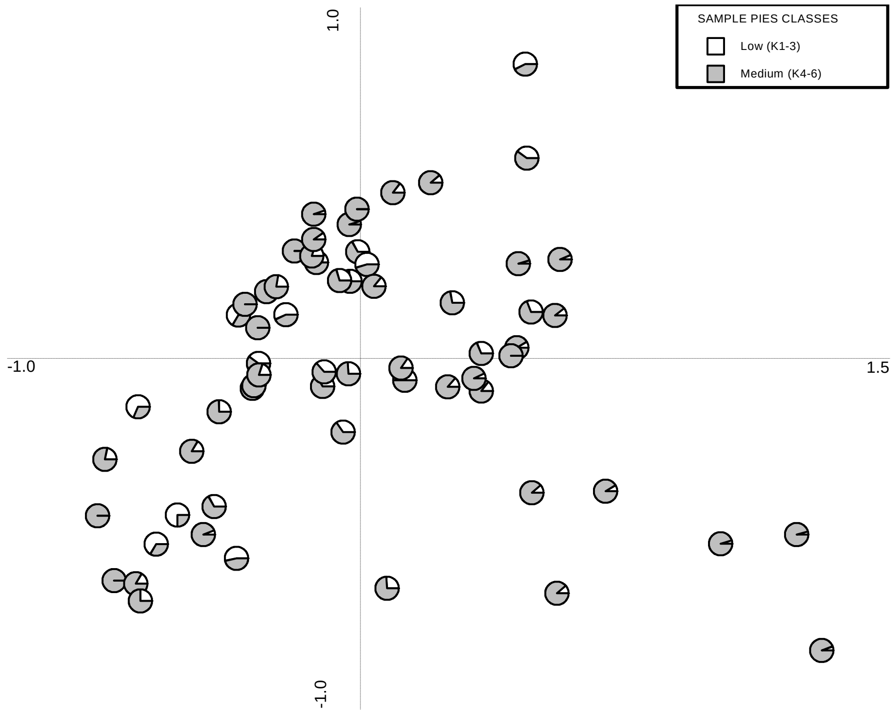


Fig 7.41. Correspondence analysis of crops and weed species without CHENSPE for samples identified as unsieved fine sieving by-products showing the ecological indicator values for continentality (after Borhidi 1995): LBA Feudvar

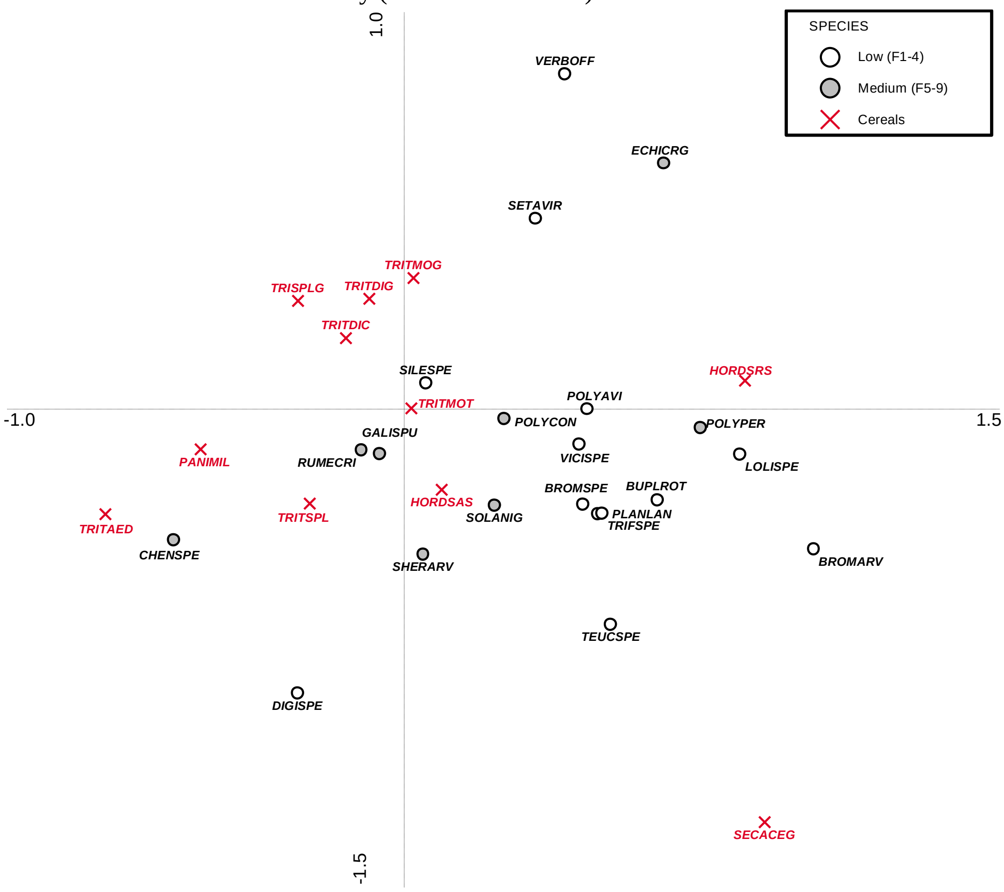


Fig 7.42. Correspondence analysis of crops and weed species for samples identified as unsieved fine sieving by-products showing the ecological indicator values for moisture (after Borhidi 1995): LBA Feudvar

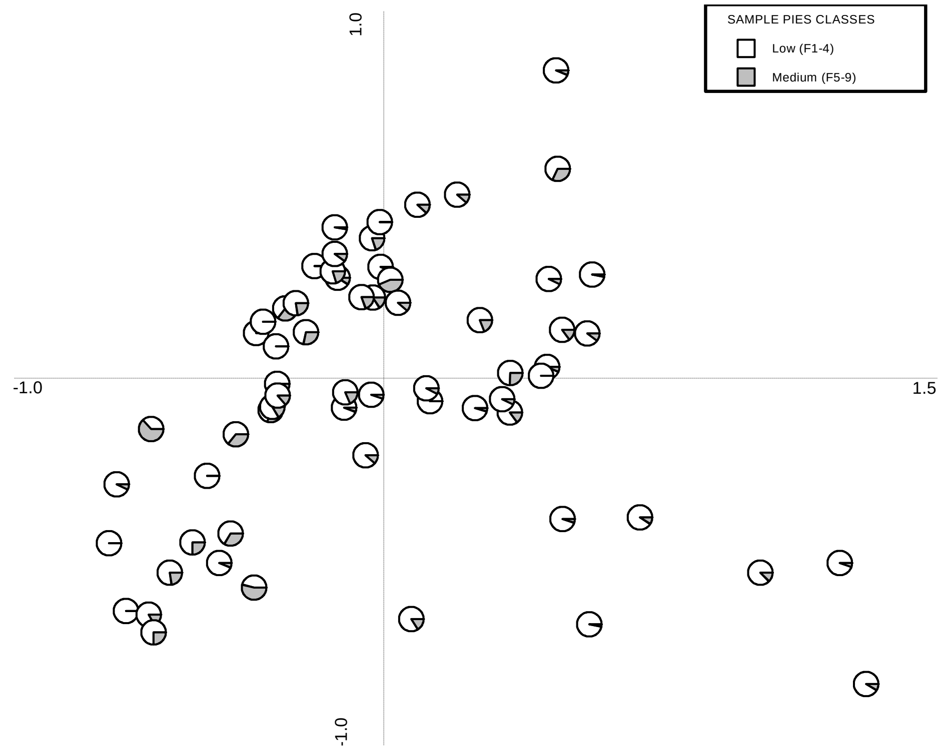


Fig 7.43. Correspondence analysis of the proportion of weed species according to their moisture indicator value for samples identified as unsieved fine sieving by-products (after Borhidi 1995): LBA Feudvar

Fig 7.44. Correspondence analysis of crops and weed species for samples identified as unsieved fine sieving by-products showing the ecological indicator values for reaction (after Borhidi 1995): LBA Feudvar

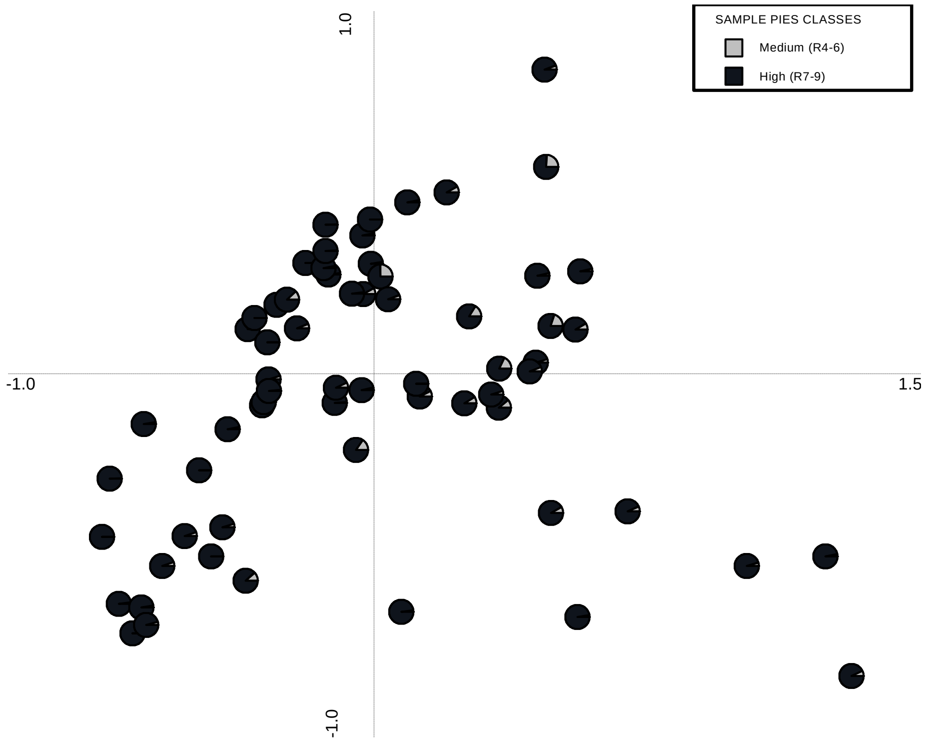


Fig 7.45. Correspondence analysis of the proportion of weed species according to their reaction indicator value for samples identified as unsieved fine sieving by-products (after Borhidi 1995): LBA Feudvar

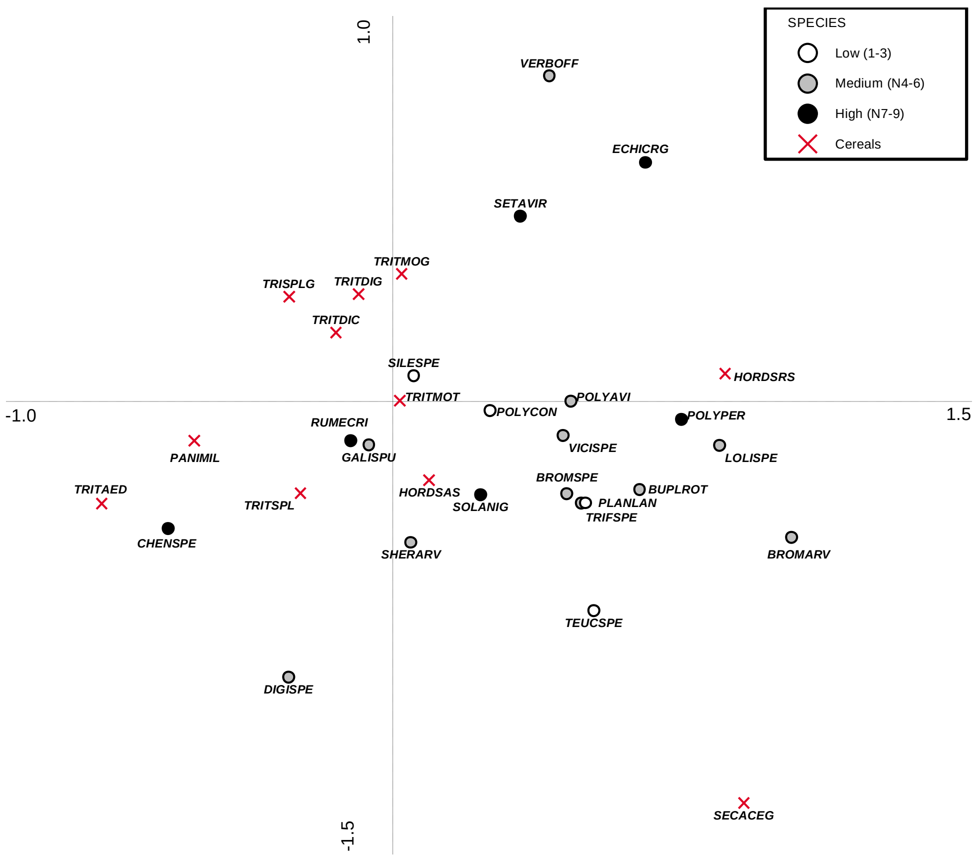


Fig 7.46. Correspondence analysis of crops and weed species for samples identified as unsieved fine sieving by-products showing the ecological indicator values for nitrogen (after Borhidi 1995): LBA Feudvar

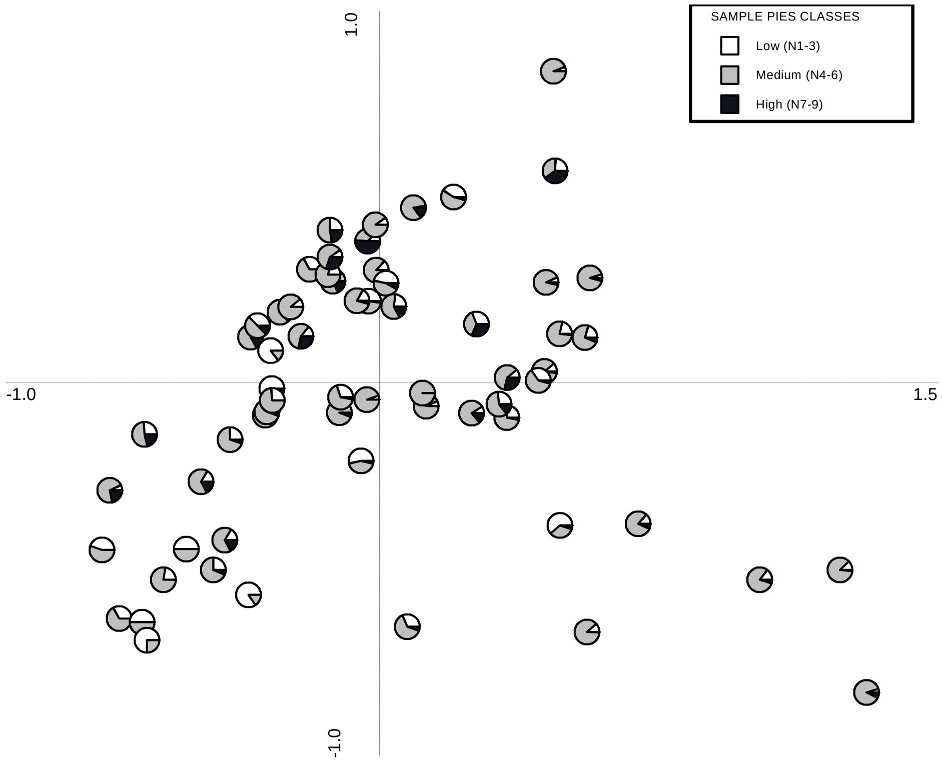


Fig 7.47. Correspondence analysis of the proportion of weed species, without CHENSPE, according to their nitrogen indicator value for samples identified as unsieved fine sieving by-products (after Borhidi 1995): LBA Feudvar

Fig 7.48. Correspondence analysis of crops and weed species for samples identified as unsieved fine sieving by-products, without CHENSPE, showing the maximum flowering height for each weed (after Bojňanský and Fargašová 2007): LBA Feudvar

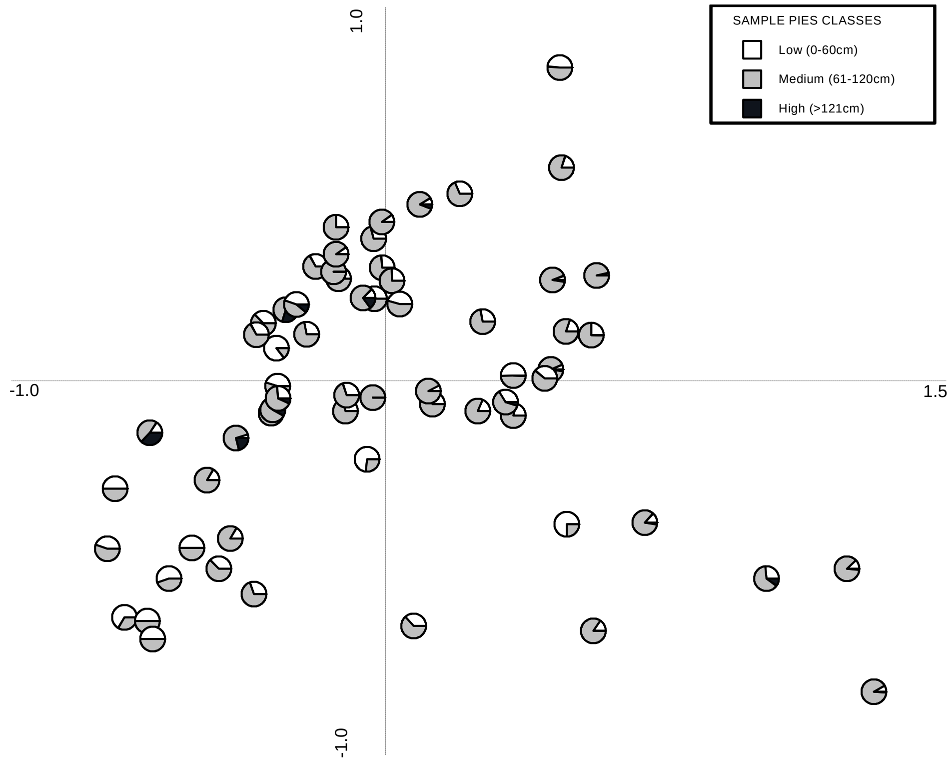


Fig 7.49. Correspondence analysis showing the proportions of weed species, without CHENSPE, according to their maximum flowering height for samples identified as unsieved fine sieving by-products spikelets (after Bojňanský and Fargašová 2007): LBA Feudvar

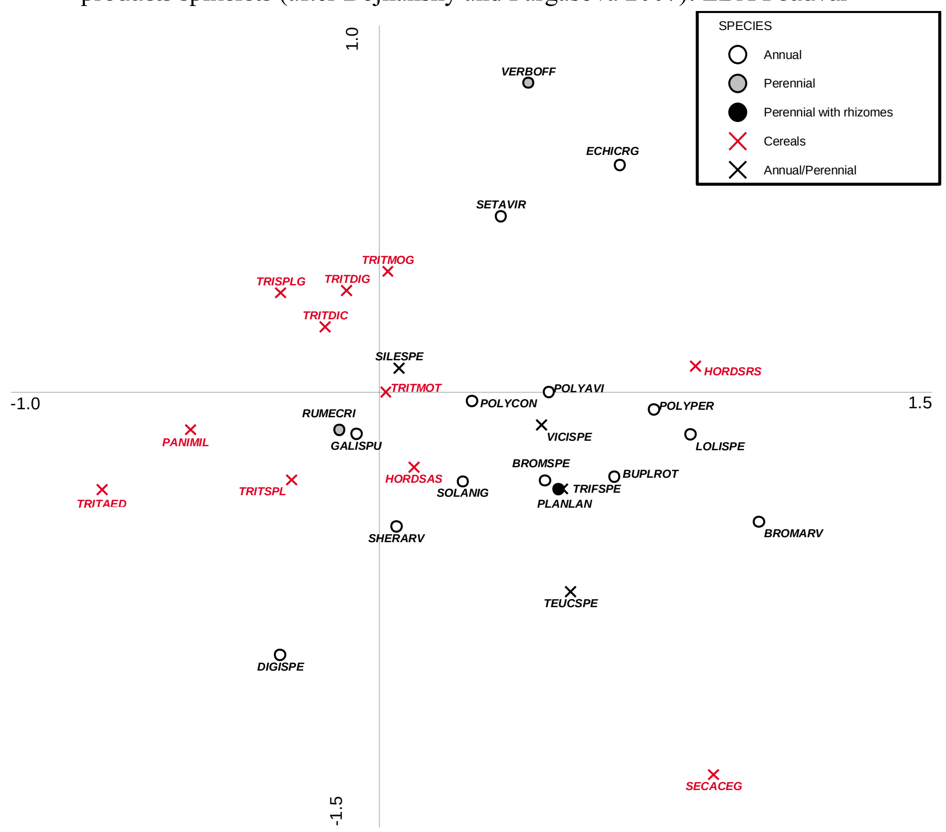


Fig 7.50. Correspondence analysis of crops and weed species for samples identified as unsieved fine sieving by-products, without CHENSPE, showing the life cycle of each weed i.e. whether they are an annual, perennial with or without rhizomes (after Bojňanský and Fargašová 2007): LBA Feudvar

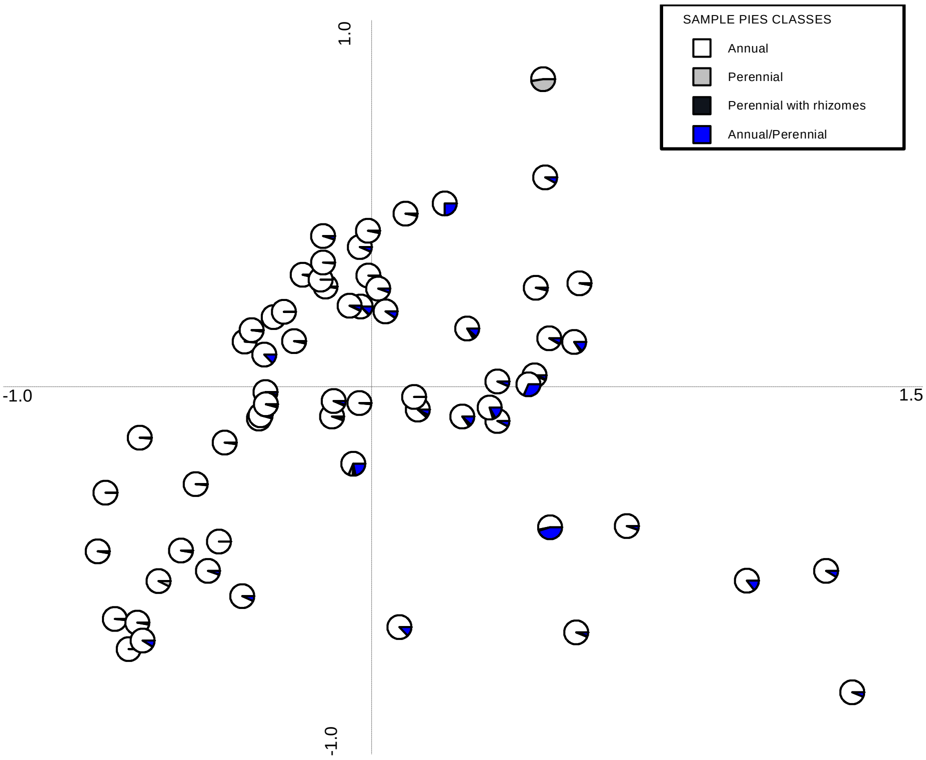


Fig 7.51. Correspondence analysis showing proportions of annuals and perennials for samples identified as unsieved fine sieving by-products, without CHENSPE (after Bojňanský and Fargašová 2007): LBA Feudvar

Fig 7.52. Correspondence analysis of crops and weed species for samples identified as unsieved fine sieving by-products, without CHENSPE, showing the germination time of each weed (after Bojňanský and Fargašová 2007): LBA Feudvar

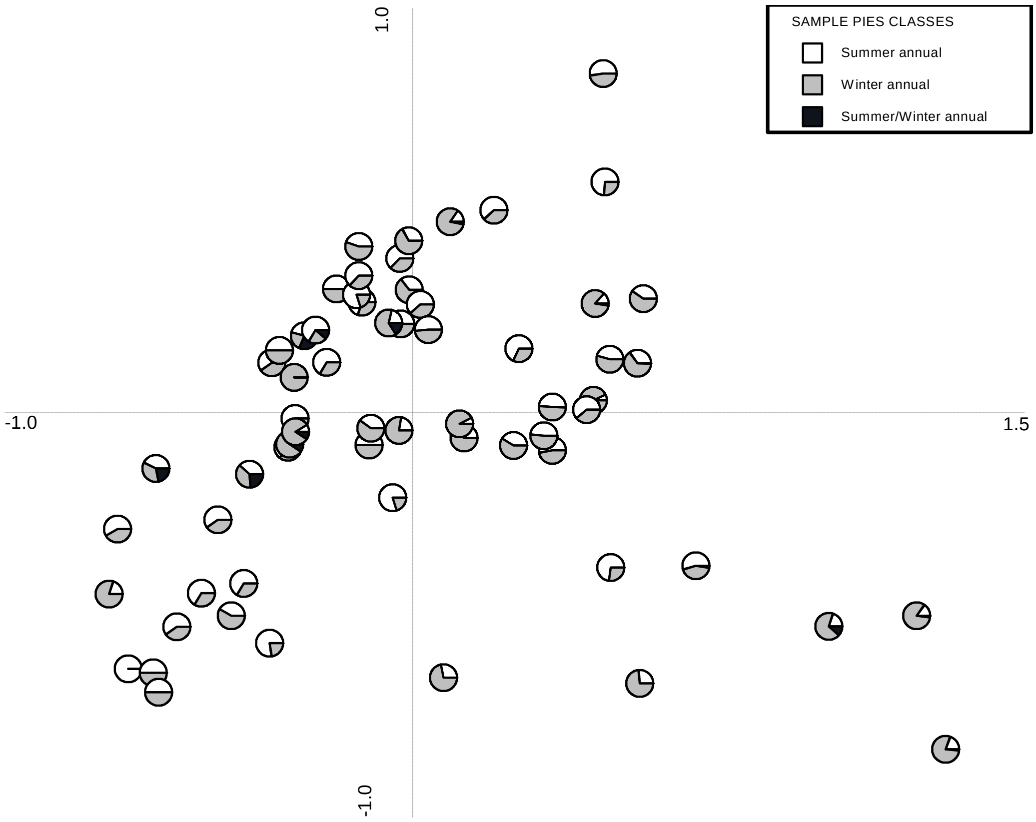


Fig 7.53. Correspondence analysis showing proportions of summer and winter annuals for samples, without CHENSPE, identified as unsieved fine sieving by-products (after Bojňanský and Fargašová 2007): LBA

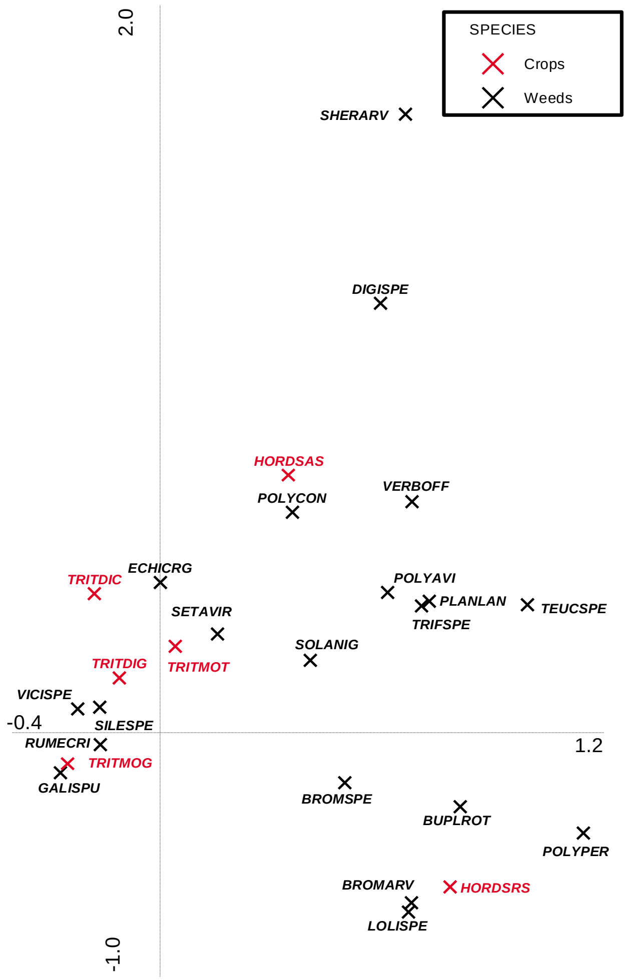


Fig 7.54. Correspondence analysis of crops, possible crops and weed species, without TRITSPL, TRITAED, CHENSPE, SECACEG AND PANMIL, for samples identified as unsieved fine sieving by-products: LBA Feudvar

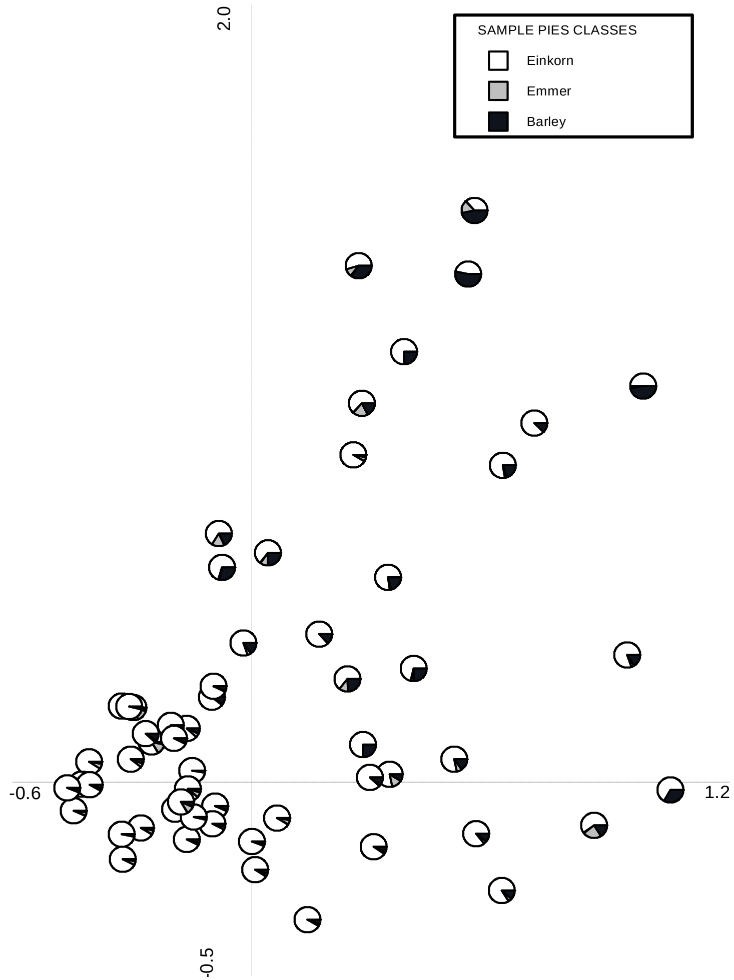


Fig 7.55. Correspondence analysis of the proportion of cereals per sample, without TRITSPL, TRITAED, CHENSPE, SECACEG AND PANMIL, identified as unsieved fine sieving by-products: LBA Feudvar

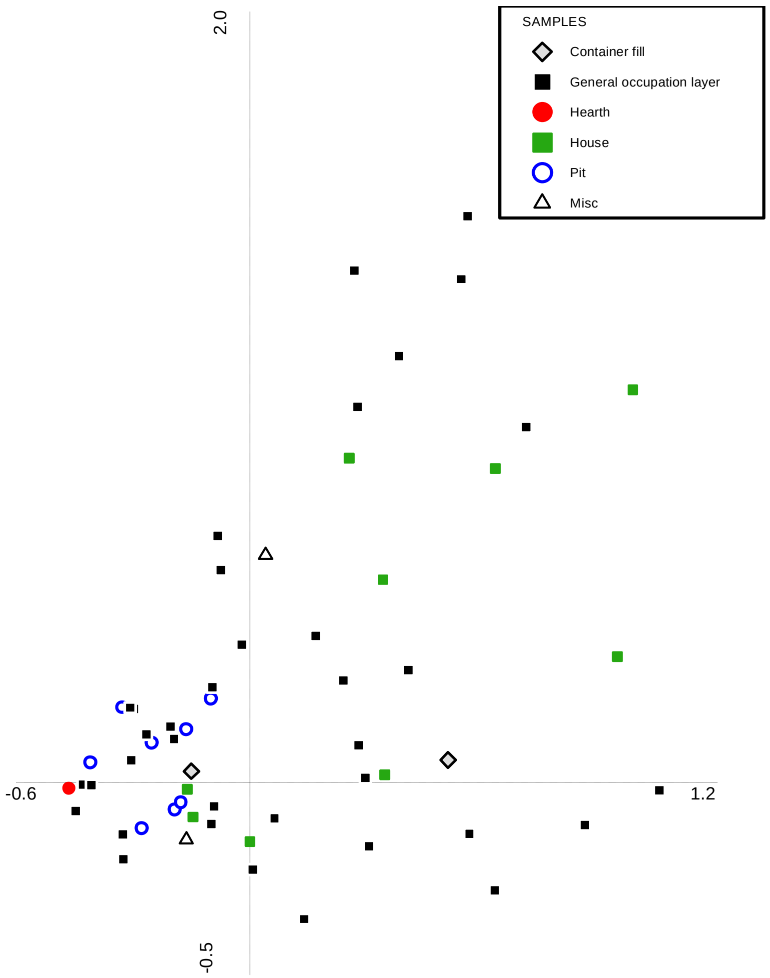


Fig 7.56. Correspondence analysis of samples, without TRITSPL, TRITAED, CHENSPE, SECACEG AND PANMIL, identified as unsieved fine sieving by-products per feature type: LBA Feudvar

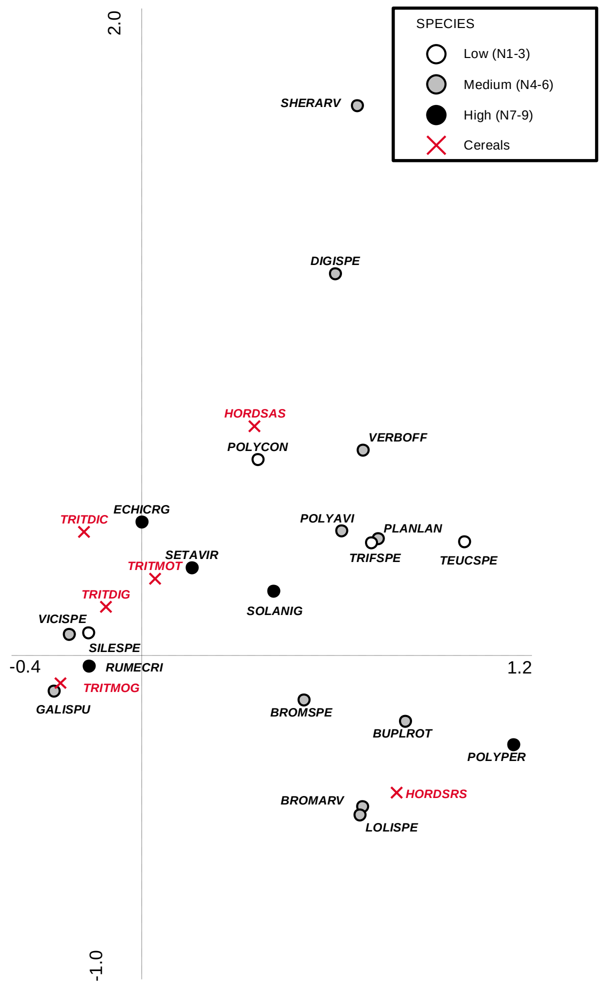


Fig 7.57. Correspondence analysis of crops and weed species, without TRITSPL, TRITAED, CHENSPE, SECACEG AND PANMIL, for samples identified as unsieved fine sieving by-products showing the ecological indicator values for nitrogen (after Borhidi 1995): LBA Feudvar

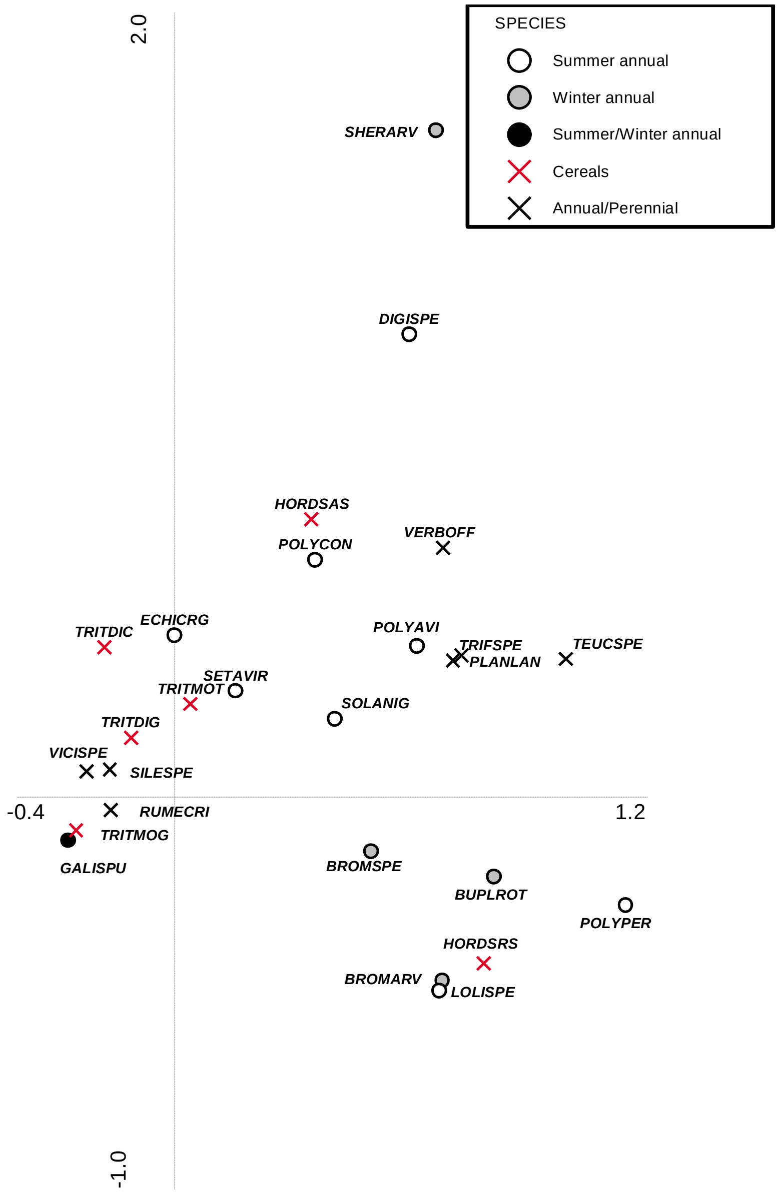


Fig 7.58. Correspondence analysis of crops and weed species , without TRITSPL, TRITAED, CHENSPE, SECACEG AND PANMIL, for samples identified as unsieved fine sieving by-products showing the germination time of each weed (after Bojňanský and Fargašová 2007): LBA Feudvar

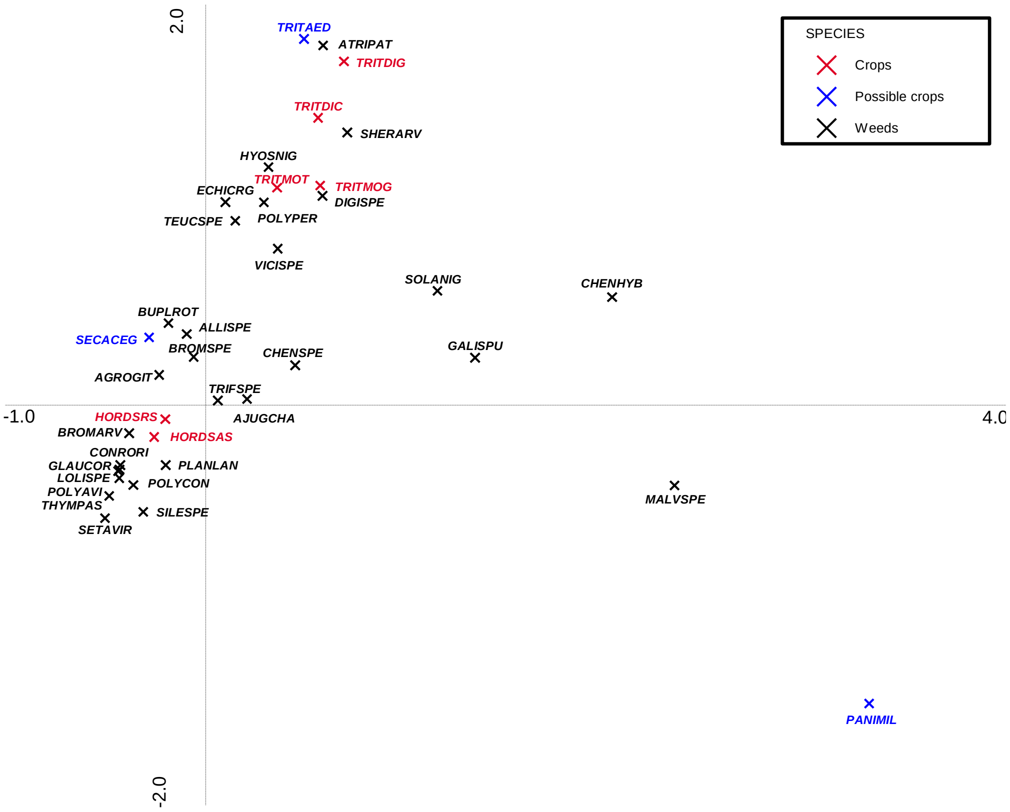


Fig 7.59. Correspondence analysis of crops, possible crops and weed species for samples identified as unsieved products on the first two principal axes (axis 1 horizontal, axis 2 vertical): LBA Feudvar

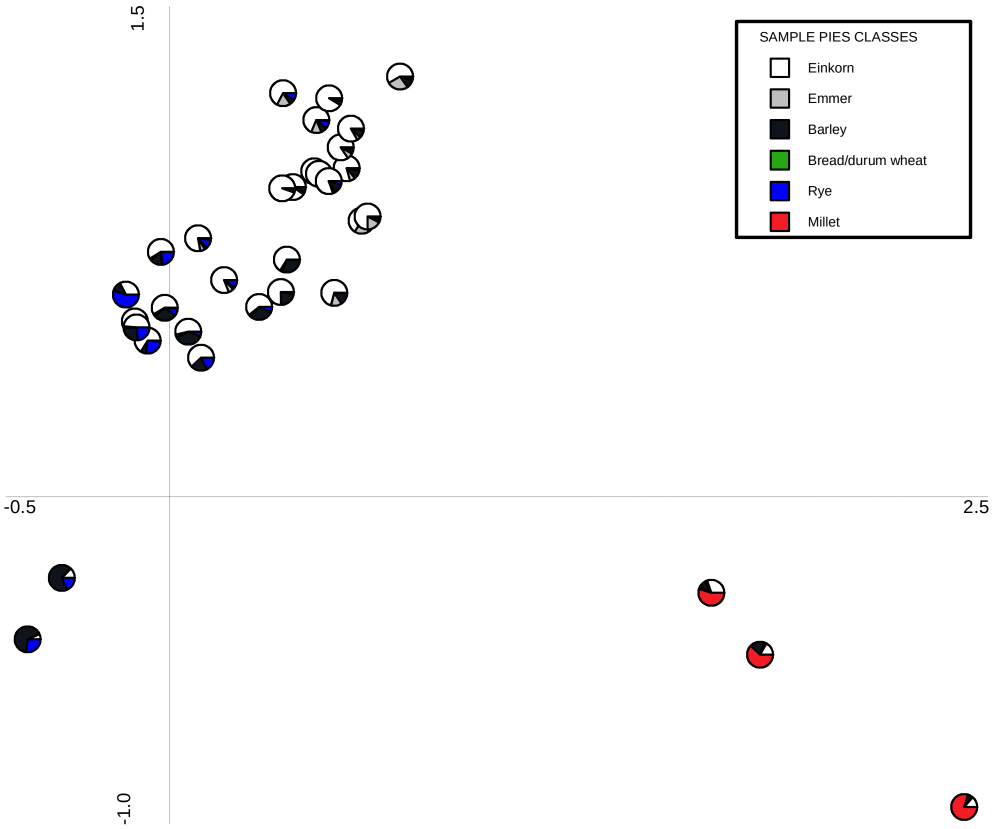


Fig 7.60. Correspondence analysis of the proportion of cereals per sample identified as unsieved products: LBA Feudvar

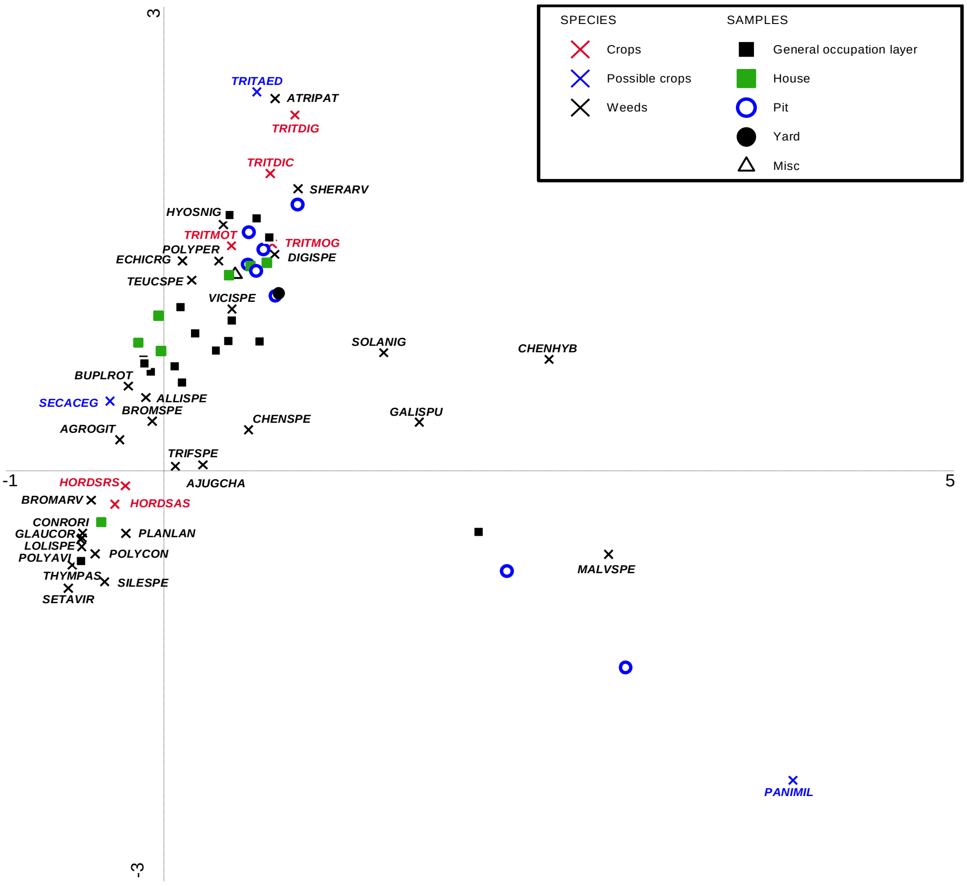


Fig 7.61. Correspondence analysis of crops, possible crops and weed species for samples identified as unsieved products per feature type: LBA Feudvar

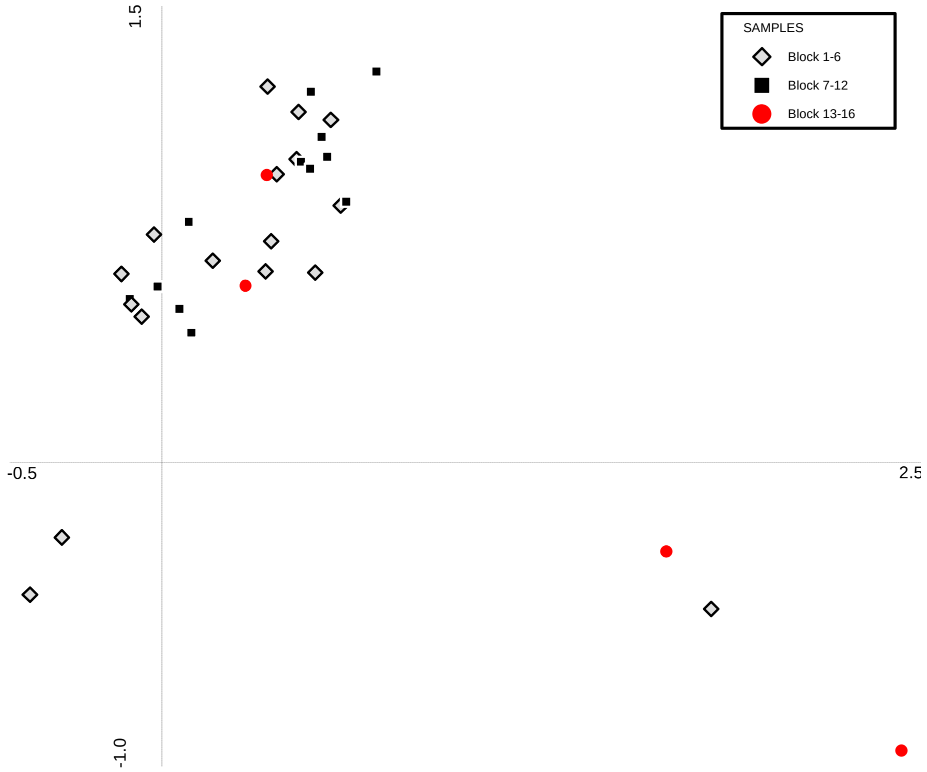


Fig 7.62. Correspondence analysis of each sample identified as unsieved products per block group: LBA Feudvar

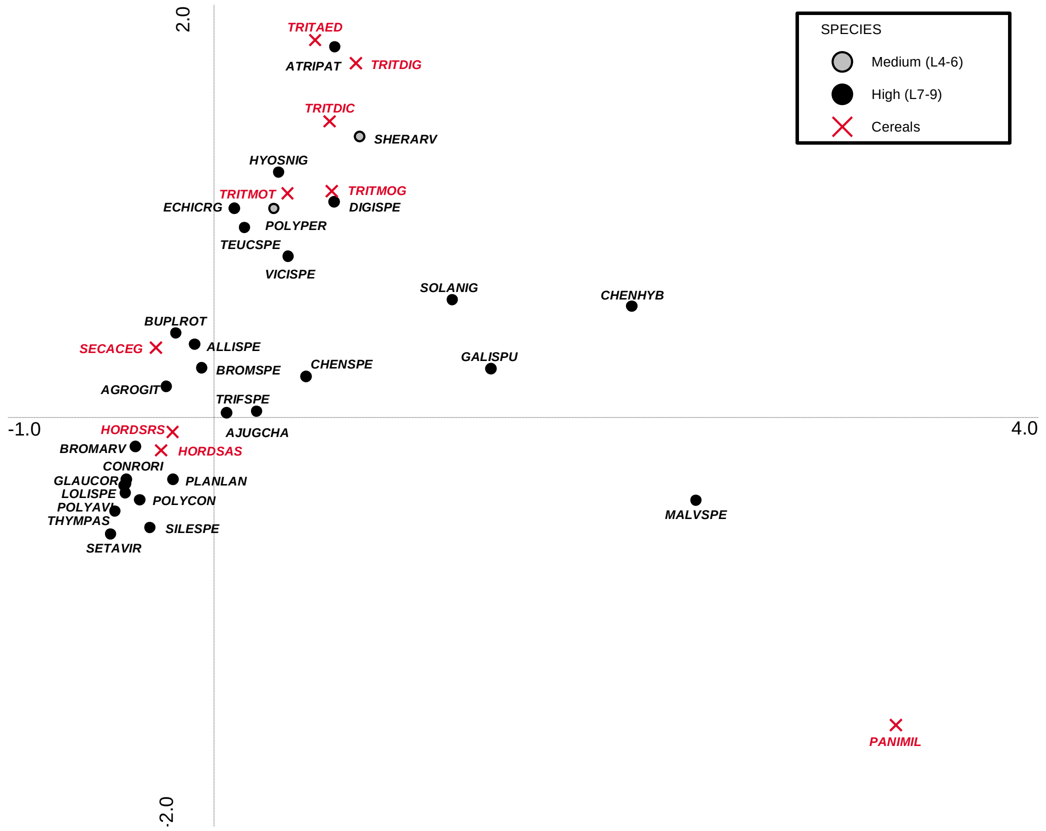


Fig 7.63. Correspondence analysis of crops and weed species for samples identified as unsieved products showing the ecological indicator values for light (after Borhidi 1995): LBA Feudvar

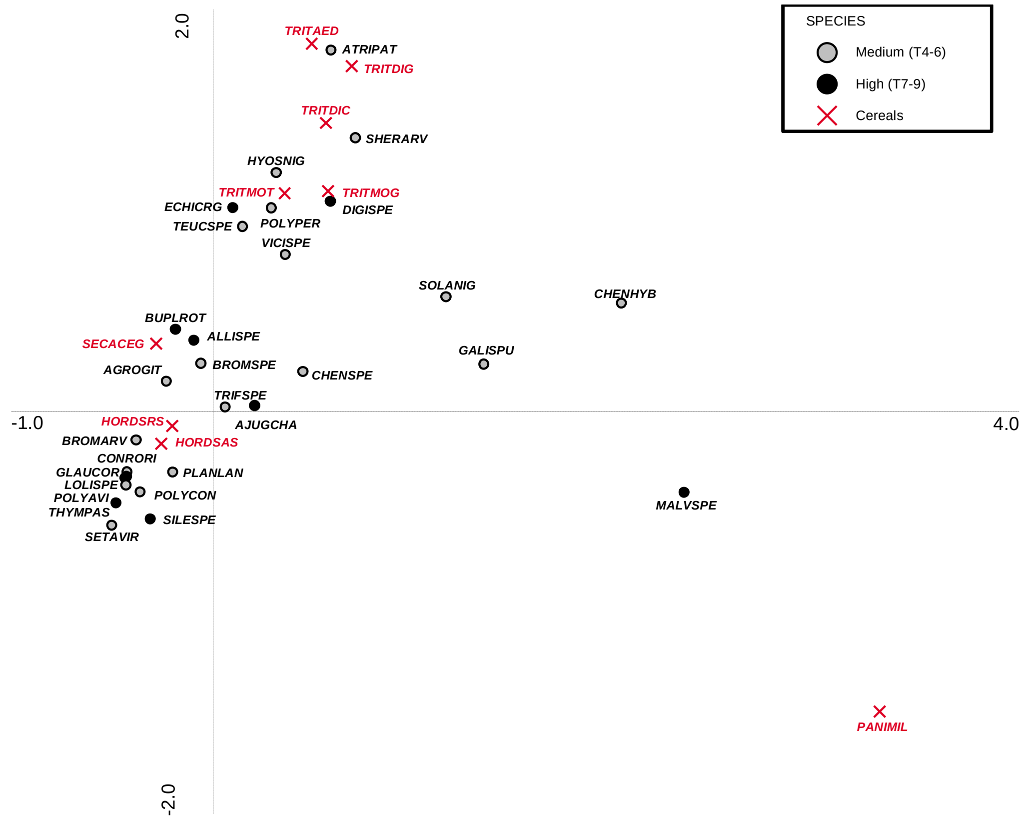


Fig 7.64. Correspondence analysis of crops and weed species for samples identified as unsieved products showing the ecological indicator values for temperature (after Borhidi 1995): LBA Feudvar

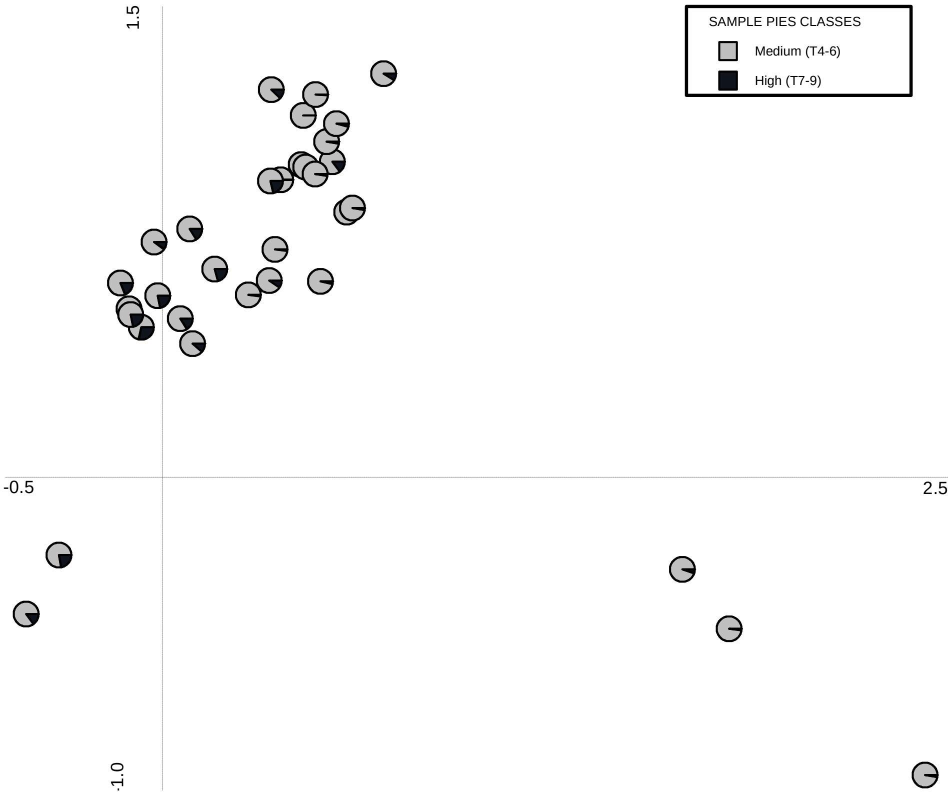


Fig 7.65. Correspondence analysis of the proportion of weed species according to their temperature indicator value for samples identified as unsieved products (after Borhidi 1995): LBA Feudvar

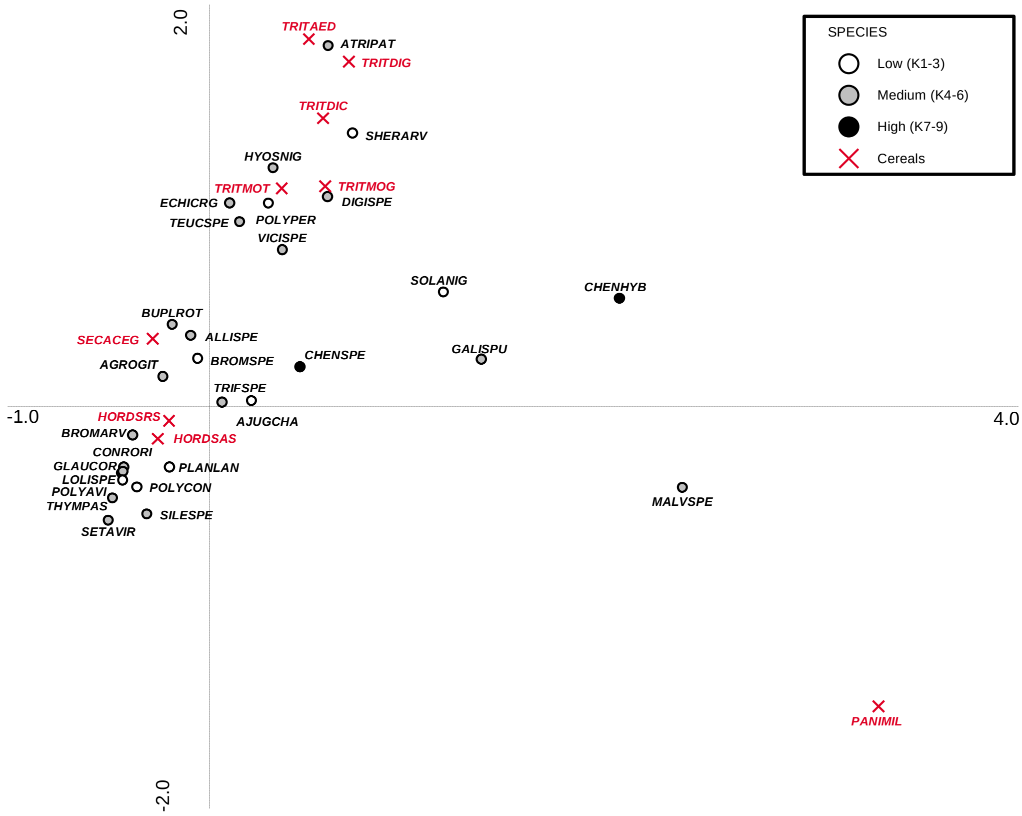


Fig 7.66. Correspondence analysis of crops and weed species for samples identified as unsieved products showing the ecological indicator values for continentality (after Borhidi 1995): LBA Feudvar

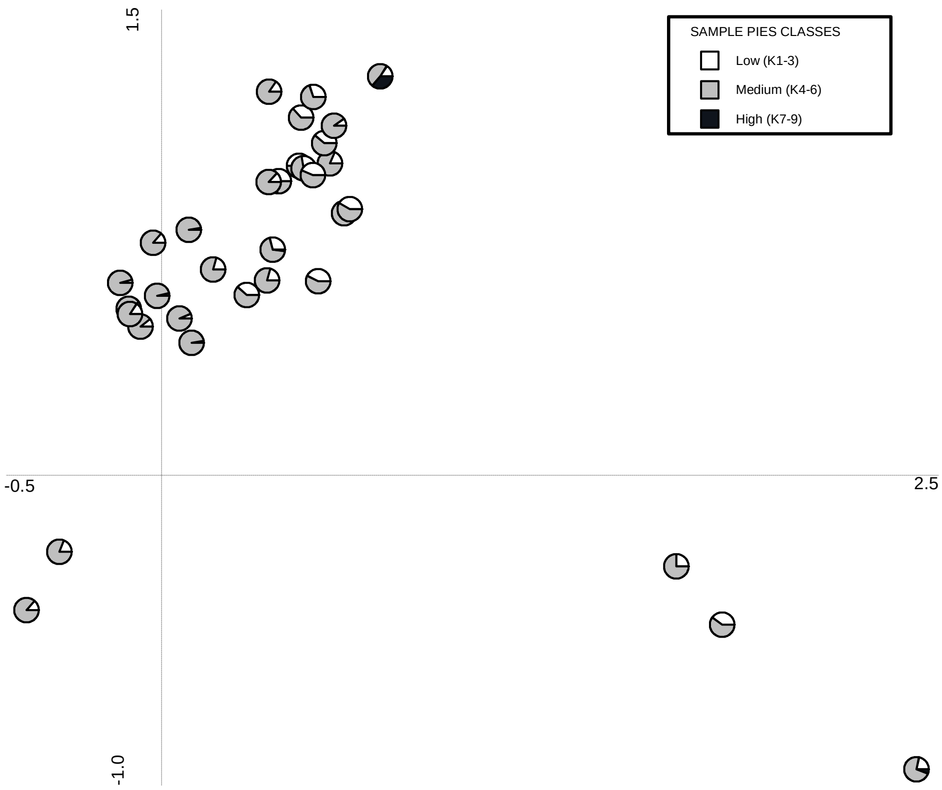


Fig 7.67. Correspondence analysis of the proportion of weed species, without CHENSPE, according to their continentality indicator value for samples identified as unsieved products (after Borhidi 1995): LBA Feudvar

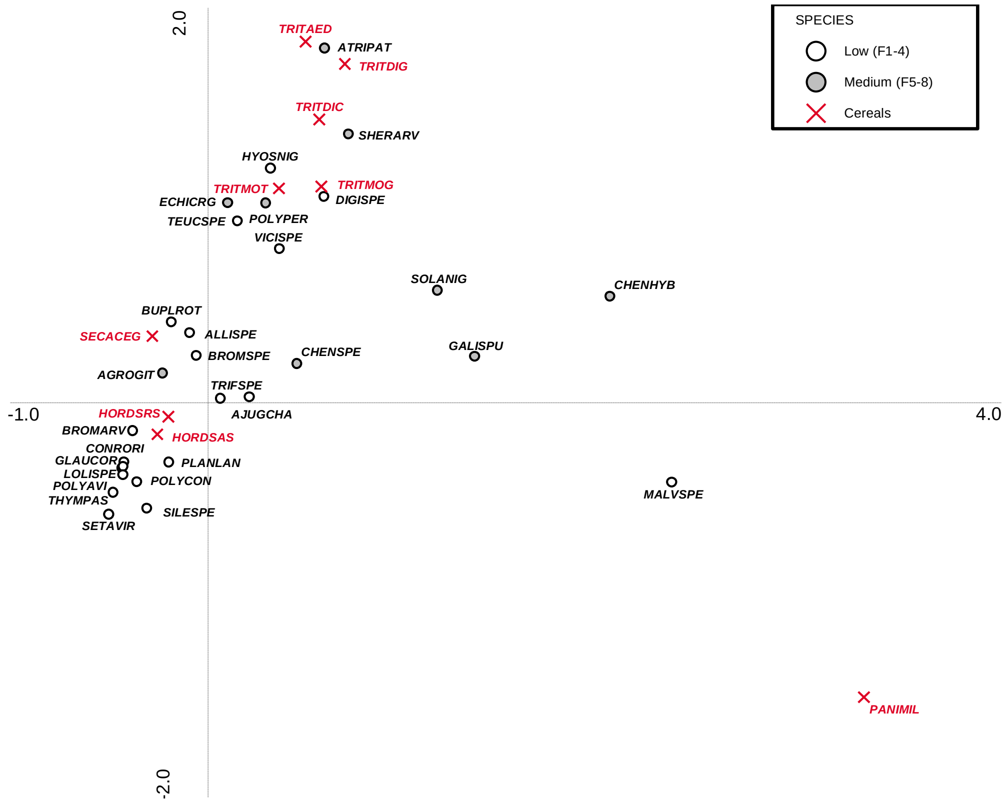


Fig 7.68. Correspondence analysis of crops and weed species for samples identified as unsieved products showing the ecological indicator values for moisture (after Borhidi 1995): LBA Feudvar

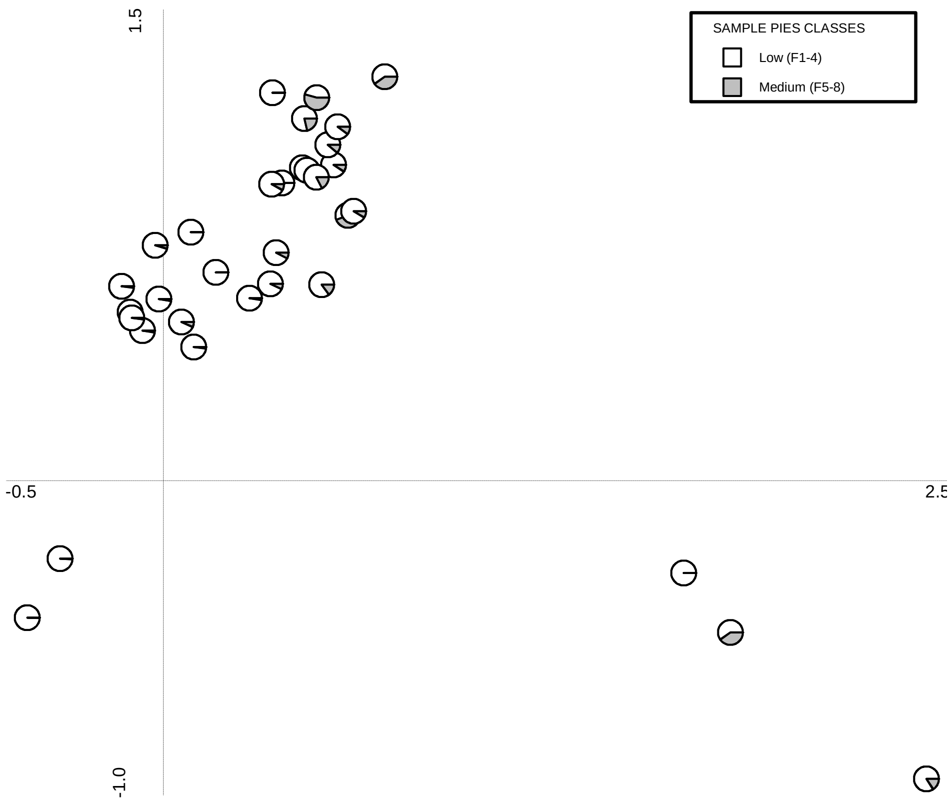


Fig 7.69. Correspondence analysis of the proportion of weed species, without CHENSPE, according to their moisture indicator value for samples identified as unsieved products (after Borhidi 1995): LBA Feudvar

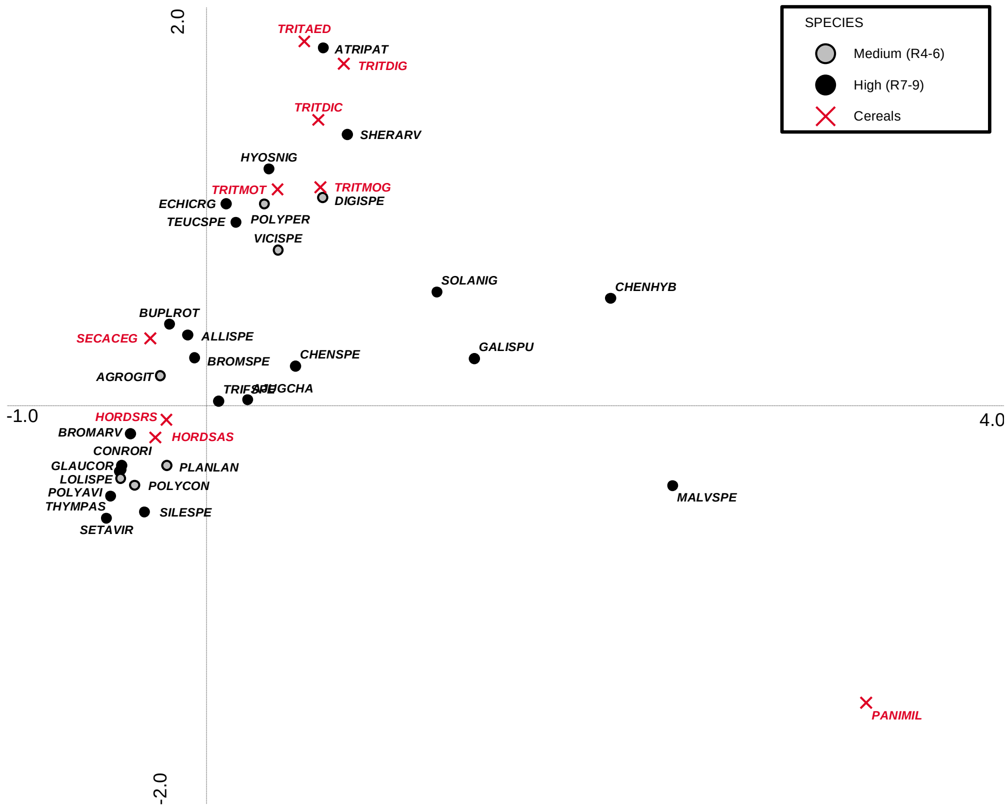


Fig 7.70. Correspondence analysis of crops and weed species for samples identified as unsieved products showing the ecological indicator values for reaction (after Borhidi 1995): LBA Feudvar

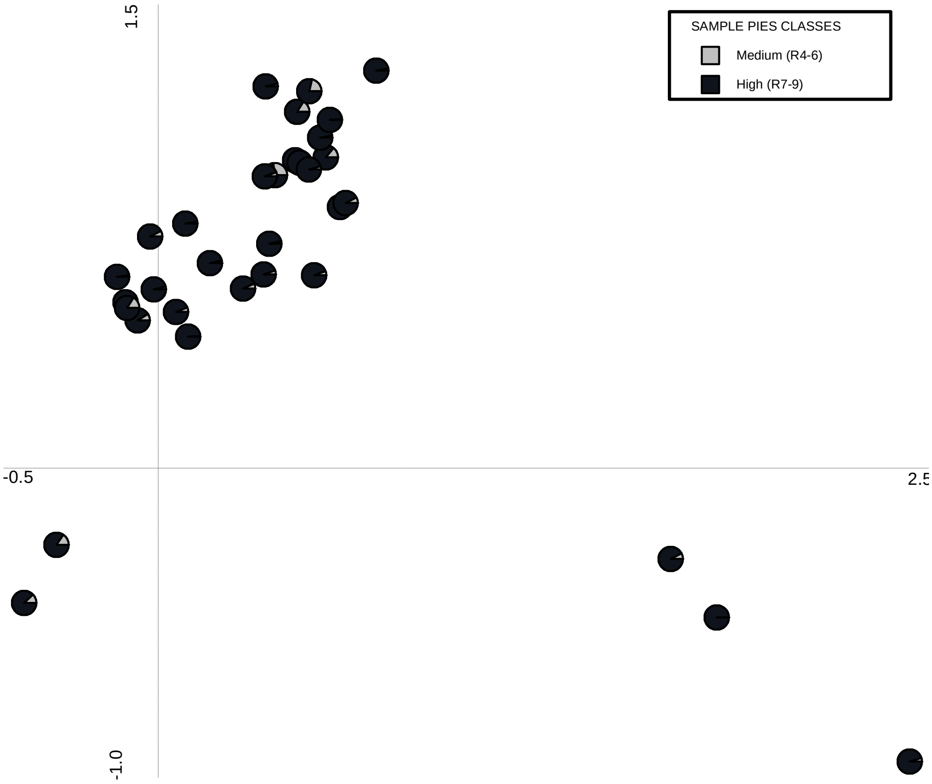


Fig 7.71. Correspondence analysis of the proportion of weed species according to their reaction indicator value for samples identified as unsieved products (after Borhidi 1995): LBA Feudvar

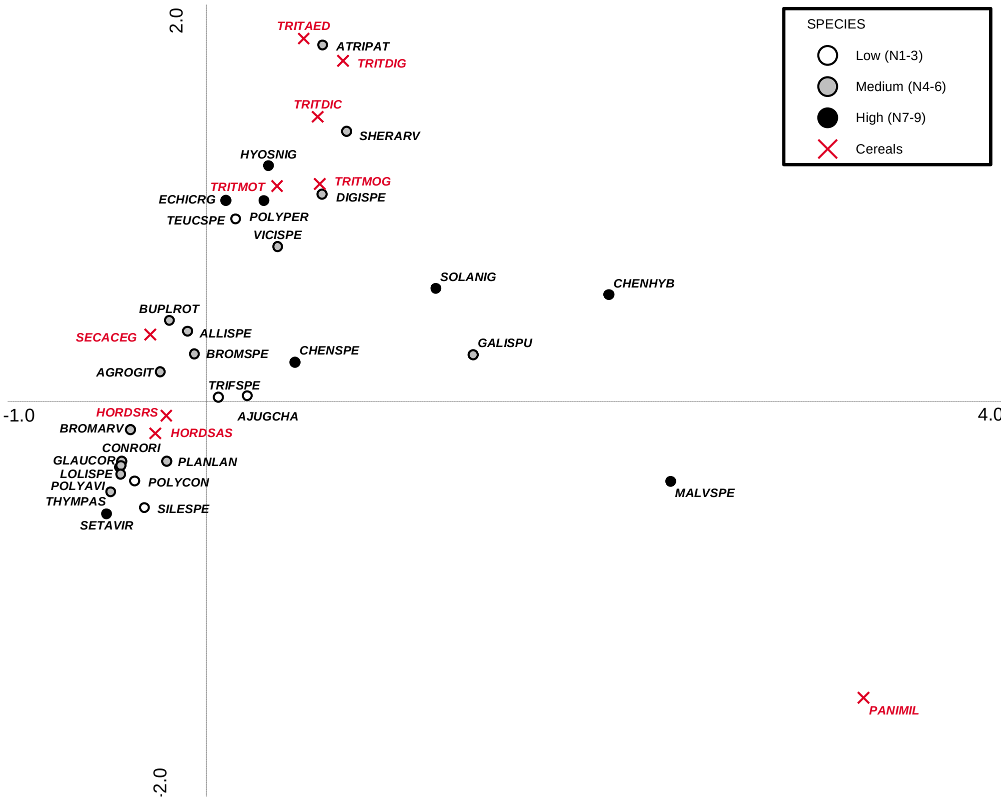


Fig 7.72. Correspondence analysis of crops and weed species for samples identified as unsieved products showing the ecological indicator values for nitrogen (after Borhidi 1995): LBA Feudvar

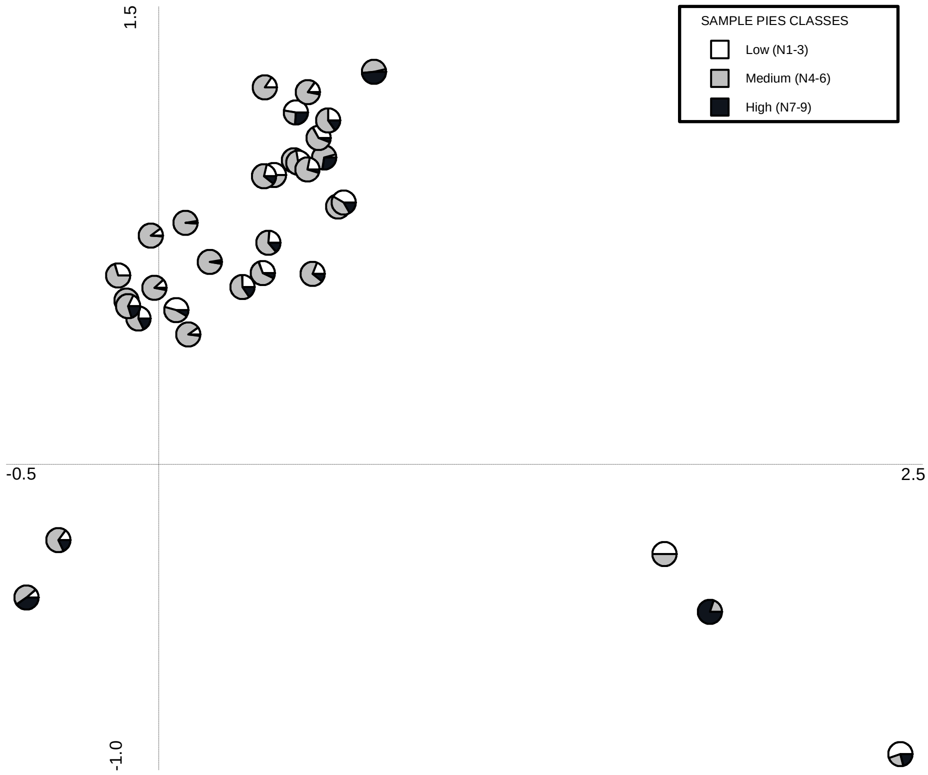


Fig 7.73. Correspondence analysis of the proportion of weed species, without CHENSPE, according to their nitrogen indicator value for samples identified as unsieved products (after Borhidi 1995): LBA Feudvar

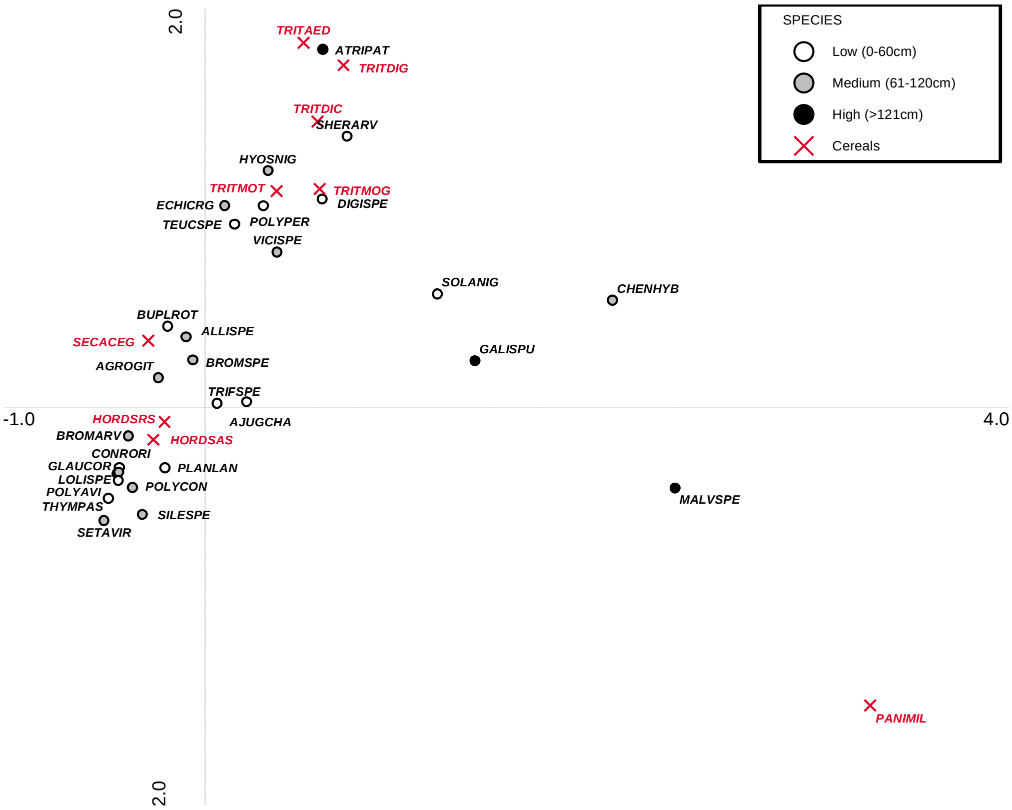


Fig 7.74. Correspondence analysis of crops and weed species for samples identified as unsieved products, without CHENSPE, showing the maximum flowering height for each weed (after Bojňanský and Fargašová 2007): LBA Feudvar

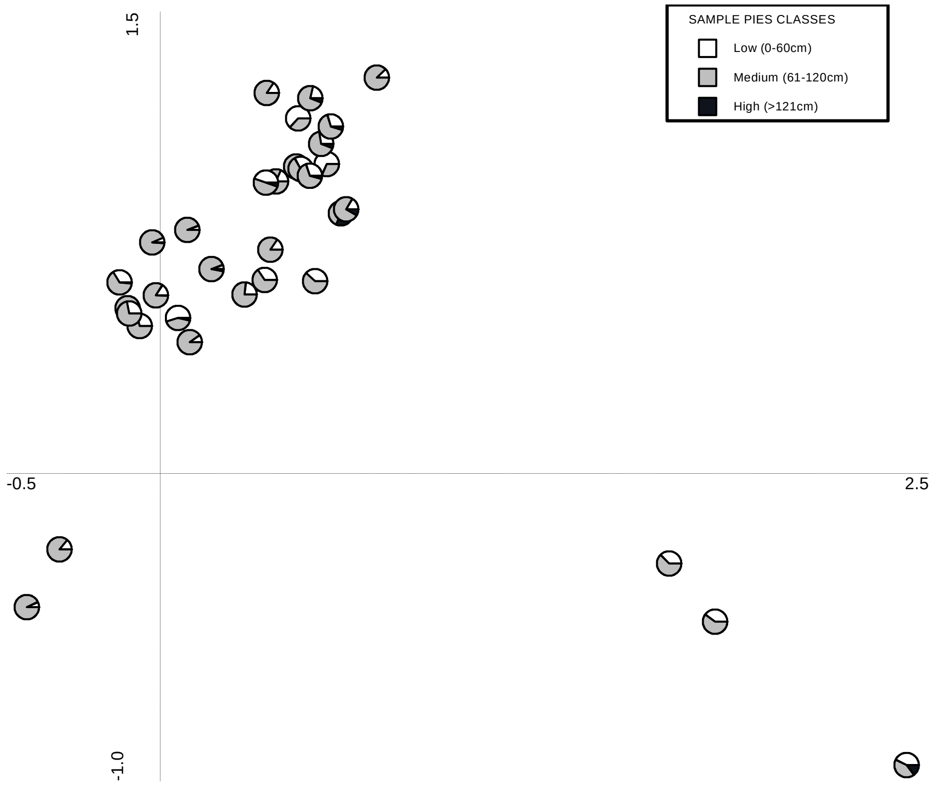


Fig 7.75. Correspondence analysis showing the proportions of weed species, without CHENSPE, according to their maximum flowering height for samples identified as unsieved products (after Bojňanský and Fargašová 2007): LBA Feudvar

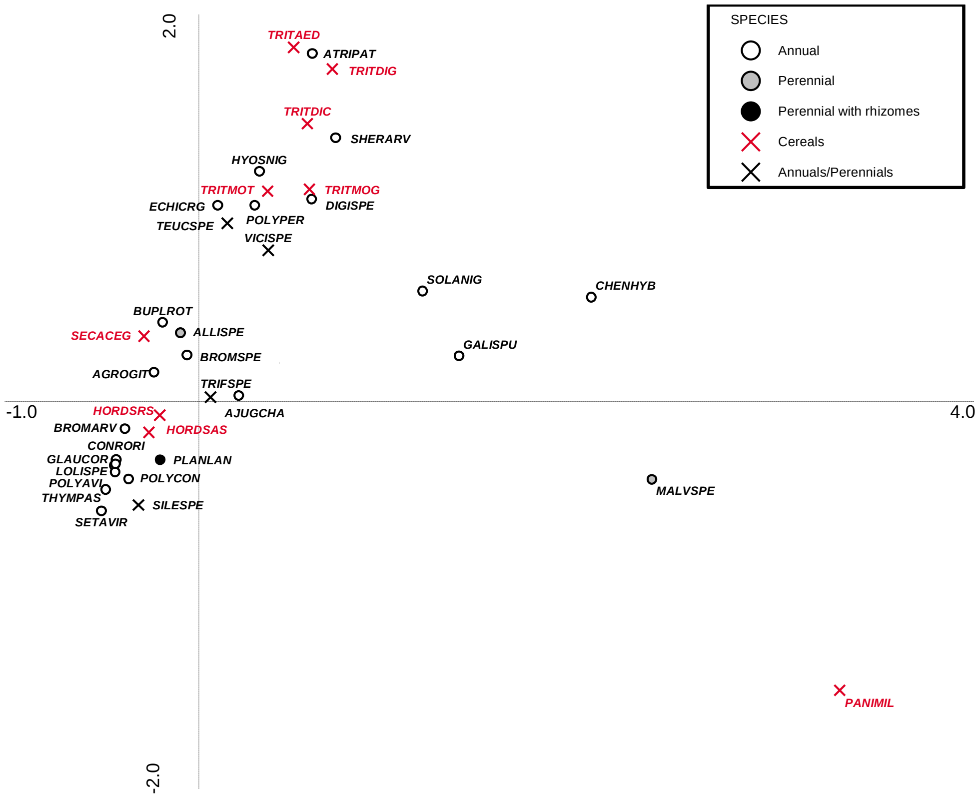


Fig 7.76. Correspondence analysis of crops and weed species for samples identified as unsieved products, without CHENSPE, showing the life cycle of each weed i.e. whether they are an annual, perennial with or without rhizomes (after Bojňanský and Fargašová 2007): LBA Feudvar

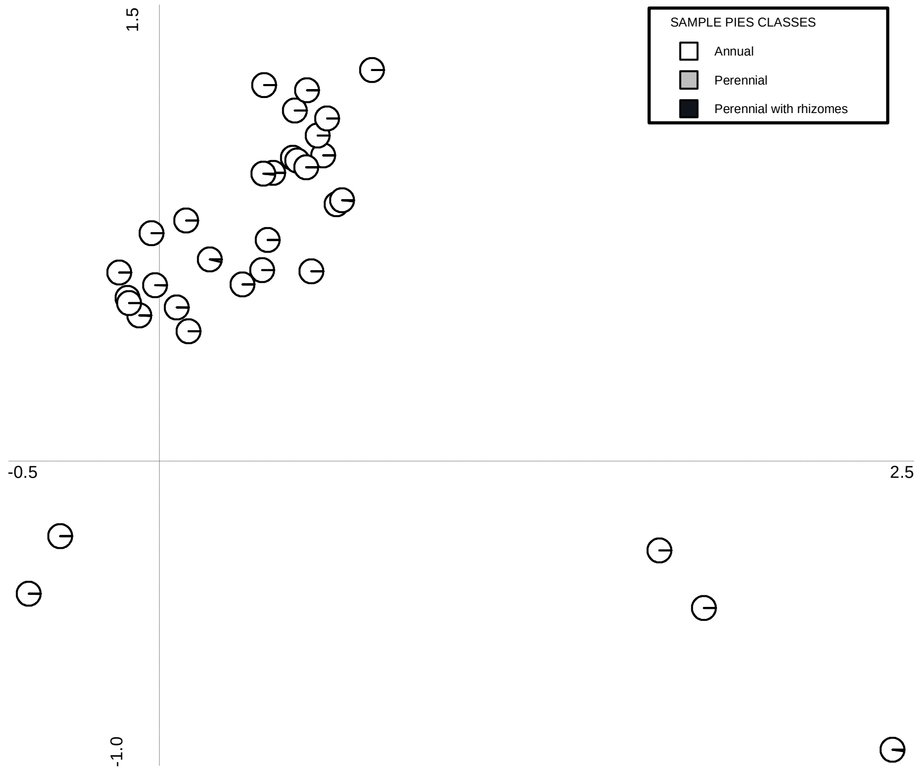


Fig 7.77. Correspondence analysis showing proportions of annuals and perennials for samples identified as unsieved products, without CHENSPE (after Bojňanský and Fargašová 2007): LBA Feudvar

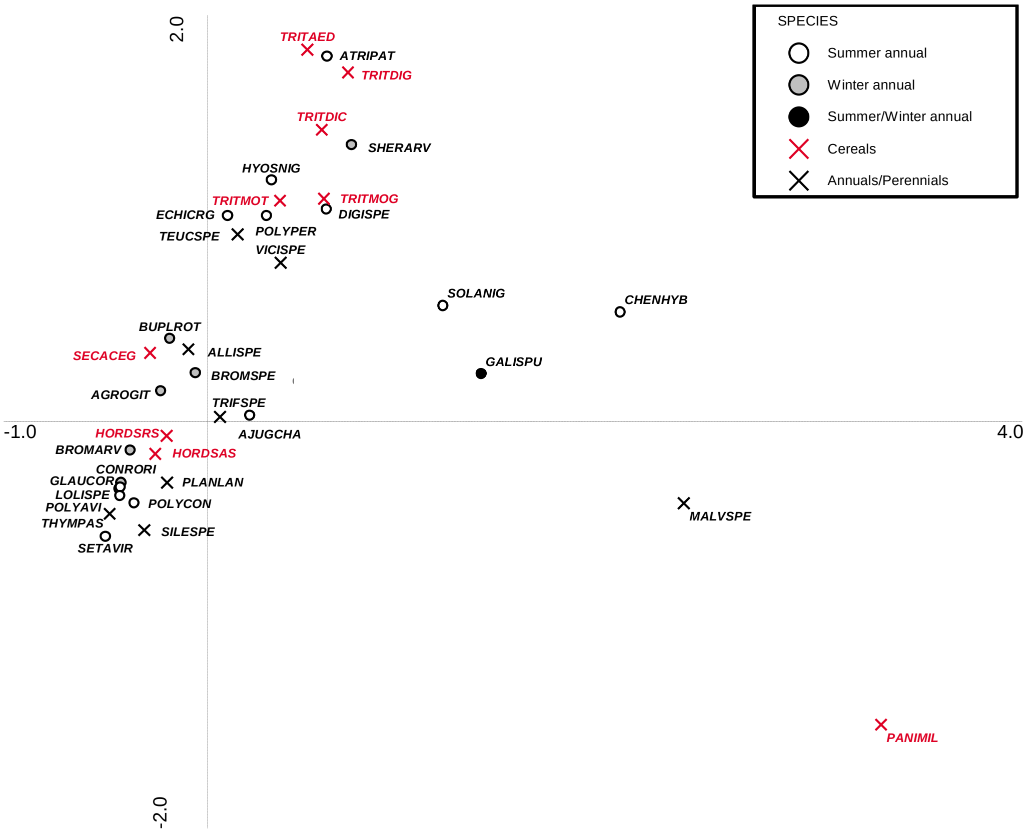


Fig 7.78 . Correspondence analysis of crops and weed species for samples identified as unsieved products, without CHENSPE, showing the germination time of each weed (after Bojňanský and Fargašová 2007): LBA Feudvar

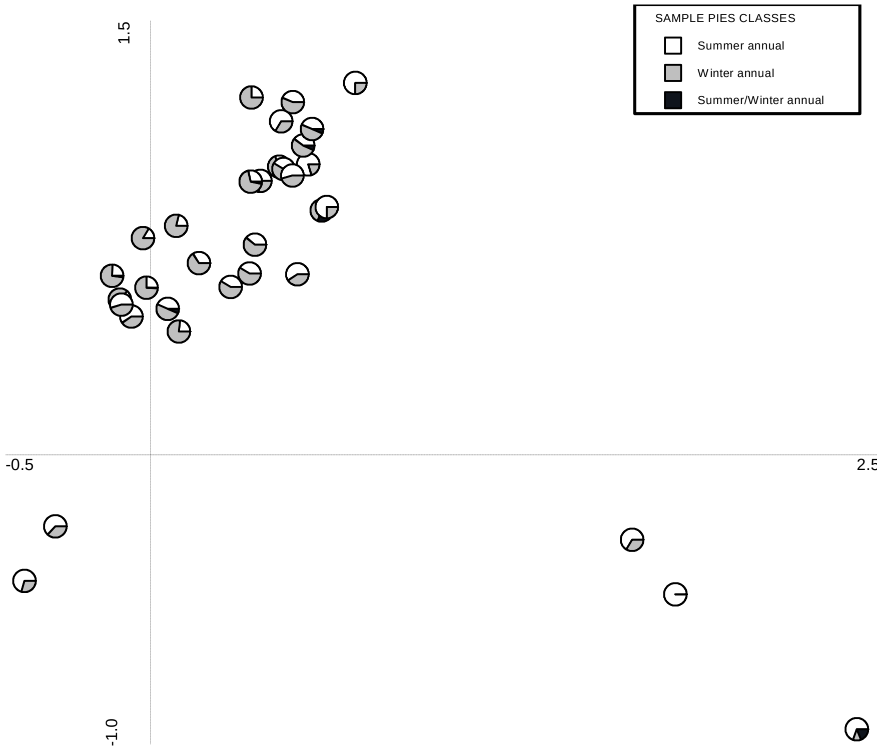


Fig 7.79. Correspondence analysis showing proportions of summer and winter annuals, without CHENSPE, for samples identified as unsieved products (after Bojňanský and Fargašová 2007): LBA Feudvar

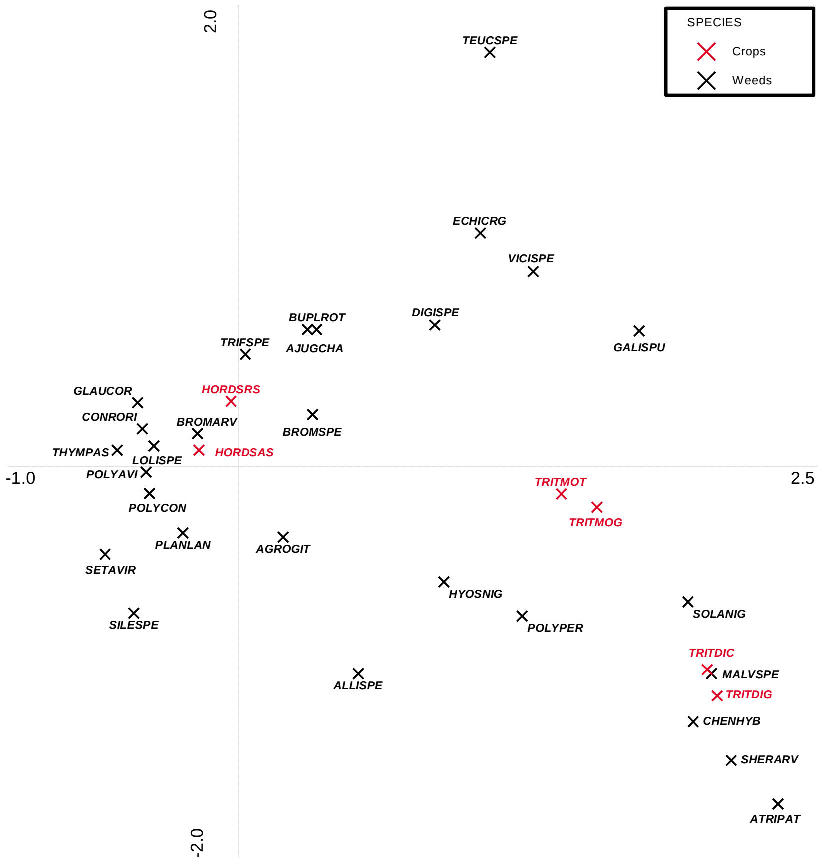


Fig 7.80. Correspondence analysis of crops, possible crops and weed species, without TRITAED, CHENSPE, SECACEG AND PANMIL, for samples identified as unsieved products: LBA Feudvar

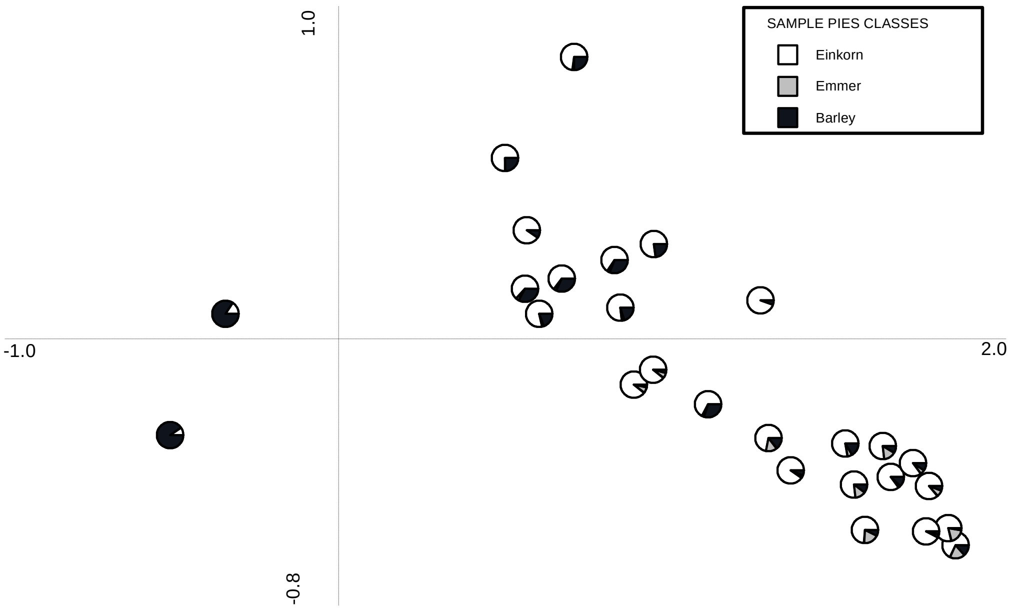


Fig 7.81. Correspondence analysis of the proportion of cereals per sample, without TRITAED, CHENSPE, SECACEG AND PANMIL, identified as unsieved fine products: LBA Feudvar

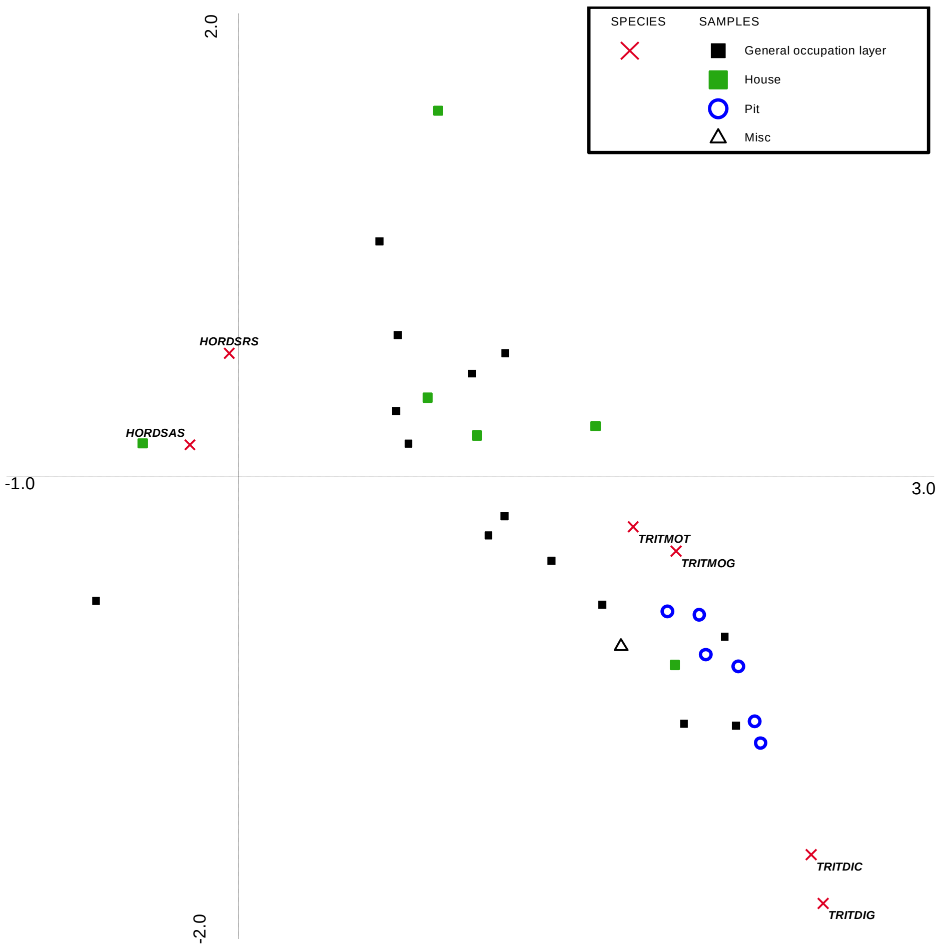


Fig 7.82. Correspondence analysis of samples, without TRITAED, CHENSPE, SECACEG AND PANMIL, identified as unsieved products per feature type: LBA Feudvar

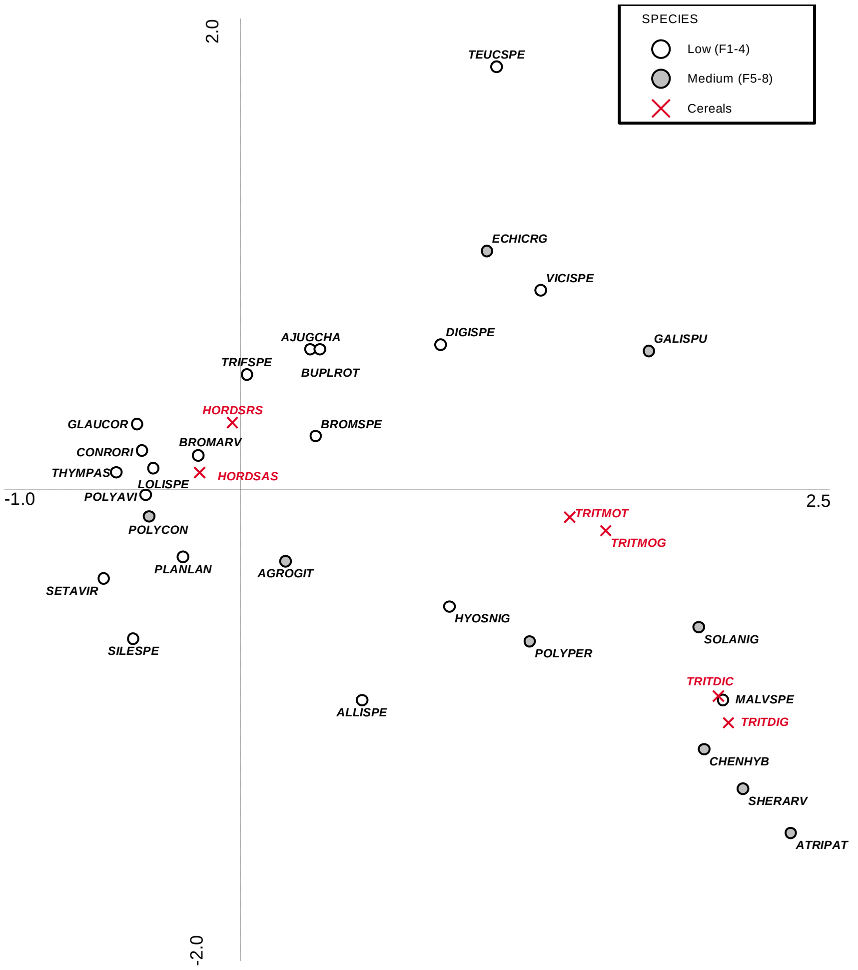


Fig 7.83. Correspondence analysis of crops and weed species for samples, without TRITAED, CHENSPE, SECACEG AND PANMIL, identified as unsieved products showing the ecological indicator values for moisture (after Borhidi 1995): LBA Feudvar

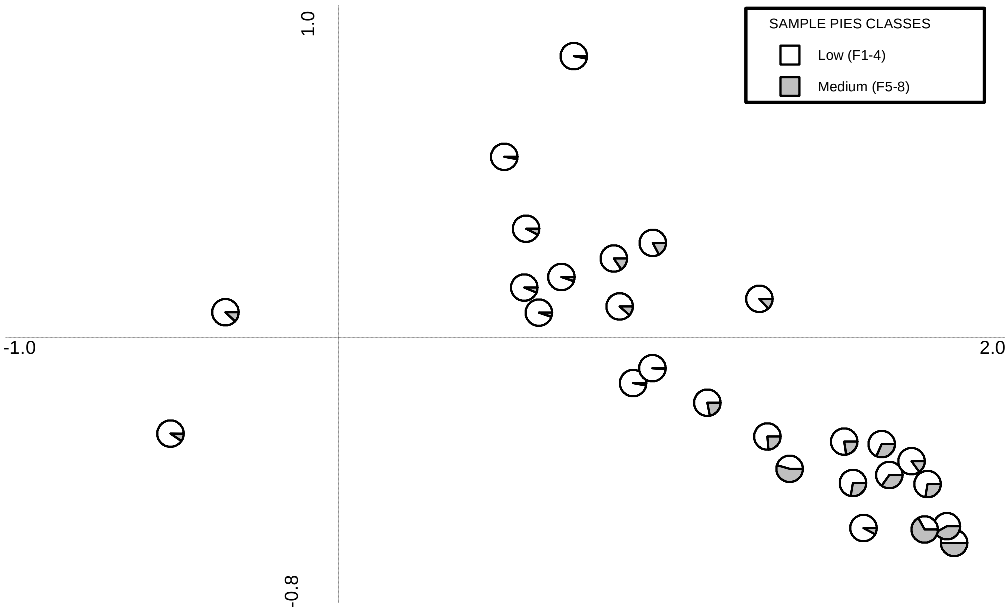


Fig 7.84. Correspondence analysis of the proportion of weed species, without TRITAED, CHENSPE, SECACEG AND PANMIL, according to their moisture indicator value for samples identified as unsieved products (after Borhidi 1995): LBA Feudvar

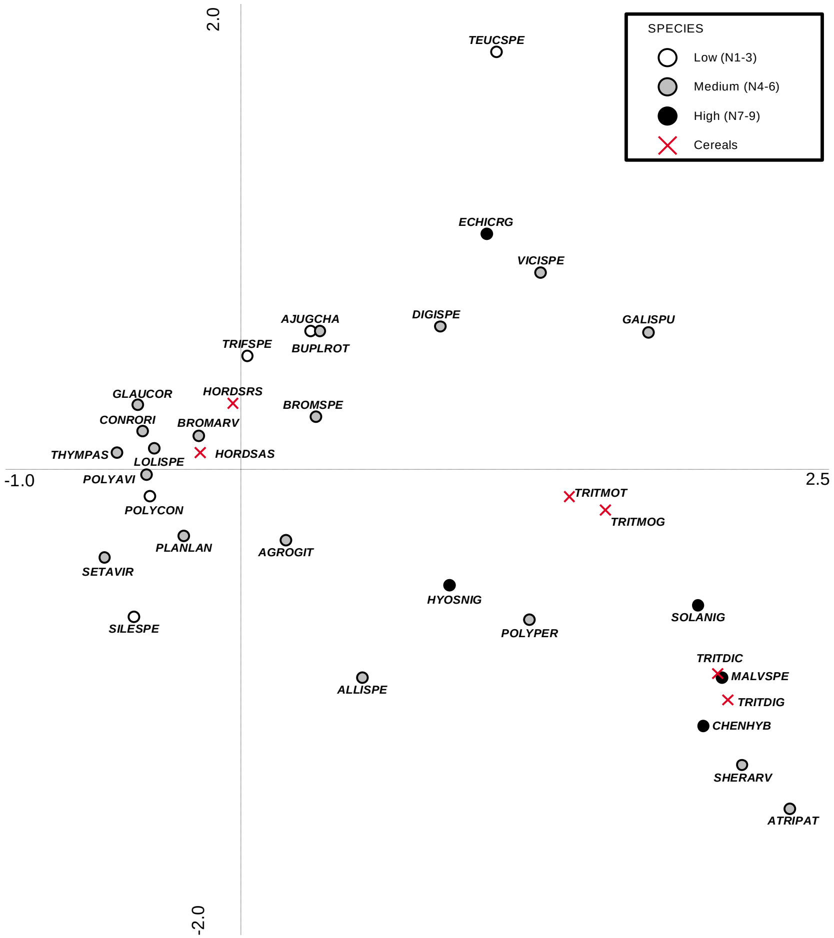


Fig 7.85. Correspondence analysis of crops and weed species, without TRITAED, CHENSPE, SECACEG AND PANMIL, for samples identified as unsieved products showing the ecological indicator values for nitrogen (after Borhidi 1995): LBA Feudvar

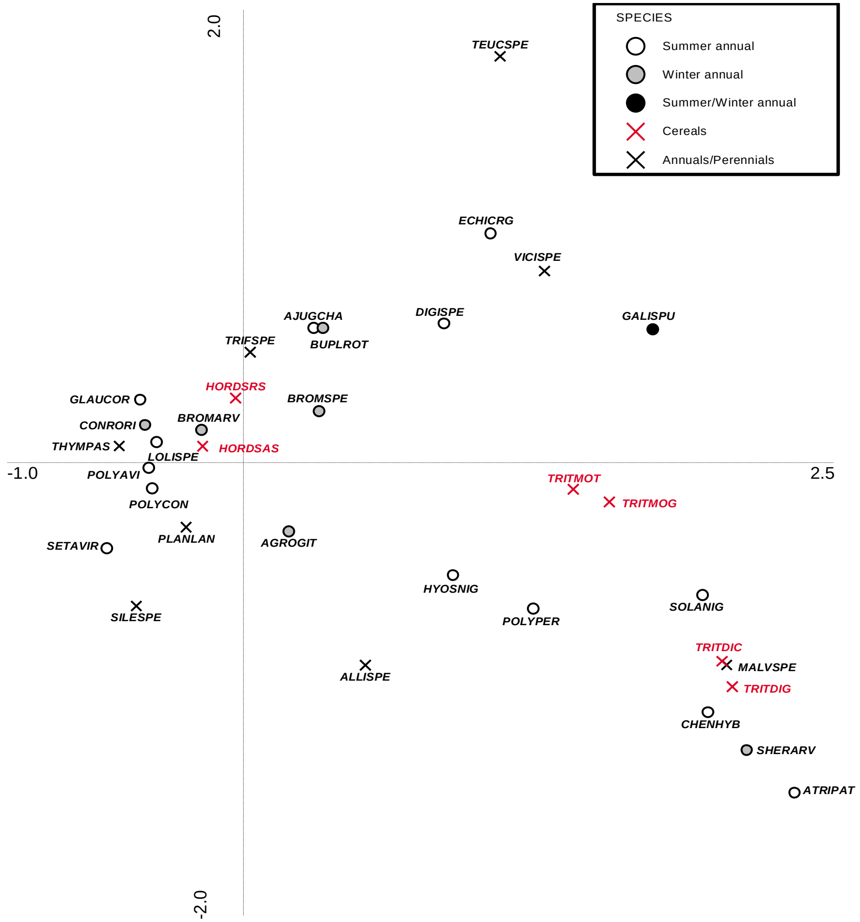


Fig 7.86. Correspondence analysis of crops and weed species , without TRITSPL, TRITAED, CHENSPE, SECACEG AND PANMIL, for samples identified as unsieved fine sieving by-products showing the germination time of each weed (after Bojňanský and Fargašová 2007): LBA Feudvar

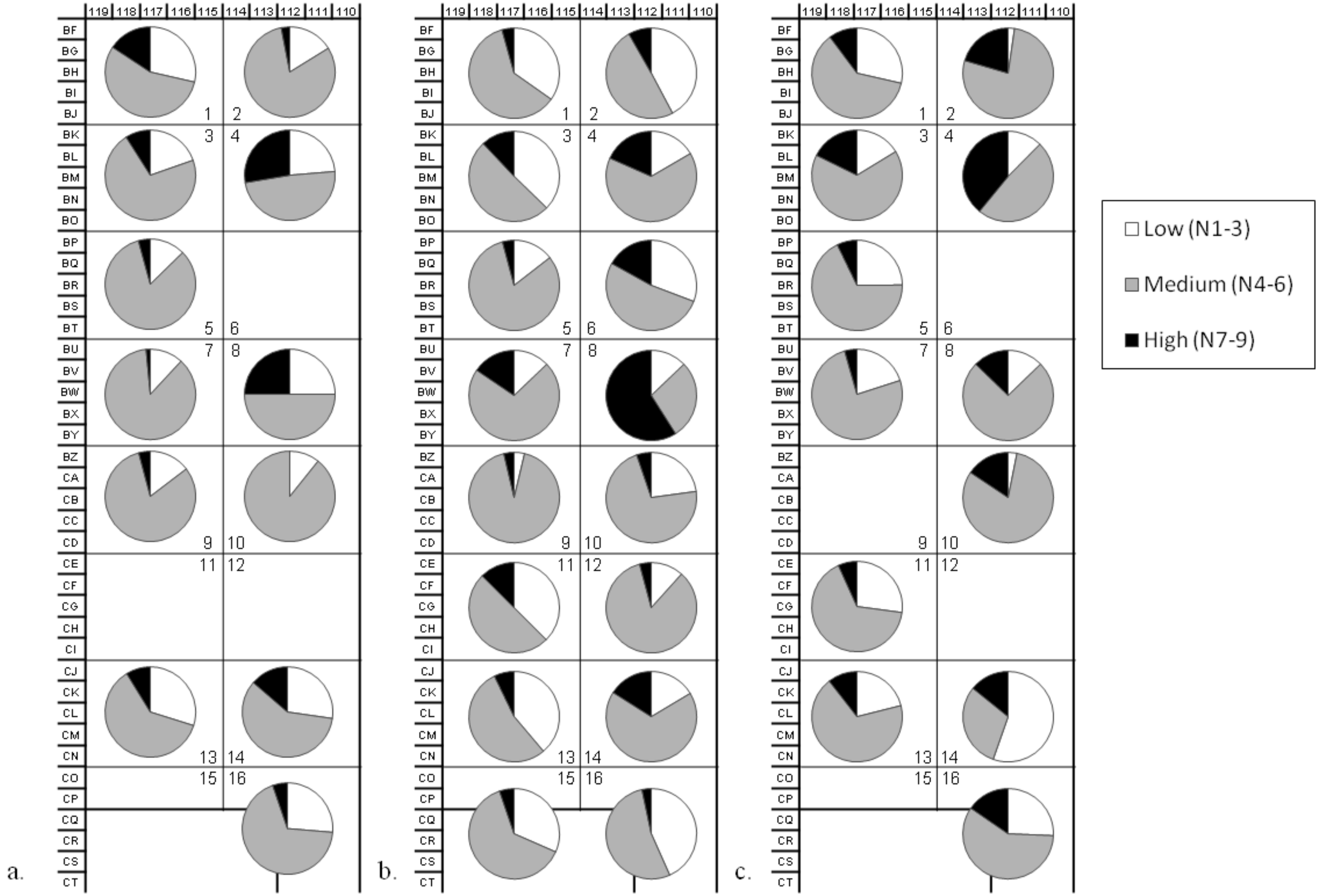


Fig 7.87. Pie charts representing the percentage of low, medium and high nitrogen indicator weed species for samples identified as a. unsieved spikelets, b. unsieved fine sieving by-products and c. unsieved products per 5x5m area: LBA Feudvar

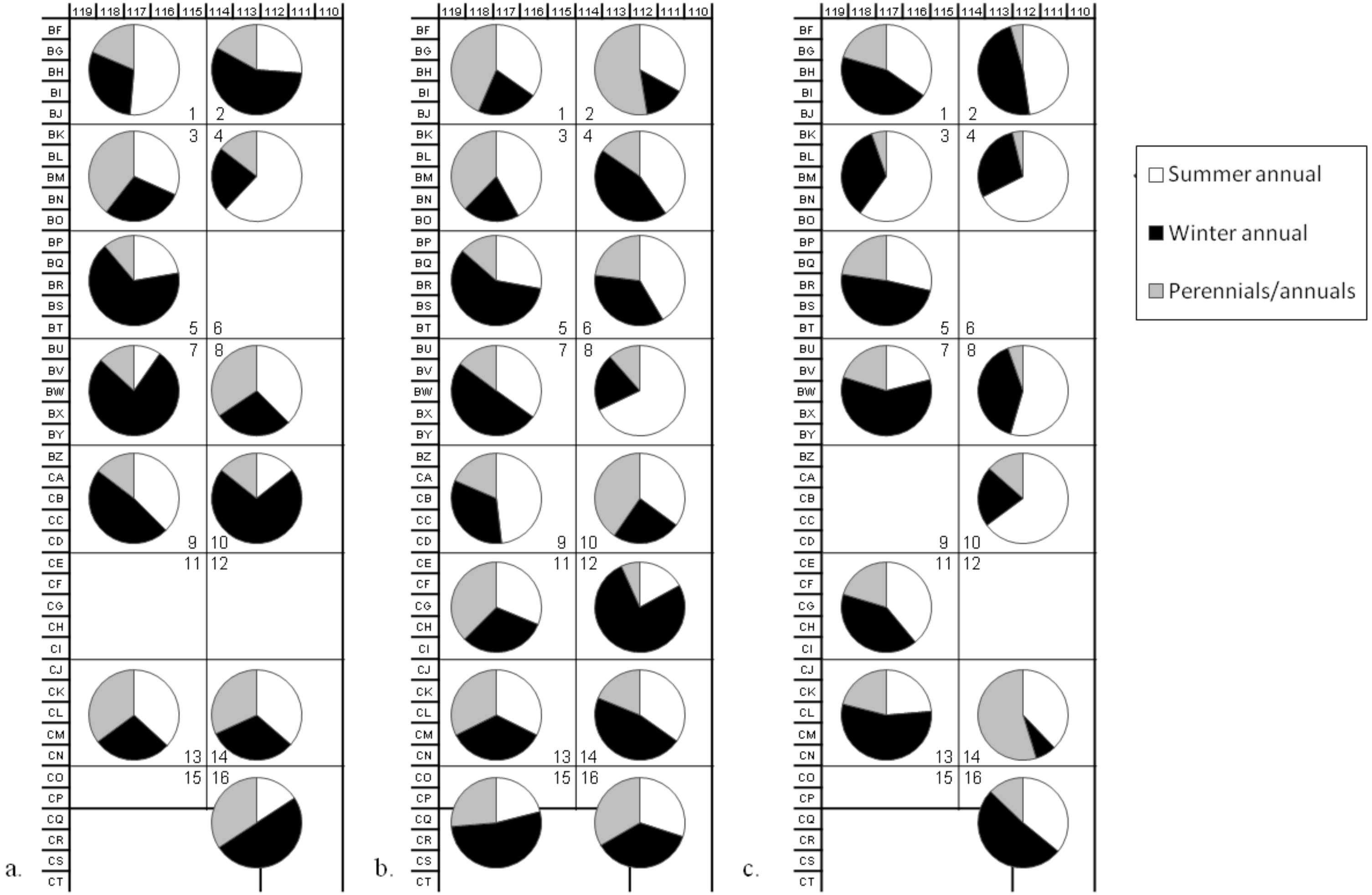


Fig 7.88. Pie charts representing the percentage of summer annuals, winter annuals and perennial/annuals for samples identified as a. unsieved spikelets, b. unsieved fine sieving by-products and c. unsieved products per 5x5m area: LBA Feudvar

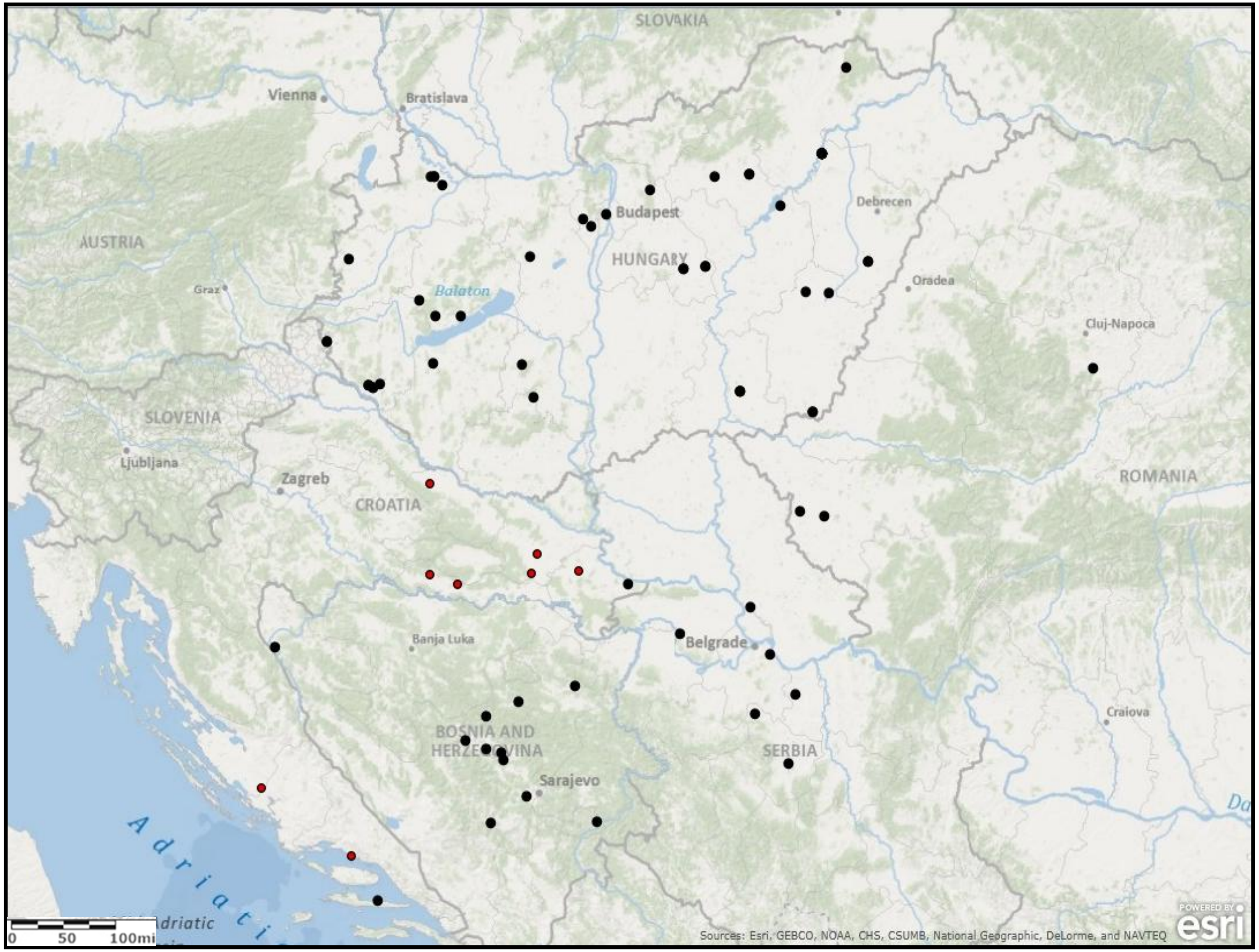


Fig 8.1. Map of sites with archaeobotanical material dating to the Mid/Late Neolithic in the Carpathian Basin. (Red = Croatian study sites)

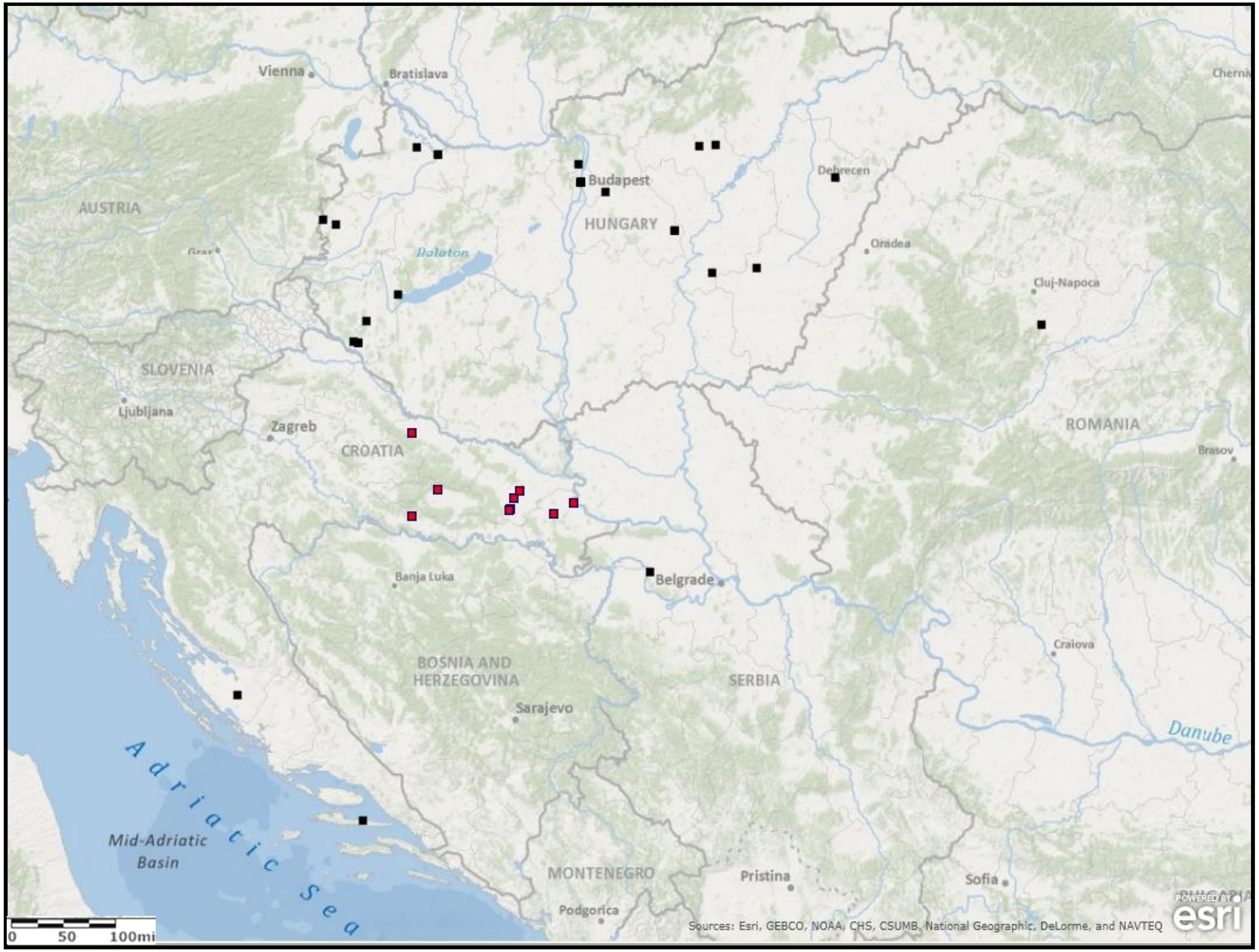


Fig 8.2. Map of sites with archaeobotanical material dating to the Copper Age in the Carpathian Basin. (Red = Croatian study sites)

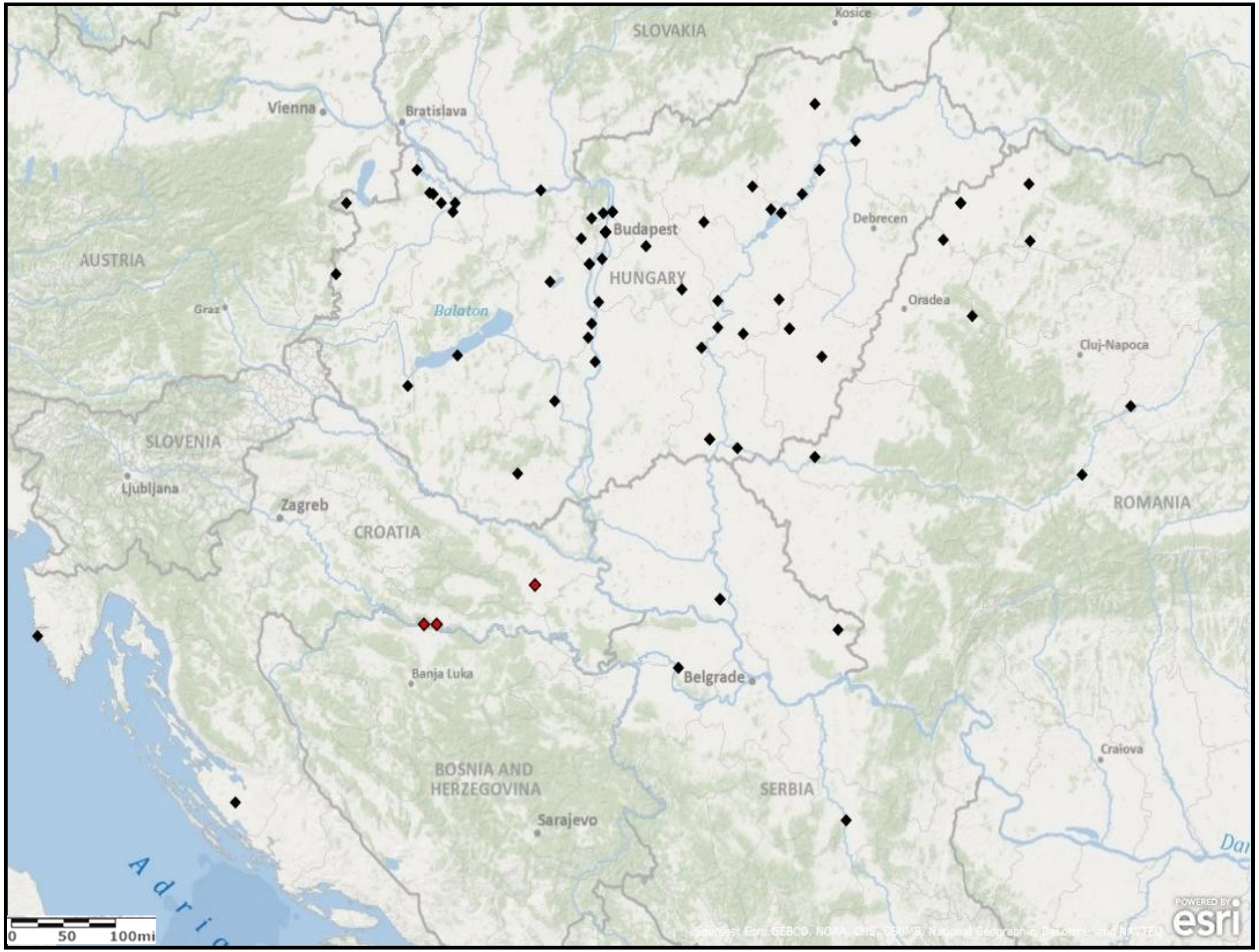


Fig 8.3. Map of sites with archaeobotanical material dating to the Bronze Age in the Carpathian Basin. (Red = Croatian study sites)

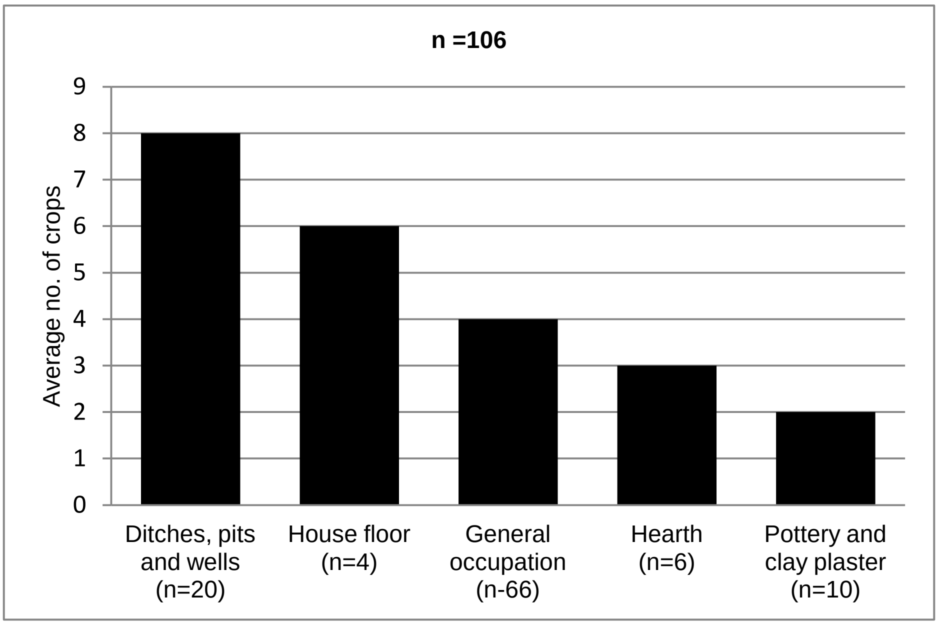


Fig 8.4. Average number of carbonised crop species recovered from each main feature type: Carpathian Basin

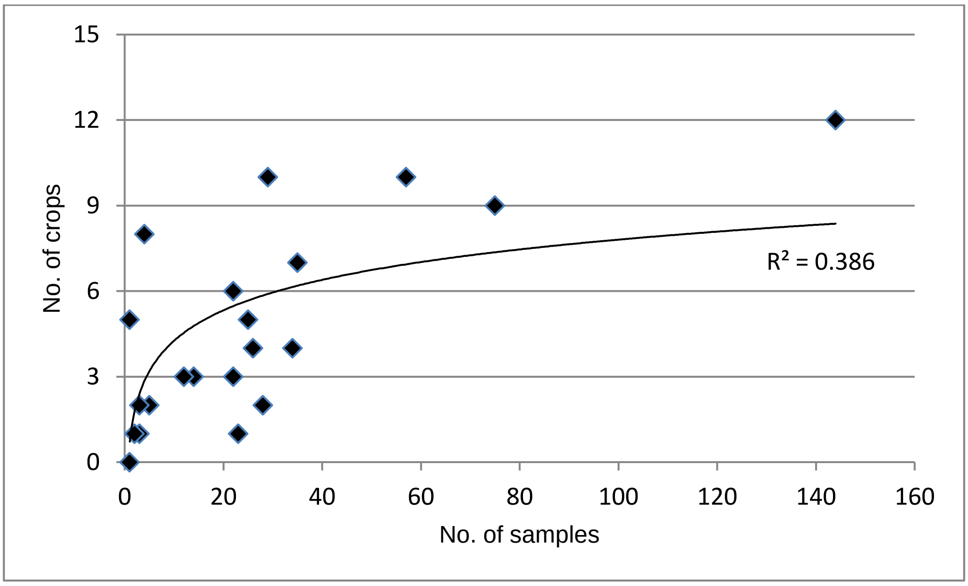


Fig 10.1. Correlation between number of samples and number of crops for all 18 Croatian sites including r² value

TABLES

5230 – 4750 BC	Mixed deciduous floodplain forest dominated by *Quercus robur* and *Fraxinus angustifolia*; coppiced lakeshore of *Corylus avellana* stand and possibly *Ulmus* trees.
4750 – 3810 BC	Mixed deciduous-coniferous floodplain forest of *Quercus robur*, *Corylus avellana*, *Ulmus*, *Picea abies*, *Carpinus betulus* and *Fraxinus angustifolia*.
3810 – 1735 BC	Mixed deciduous floodplain woodland dominated by *Corylus avellana*, *Ulmus* and *Quercus robur*; gradual spread of *Carpinus betulus* and *Fagus sylvatica* in the floodplain; *Alnus* fen-woods expand around the lake.
1735 - 620 BC	*Carpinus betulus - Quercus robur* woodland with the admixture of *Fagus sylvatica*. Anthropogenic woodland clearances, grazing and pastureland.

Table 2.1. Pollen record from Báb-tava northeast Hungary (Magyari *et al.* 2008: 37, Table 3)

	Greece	Bulgaria	Albania	Romania	Serbia	Bosnia Herzegovina	Croatia	Slovenia	Hungary
No. of sites	19	5	1	2	7	9	1	4	24
Hordeum vulgare	+	+	+	+	+	+	.	+	+
T. monococcum	+	+	+	+	+	+	+	+	+
Triticum dicoccum	+	+	+	+	+	+	.	+	+
T. aestivum/durum/compactum	+	+	.	.	+	+	.	.	+
Triticum spelta	.	.	.	.	.	.	.	.	+
'New' glume wheat	+	.	.		.	.	.	.	+
Panicum miliaceum	.	+	.	+	+	+	.	.	+
Setaria italica	.	.	.	.	.	.	.	.	+
Secale cereale	+	.	.	.	.	.	.	.	+
Avena sativa	.	.	.	.	.	.	cf.	.	.
Lathyrus sativus	+	+	.	.	+	.	.	+	+
Lens culinaris	.	.	.	+	+	.	.	.	+
Pisum sativum	+	+	.	+	+	+	.	+	+
Vicia ervilia	+	+	+	+	+	.	.	.	+
Vicia faba	+	.	.	.	.	.	.	.	+
Cicer arietinum		.	.	.	.	.	.	.	.
Linum usitatissimum	+	.	.	.	.	+	.	+	+
Camelina sativa	.	.	.	.	.	.	.	.	+
Vitis vinifera ssp. silvestris	+	.	.	.	.	.	.	+	+

Table 2.2. Presence of crop remains recovered from Late Neolithic sites in Southeast Europe

	Greece	Albania	Bulgaria	Romania	Serbia	Bosnia Herzegovina	Croatia	Slovenia	Hungary
No. of sites	7	-	29	1	1	-	2	2	26
Hordeum vulgare	+	.	+	.	+	.	.	.	+
T. monococcum	+	.	+	+	+	.	+	.	+
Triticum dicoccum	+	.	+	+	+	.	+	.	+
T. aestivum/durum/compactum	+	.	+	+	+	.	.	+	+
Triticum spelta	.	.	+	+	.	.	.	.	+
'New' glume wheat	+	.	.	.	.	.	.	.	.
Panicum miliaceum		.	+	+	+	.	.	+	+
Setaria italica	+	.	.	.	.	.	cf.	.	.
Secale cereale	.	.	.	+	.	.	.	.	+
Avena sativa	.	.	.	.	.	.	.	.	.
Lathyrus sativus	+	.	.	.	+	.	.	.	.
Lens culinaris	.	.	+	.	+	.	.	.	+
Pisum sativum	+	.	+	.	+	.	.	.	+
Vicia ervilia	+	.	+	.	+	.	.	.	.
Vicia faba	.	.	.	.	.	.	.	.	.
Cicer arietinum	.	.	+	.	.	.	.	.	.
Linum usitatissimum	+	.	+	.	+	.	.	.	+
Camelina sativa	.	.	.	.	.	.	.	.	.
Vitis vinifera ssp. silvestris	+	.	.	.	.	.	.	+	+

Table 2.3. Presence of crop remains recovered from Copper Age sites in Southeast Europe

	Greece	Albania	Bulgaria	Romania	Serbia	Bosnia Herzegovina	Croatia	Slovenia	Hungary
No. of sites	27	-	8	8	2	-	2	2	56
Hordeum vulgare	+	.	+	+	+	.	+	+	+
T. monococcum	+	.	+	+	+	.	+	+	+
Triticum dicoccum	+	.	+	+	+	.	.	.	+
T. aestivum/durum/compactum	+	.	+	+	+	.	.	+	+
Triticum spelta	+	.	+	+	+	.	.	.	+
'New' glume wheat	+	.	.	.	+	.	.	.	.
Panicum miliaceum	+	.	+	+	+	.	.	+	+
Setaria italica	+	.	.	.	+	.	.	.	+
Secale cereale	+	.	+	+	cf.	.	.	.	+
Avena sativa	.	.	.	.	.	.	.	+	.
Lathyrus sativus	+	.	+	.	+	.	.	.	+
Lens culinaris	+	.	+	+	+	.	+	+	+
Pisum sativum	+	.	+	+	+	.	.	.	+
Vicia ervilia	+	.	+	+	+	.	.	.	+
Vicia faba	+	.	.	+	+	.	+	+	+
Cicer arietinum	+	.	.	.	+	.	.	.	+
Linum usitatissimum	+	.	.	.	+	.	.	.	+
Camelina sativa	+	.	.	.	+	.	.	.	+
Vitis vinifera ssp. silvestris	+	.	.	.	+	.	+	+	+

Table 2.4. Presence of crop remains recovered from Bronze Age sites in Southeast Europe

Full site name	Period	Site type	No. of Samples	Average sample size	Recovery method	Sieve size	Features sampled	Representativeness
Virovitica-Brekinja	MN	Flat	5	11	MF	1mm	Pits	4
Ivandvor-Gaj	LN	Flat	14	11	MF	1mm	Pits	4
Čista Mala -Velištak	LN	Flat	34	11	BF	250µm	Multiple	3
Turska Peć	LN	Cave	22	11	BF	250µm	Multiple	3
Sopot	LN	Tell	144	20	MF	250µm	Multiple	2
Ravnjaš-Nova Kapela	LN	Tell	57	11	BF	250µm	Multiple	4
Slavča	LN, LN/CA, CA	Tell	24 51 22	11	BF	250µm	Pits	4
Đakovo-Franjevac	CA	Flat	29	11	MF	1mm	Pits	4
Pajtenica-Velike Livade	CA	Flat	23	11	MF	1mm	Pits	4
Potočani	CA	Flat	1	11	MF	1mm	Pits	4
Jurjevac-Stara Vodenica	CA	Flat	12	11	MF	1mm	Pits	4
Tomašanci-Palača	LN, CA, EBA	Flat	1 26 28	11	MF	1mm	Pits	4
Vučedol	CA	Tell	35	11	MF	1mm	Pits	4
Vinkovci/Matije Gupca 14	CA	Flat	4	11	MF	250µm	Pits	4
Virovitica-Batelije	CA	Flat	3	11	MF	1mm	Multiple	3
Crišnjevi-Oštrov	LBA	Necropolis	3	11	BF	250µm	Pits	4
Orubica-Veliki Šeš	LBA	Flat	2	11	BF	250µm	Pits	4
Mačkovac-Crišnjevi	LBA	Flat	25	11	BF	250µm	Multiple	3
Feudvar	LBA	Tell	524	10	BF	300µm	Multiple	2

Table 3.1. Summary of sampling, recovery and representativeness of the samples from each site Abbreviations: MN = Middle Neolithic, LN = Late Neolithic, CA = Copper Age, EBA = Early Bronze Age, LBA = LBA. Machine flotation (MF), bucket flotation (BF). (Representativeness: see Methodology, pp. 36)

Site code	**Full site name**	C14 dates (cal BC)	Cultural group	Reference
VIRBRE	Virovitica-Brekinja	5400-5200	Late Starčevo	Sekelj-Ivančan and Balen 2006
IVAGAJ	Ivandvor-Gaj	5050-4780 4730-4490	Sopot	Balen *et al.* 2009; Lipovac Vrkljan and Šiljeg 2006
CISMAV	Čista Mala -Velištak	4900-4700	Hvar	Podrug 2010
TURPEC	Turska Peć	-	Hvar	Kliškić 2006a, b, 2007
SOPOT	Sopot	5050-4550 4790-4320 4340-3940	Sopot	Škrivanko 2003, 2003, 2011
RAVNJA	Ravnjaš-Nova Kapela	-	Sopot	Mihaljević 2006a, 2007b, 2008a
SLAVCA	Slavča	-	Sopot, Lasinja, Kostolac, Vučedol	Mihaljević 2004, 2005, 2006b, 2007c, 2008b, 2009
TOMPAL	Đakovo-Franjevac	4300-3900 3700-3600	Sopot, Lasinja, Baden, Retz-gajary, Kostolac, Vinkovačka	Balen 2008c
ĐAKFRA	Pajtenica-Velike Livade	3300-2700	Kostolac	Balen 2007a, 2008a, 2011
JURSTV	Potočani	4320-3960	Lasinja	Balen 2008a
PAJVEL	Jurjevac-Stara Vodenica	4350-3540	Lengyel	Balen 2006a
POTOCA	Tomašanci-Palača	4200	Lasinja	Balen 2007b
VUCEDO	Vučedol	2900-2600	Vučedol	Balen 2004, 2005b, 2007c, 2008b
VINMAG	Vinkovci/Matije Gupca 14	-	Vučedol	Krznarić Škrivanko 2007; Miloglav 2007
VIRBAT	Virovitica-Batelije	3700-3400	Retz-gajary/Boleraz	Balen 2006b
MACCRI	Mačkovac-Crišnjevi	-	Barice-Gređani	Karavanić *et al.* 2002
CRIOST	Crišnjevi-Oštrov	-	Barice-Gređani	Mihaljević and Kalafatić 2005, 2008, 2009; Mihaljević 2007a
ORUVES	Orubica-Veliki Šeš	-	13^{th}-12^{th} century BC	Mihaljević and Kalafatić 2007

Table 4.1. Summary of Croatian sites with associated C14 dates and cultural groups

Total no. of sites	18
Total no. of samples	565
Total volume (litres)	7,826
Total no. of seed items (not including indet. frags)	18,910
Mean seed density per litre	2.4
Median seed density per litre	0.6
St. deviation	6.9

Table 4.2. Summary statistics for the 18 Croatian sites

	Mid- Late Neolithic	Copper Age	Bronze Age
No. of sites	8	9	4
No. of samples	352	155	58
Volume floated (l)	5,240	1,915	671
No. of identified seeds	14,052	4,385	472
No. of crops	14	13	10
Mean seed density per litre	3.1	1.7	0.7
Median seed density per litre	0.5	0.5	0.1
St. deviation	19	4.6	3

Table 4.3. Summary statistics of the Croatian sites per period

Site code	Total number of samples	Total volume sampled (l)	Mean charcoal density (cm³/l)	Total no. of seed items (not inc. indet. frags)	Mean seed density per litre	Median seed density per litre	St. deviation	Feature type
VIRBRE	5	55	-	15	0.3	0.1	0.4	Pits only
IVAGAJ	14	154	0	22	0.1	0.1	0.2	Pits only
CISMAV	34	268	0.4	152	0.7	0.2	2.2	Multiple
TURPEC	22	304	1.3	5,391	21	2	74	Occupation levels
SOPOT	144	2,842	0.2	2,581	0.9	0.3	2	Multiple
SLAVCA	75	825	0.6	3,718	4.5	1.5	7.5	Multiple
RAVNOK	57	627	0.3	2,176	3.5	1.5	6.8	Multiple
TOMPAL	1	11	0	1	0.2	0.2	0	Pits only

Table 4.4. Summary table of the charcoal and seed densities per litre for each site: Middle/late Neolithic Croatia

Site code	Total number of samples	Total volume sampled (l)	Total no. of seeds (not inc. indet.)	Grain	Chaff	Pulse	Oil plant	Fruit	Wild/weed
VIRBRE	5	55	15	0.1	0	0	0	0	0
IVAGAJ	14	154	22	0.1	0	0	0	0	0
CISMAV	34	268	152	0.1	0	0	0	0	0
TURPEC	22	304	5,391	0	0	0	0	0	0.6
SOPOT	144	2,842	2,581	0.2	0.1	0	0	0	0
SLAVCA	75	825	3,718	0.1	1.4	0	0	0	0
RAVNOK	57	627	2,176	0.3	0.6	0	0	0	0
TOMPAL	1	11	1	0	0	0	0	0.1	0

Table 4.5. Summary table of the median seed densities (per litre) for each plant category per site: Mid/Late Neolithic Croatia

Site code	Total number of samples	Total volume sampled (l)	Mean charcoal density (cm³/l)	Total no. of seed items (not inc. indet. frags)	Mean seed density per litre	Median seed density per litre	St. deviation	Feature type
ĐAKFRA	29	302	1	275	1	0.7	1	Pits only
JURSTV	12	132	0.1	50	0.4	0.3	0.4	Pits only
PAJVEL	23	253	0.06	25	0.1	0.1	0.1	Pits only
POTOCA	1	55	-	70	1	1	-	Pits only
SLAVCA	22	242	1.1	466	1.9	1.5	1.7	Pits only
TOMPAL	27	297	0.1	188	0.7	0.2	1.2	Pits only
VINMAG	4	216	2	1,734	8	8	3	Pits only
VIRBAT	3	33	-	14	0.4	0.4	0.5	Pits only
VUCEDO	35	385	1	1,580	4	1	9	Multiple

Table 4.6. Summary table of the charcoal and seed densities per litre for each site: Copper Age Croatia

Site code	Total number of samples	Total volume sampled (l)	Total no. of seeds (not inc. indet.)	Grain	Chaff	Pulse	Oil plant	Fruit	Wild/weed
ĐAKFRA	29	302	275	0.5	0	0	0	0	0.1
JURSTV	12	132	50	0.2	0	0	0	0	0
PAJVEL	23	253	25	0.1	0	0	0	0	0
POTOCA	1	55	70	1	0.1	0.02	0	0	0.02
SLAVCA	22	242	466	0.2	1.1	0	0	0	0
TOMPAL	27	297	188	0.2	0	0	0	0	0
VINMAG	4	216	1,734	2	0	0	0.2	0.03	6
VIRBAT	3	33	14	0.1	0.2	0	0	0	0
VUCEDO	35	385	1,580	0.6	0	0	0	0	0.2

Table 4.8. Summary table of the median seed densities (per litre) for each plant category per site: Copper Age Croatia

Site code	Total number of samples	Total volume sampled (l)	Mean charcoal density (cm³/l)	Total no. of seed items (not inc. indet. frags)	Mean seed density per litre	Median seed density per litre	St. deviation	Feature type
CRIOST	3	33	0.2	20	0.6	0.3	0.7	Occupation levels
MACCRI	25	275	0.9	412	1.5	0.2	5	Multiple
ORUVES	3	33	0.1	4	0.2	0.2	0.5	Pits only
TOMPAL	28	308	-	36	0.1	0	0.2	Pits only

Table 4.9. Summary table of the charcoal and seed densities per litre for each site: Bronze Age Croatia

Site code	Total number of samples	Total volume sampled (l)	Total number of seeds (not inc. indet.)	Grain	Chaff	Pulse	Oil plant	Fruit	Wild/weed
CRIOST	3	33	20	0.1	0	0	0	0	0
MACCRI	25	275	412	0	0	0	0	0	0
ORUVES	3	33	4	0	0	0	0	0	0
TOMPAL	28	308	36	0	0	0	0	0	0

Table 4.11. Summary table of the median seed densities (per litre) for each plant category per site: Bronze Age Croatia

Site code	Period	Preservation class 1	2	3	4	5	N/A	**Total no. samples**
VIRBRE	MN	-	-	-	1	2	2	**5**
IVAGAJ	LN	-	-	1	-	7	6	**14**
CISMAV	LN	1	-	5	10	10	8	**34**
TURPEC	LN	-	4	7	6	4	1	**22**
SOPOT	LN	-	2	7	21	107	7	**144**
RAVNOK	LN	-	1	11	20	23	2	**57**
TOMPAL	LN	-	-	-	1	-	-	**1**
SLAVCA	LN/CA	-	6	6	27	29	7	**75**
SLAVCA	CA	-	3	2	8	7	2	**22**
PAJVEL	CA	-	-	1	3	12	7	**23**
POTOCA	CA	-	-	-	-	1	-	**1**
JURSTV	CA	-	-	-	-	8	4	**12**
TOMPAL	CA	-	-	1	2	16	7	**26**
ĐAKFRA	CA	-	-	1	6	19	3	**29**
VIRBAT	CA	-	-	-	1	2	-	**3**
VINMAG	CA	-	-	2	2	-	-	**4**
VUCEDO	CA	-	2	10	10	12	1	**35**
TOMPAL	EBA	-	1	-	3	14	10	**28**
MACCRI	LBA	1	2	2	5	4	11	**25**
CRIOST	LBA	-	-	-	3	-	-	**3**
ORUVES	LBA	-	-	-	2	-	-	**2**
Total no. samples		**2**	**21**	**56**	**131**	**277**	**78**	**565**

Table 4.12. Summary of samples identified to a preservation class per site: All 18 Croatian sites

NB: Preservation classes per sample. All classes based on >50% of the whole identified plant remains from a sample (including indet frag) being allocated to one class. 1= Perfect, 2= epidermis virtually intact (>75% epidermis present), 3=epidermis incomplete (>25% <75% epidermis present), 4=fragments of epidermis remaining (<25% epidermis), 5= identifiable by gross morphology only, N/A= no seed remains present in sample. (See Chapter 3 for more details).

	1	2	3	4	5	N/A
Tell/cave	0%	5%	13%	27%	54%	2%
Flat	1%	2%	9%	26%	63%	10%

Table 4.14. Percentage of samples identified to a preservation class per site type: All 18 Croatian sites

Density	0-5	5.1-10	10.1-25	25.1+	No. of samples
No. of samples	519	22	16	8	565
Feature type					
Ditch (inc. canal)	95%	-	5%	-	38
General occupation layer	93%	2%	2%	2%	122
Hearth	89%	11%	-	-	9
House area (inc. floor)	89%	5%	3%	3%	73
Outside House	100%	-	-	-	5
Pit (inc. hole, mass grave pit)	91%	5%	3%	1%	317
Pot fill	100%	-	-	-	1

Table 4.15. Percentage of samples from each feature type per density group: All 18 Croatian sites

Feature type	Period	Sample no.	Grain density	Chaff density	Pulse density	Oil plant density	Fruit density	Wild/weed density	Dominant component
General occupation layer	LN	TPEC01	0	0	0	0	0	347	Weed
General occupation layer	LN	TPEC02	0	0	0	0	0	31	Weed
General occupation layer	LN	TPEC03	0	0	0	0	0	41	Weed
Pit	LN	SLAV37	1	27	0	0	0	0	Chaff
Pit	LN	SLAV30	4	38	0	0	0	0	Chaff
Pit	LN	SLAV70	4	48	0	0	0	0	Chaff
House	CA	VUCE10	29	0	0	0	0	0	Grain
House	CA	VUCE21	39	0	0	0	0	1	Grain

Table 4.16. Samples from the Croatian sites with >25.1 seed density (per litre) and details of the dominant component of each sample

Feature types	Grain	Chaff	Pulses	Oil plants	Fruits	Wild/weed	Total no. of seeds
Ditch	30%	54%	0.2%	0.1%	2%	14%	1,013
General occupation layer	23%	5%	1%	0.1%	1%	70%	7,516
Hearth	83%	2%	1%	-	3%	11%	152
House	80%	6%	1%	0.2%	7%	7%	2,088
Outside House	68%	30%	-	-	-	2%	44
Pit	21%	58%	1%	1%	1%	18%	8,098

Table 4.17. Percentage of seeds identified to each plant category per feature type: All 18 Croatian sites

Site code	CISMAV	IVAGAJ	RAVNOK	SLAVCA	SOPOT	TOMPAL	TURPEC	VIBBRE	Total frequency
No. of samples	34	14	57	75	144	1	22	5	352
GRAIN									
Hordeum vulgare hulled					1%		18%		2%
Hordeum vulgare var. *nudum*	18%		14%	12%	8%				10%
Triticum dicoccum	9%	14%	47%	13%	23%		41%		24%
Triticum monococcum	24%	14%	39%	9%	22%		14%	20%	21%
T. monococcum 2-g			4%		1%				1%
Triticum mono/dicoc	6%		14%		19%		5%	20%	11%
Triticum spelta			12%		3%		9%		4%
Triticum cf. *spelta*							5%		0.3%
T. aestivum/durum			2%	3%	2%		9%		2%
T. spelta/new glume wheat				3%					1%
Triticum spp.		21%	53%	21%	35%		27%	20%	30%
Secale cereale			2%	3%	2%		5%		2%
Secale cf. *cereale*					2%				1%
cf. *Secale* sp.	3%								0.3%
Avena sp.	3%		2%		3%				2%
Cerealia indet.	35%	29%	72%	47%	76%		36%	20%	60%
Panicum miliaceum			2%						0.3%
cf. *Panicum miliaceum*							5%		0.3%
Setaria italica				1%					0.3%
CHAFF									
Hordeum vulgare rachis				3%	2%				1%
T. dicoccum g/b	3%		18%	21%	10%		5%		12%
T. monococcum g/b	6%		5%	20%	8%				9%
T. mono/dicoc/ 'new' g/b	15%	7%	2%	11%	2%				5%
Triticum spelta g/b			4%	4%	1%		5%		2%
cf. Triticum spelta g/b					1%				1%
"New glume wheat" g/b	3%		2%	8%	1%				3%
cf. *"New glume wheat"* g/b					1%				1%
Triticum sp. g/b	6%		84%	80%	54%		14%		54%
T.aestivum/durum rachis				1%					0.3%
Cerealia rachis			2%	4%	1%				2%
PULSES									
Lathyrus sativus					1%		9%	20%	1%
Lens culinaris	6%	14%	14%	1%	3%		5%		5%
cf. *Lens culinaris*					3%				1%
Pisum sativum			9%	1%	2%				3%
Pisum cf. *sativum*					1%				1%
Vicia ervilia				3%			5%		1%
Large legumes indet.	6%	7%		11%	8%			20%	7%
OIL PLANTS									
Linum usitatissimum				3%	6%				3%
Linum sp.	3%								0.3%
FRUITS									
Cornus mas				5%	3%	100%			3%
Physalis alkekengi				3%	23%				10%

Table 4.18. Frequency of species per site: Mid-Late Neolithic Croatia

Site code	CISMAV	IVAGAJ	RAVNOK	SLAVCA	SOPOT	TOMPAL	TURPEC	VIBBRE	Total frequency
No. of samples	34	14	57	75	144	1	22	5	352
Prunus sp.							5%		0.3%
Rosa sp.							5%		0.3%
Rosa canina	3%								0.3%
Rubus fruticosus			2%				5%		1%
Sambucus ebulus			2%		3%				1%
Indet Fruit				3%	1%				1%
WILD/WEED SPECIES									
cf. *Astragalus cicer*							55%		3%
Ajuga reptans			2%	1%					1%
Asteraceae				3%	1%				1%
Bromus sp.				5%	29%				13%
Carex sp.							5%		0.3%
Cerastium sp.							9%		1%
Chenopodiaceae			2%	5%	22%		5%		11%
Chenopodium album				4%	1%		36%		3%
Chenopodium sp.				1%	1%				1%
Compositae				1%	1%				1%
Coronilla varia							5%		0.3%
Cyperaceae							9%		1%
Echinochloa crus-galli					1%				1%
Galium aparine				4%	1%				1%
Galium sp.	3%			3%			9%		1%
Gramineae large	9%			7%	16%		18%		10%
Gramineae small				3%	2%		5%		2%
Hyoscyamus sp.							9%		1%
Lolium sp.					1%				0.3%
Medicago sativa							9%		1%
Papaver sp.					1%				0.3%
Phleum sp.					1%				0.3%
Phalaris/Phleum sp.				1%					0.3%
Polygonum sp.			4%	3%	3%		5%		3%
Potentilla sp.			2%		2%				1%
Rumex sp.	3%						5%		1%
Rumex/Polygonum sp.				5%	8%		5%		5%
Setaria viridis				1%	1%		14%		1%
cf. *Sherardia arvensis*				1%					0.3%
small seeded legumes					1%		9%		1%
large seeded legume							18%		1%
Solanaceae				1%					0.3%
Solanum sp.							5%		0.3%
Teucrium sp.							9%		1%
Trifolium sp.					1%		27%		2%
Trigonella sp.							14%		1%
Urtica urens					1%				0.3%
Urtica dioica					1%				0.3%
Urtica sp.				1%					0.3%
INDETERMINATE	68%	43%	93%	81%	90%		82%	40%	83%

Table 4.18. (Continued)

Unique sample no.	ĐAKFRA	JURSTV	PAJVEL	POTOCA	SLAVCA	TOMPAL	VIRBAT	VINMAG	VUCEDO	Total frequency
No. of samples	29	12	23	1	22	26	3	4	35	155
GRAIN										
Hordeum vulgare hulled								75%	9%	4%
Hordeum vulgare var. *nudum*	10%		9%	100%		4%		100%	6%	8%
Triticum dicoccum	10%	25%		100%	18%	8%		100%	23%	16%
Triticum monococcum	41%			100%	18%	4%		100%	63%	28%
T. monococcum 2-g						4%			3%	1%
Triticum mono/dicoc	17%		4%		5%	4%		100%	23%	13%
Triticum spelta								100%	3%	3%
Triticum cf. *spelta*									3%	1%
T. aestivum/durum	3%					4%		50%	3%	3%
Triticum spp.	24%		4%	100%	32%	12%	33%	100%	49%	26%
Secale cereale				100%				25%		1%
Cerealia indet.	90%	58%	48%	100%	64%	62%	33%	100%	71%	68%
Panicum miliaceum	3%							50%		1%
Setaria italica				100%					6%	2%
CHAFF										
T. dicoccum g/b		8%		100%	18%	8%	33%			6%
T. monococcum g/b	7%				32%	4%	33%		14%	10%
T. mono/dicoc/ 'new' g/b	7%				23%				9%	6%
Triticum spelta g/b		8%			5%					1%
Triticum sp. g/b	3%	17%		100%	73%	23%	33%	25%		18%
T.aestivum/durum rachis		0%							3%	1%
Cerealia rachis					5%	4%				1%
Straw					5%					1%
PULSES										
Lathyrus sativus	3%									1%
Lens culinaris	3%									1%
cf. *Lens culinaris*										
Pisum sativum	17%								11%	6%
Vicia ervilia										
Large legumes indet.	10%			100%				25%	3%	4%
OIL PLANTS										
Linum usitatissimum	10%							100%	14%	8%
Linum cf. *usitatissimum*					5%					1%
Linum sp.										
FRUITS										
Cornus mas	14%	8%			9%	12%		25%		7%
Corylus sp.						4%				1%
Physalis alkekengi	21%				9%	8%		50%	3%	8%
Prunus cf. *spinosa*		8%								1%
Rubus fruticosus	7%				5%					2%
Rubus sp.	3%									1%
Sambucus ebulus	7%					8%		25%	9%	5%
Indet Fruit	3%					8%				2%

Table 4.19. Frequency of species per site: Copper Age Croatia

Unique sample no.	ĐAKFRA	JURSTV	PAJVEL	POTOCA	SLAVCA	TOMPAL	VIRBAT	VINMAG	VUCEDO	Total frequency
No. of samples	29	12	23	1	22	26	3	4	35	155
WILD/WEED SPECIES										
Ajuga reptans									3%	1%
Agrostemma githago	3%							50%	11%	5%
Asteraceae								25%		1%
Bromus sp.	21%				9%	4%		100%	26%	14%
Carex sp.					9%	4%		25%	3%	3%
cf. *Carpinus betulus*	3%									1%
Chenopodiaceae/Caryophylaceae									3%	1%
Chenopodium sp.					5%			25%		1%
Chenopodium album	7%							100%	3%	5%
cf. *Convolvulus arvensis*									3%	1%
Cyperaceae								25%		1%
Festuca sp.									3%	1%
Galium aparine						8%		25%	3%	3%
Galium sp.	7%		4%			4%			3%	3%
Gramineae large	14%		9%	100%	5%	8%		100%	26%	15%
Gramineae small	3%							50%	6%	3%
Hypericum sp.								25%	3%	1%
Lolium sp.	3%							25%	3%	2%
Mentha sp.									3%	1%
Phalaris sp.									9%	2%
Phalaris/Phleum sp.									3%	1%
Phleum sp.	3%							50%	9%	4%
Plantago lanceolata									3%	1%
Plantago sp.									3%	1%
Poa sp.									3%	1%
Polygonum sp.	14%				5%			50%	11%	7%
Polygonum aviculare									3%	1%
Potentilla sp.					5%			25%	3%	2%
Rumex sp.									3%	1%
Rumex/Polygonum sp.	10%									2%
Setaria viridis	7%				5%				9%	4%
Silene sp.	3%								6%	2%
Salvia sp.									3%	1%
small seeded legumes	7%							100%	3%	5%
Solanaceae	3%									1%
Teucrium sp.	3%							25%	14%	5%
Teucrium chamaedrys									9%	2%
Trifolium sp.									9%	2%
Urtica sp.									3%	1%
Verbena officinalis								25%		1%
Viola sp.					5%			25%		1%
INDETERMINATE	90%	67%	57%	100%	86%	62%	100%	1	83%	77%

Table 4.19. (Continued)

Unique sample no.	MACCRI	CRIOST	ORUVUS	TOMPAL	Total frequency
No. of samples	25	3	2	28	58
GRAIN					
Hordeum vulgare var. *nudum*				4%	2%
Triticum dicoccum	4%				2%
Triticum mono/dicoc				4%	2%
T. aestivum/durum				4%	2%
Triticum spp.	4%				2%
Avena sativa	20%				9%
Cerealia indet.	20%	33%		36%	28%
Panicum miliaceum	24%	67%	50%		16%
Setaria italica	8%				3%
CHAFF					
Triticum sp. g/b	4%				2%
Avena sativa floret base	8%				3%
Straw				4%	2%
PULSES					
Lens culinaris	4%				2%
FRUITS					
Cornus mas			50%	4%	3%
Prunus spinosa	8%				3%
Vitis vinifera				4%	2%
WILD/WEED SPECIES					
Bromus sp.	4%				2%
Carex sp.	8%		50%		5%
Chenopodiaceae	4%			4%	3%
Cyperaceae	4%				2%
Digitaria sanguinalis	4%	33%			3%
Gramineae large	16%	33%			9%
Gramineae small	8%				3%
Lamiaceae	4%				2%
Papaver sp.	4%				2%
Phleum sp.	4%			4%	3%
Plantago sp.	4%				2%
Polygonum sp.	16%	33%			9%
Prunella vulgaris	4%				2%
Scirpus sp.	4%				2%
Setaria sp.	4%				2%
small seeded legumes	8%				3%
INDETERMINATE	40%	33%	50%	39%	40%

Table 4.20. Frequency of species per site: Bronze Age Croatia

Phase	Site code	No. of samples	GRAIN	*Hordeum vulgare*	*Triticum dicoccum*	*Triticum monococcum*	*Triticum spelta*	*T. aestivum/durum*	"New glume wheat"	*Secale cereale*	*Avena sativa*	*Panicum miliaceum*	*Setaria italica*	CHAFF	*H. vulgare* rachis	*T. dicoccum* g/b	*T. monococcum* g/b	*T. mono/dicoc g/b*	*T. spelta* g/b	*T.aestivum/durum* rachis	"New glume wheat" g/b	PULSES	*Lathyrus sativus*	*Lens culinaris*	*Pisum sativum*	*Vicia ervilia*	OIL PLANTS	*Linum usitatissimum*
MN	VIRBRE	5				■																	■					
LN	IVAGAJ	14			■	■												■						■				
LN	CISMAV*	34		■	■	■											■	■			■							
LN	TURPEC*	22		■	■	■	■	■								■			■					■				
LN	SOPOT*	144		■	■	■	■	■		■					■	■	■	■	■		■		■	■	■	■		■
LN	RAVNOK*	57		■	■	■	■	■				■				■	■		■		■			■	■	■		
LN/CA	SLAVCA*	75		■	■	■		■					■		■	■	■	■	■	■	■			■				■
CA	SLAVCA*	22			■	■										■	■	■	■									
CA	PAJVEL	23		■																								
CA	POTOCA	1		■	■	■				■			■			■												
CA	JURSTV	12			■	■													■									
CA	TOMPAL	26		■	■	■		■								■	■											
CA	ĐAKFRA	29		■	■	■		■				■					■						■	■	■	■		■
CA	VIRBAT	3														■	■											
CA	VINMAG*	4		■	■	■	■	■		■		■																■
CA	VUCEDO	35		■	■	■	■	■					■				■			■								■
EBA	TOMPAL	28		■				■																				
LBA	MACCRI*	25			■						■	■	■											■				
LBA	CRIOST*	3										■																
LBA	ORUVES*	2										■																

Table 4.21. Presence/absence of crops per site: All 18 Croatian sites

Abbreviations: MN = Middle Neolithic; LN = Late Neolithic; CA = Copper Age; EBA= Early Bronze Age LBA = Late Bronze Age.

* Samples collected with flot mesh of 250 µm (Shaded boxes = species present at site)

Period	M/LN	CA	BA
No. sites	8	9	4
No .of samples	352	155	58
GRAIN			
Hordeum vulgare	10%	8%	2%
Triticum dicoccum	24%	16%	2%
Triticum monococcum	21%	28%	2%
T. monococcum 2-g	1%	1%	-
Triticum spelta	4%	3%	-
T. aestivum/durum	2%	3%	2%
Secale cereale	2%	1%	-
Avena sativa	-	-	9%
Panicum miliaceum	0.3%	1%	16%
Setaria italica	0.3%	2%	3%
CHAFF			
Hordeum vulgare rachis	1%	-	-
Triticum dicoccum g/b	12%	6%	-
Triticum monococcum g/b	9%	10%	-
Triticum spelta g/b	2%	1%	-
"New glume wheat" g/b	3%	-	-
T.aestivum/durum rachis	0.3%	1%	-
PULSES			
Lathyrus sativus	1%	1%	-
Lens culinaris	5%	1%	2%
Pisum sativum	3%	6%	-
Vicia ervilia	1%	-	-
OIL PLANTS			
Linum usitatissimum	3%	8%	-

Table 4.22. Frequency of each crop per period: All 18 Croatian sites

Total no. of samples	524
Total volume (litres)	5,240
Total no. of seed items (not inc. indet. frags)	329,535
Mean seed density per litre	63
Median seed density per litre	20
St. deviation	268

Table 5.1. Summary statistics: Late Bronze Age Feudvar

	Total no. of samples	Total volume sampled (l)	Grain	Chaff	Pulse	Oil plant	Fruit	Wild/weed	Feature type
Total no. of items	524	5240	104,448	144,578	8,195	817	1,717	69,780	Multiple
Mean			194	276	19	6	4	133	
Median			58	45	4	2	1	48	
St. deviation			744	1,924	143	21	40	512	

Table 5.2. Summary table of seed densities (per litre) of plant remains, grouped by plant category: Late Bronze Age Feudvar

Density	0-5	5.1-10	10.1-25	25.1+	Total no. of samples
No. samples	39	71	205	209	524
Feature type					
House floor deposits	18%	17%	32%	32%	115
Container fill	33%	22%	17%	28%	18
Pits	7%	7%	38%	49%	74
Yard	-	25%	50%	25%	12
Hearth	14%	10%	33%	43%	21
Street deposits	-	15%	31%	54%	13
General occupation level	1%	13%	46%	40%	257
Miscellaneous	7%	21%	36%	36%	14

Table 5.3. Percentage of samples from each feature type per density group: Late Bronze Age Feudvar

Unique sample no.	Sample volume (l)	Grain	Chaff	Pulse	Oil plant	Fruit	Wild/weed	Feature type	Dominant component
FEU487	10	27	78	0.4	0.6	0.4	17	General occupation layer	Chaff
FEU385	10	22	89	1	-	0.8	30	General occupation layer	Chaff
FEU441	10	20	83	0.2	0.5	0.4	48	General occupation layer	Chaff
FEU034	10	5	172	0.1	-	0.1	4	General occupation layer	Chaff
FEU084	10	26	171	0.3	-	0.1	11	House	Chaff
FEU057	10	51	152	0.2	-	-	47	General occupation layer	Chaff
FEU056	10	18	271	0.1	-	-	16	General occupation layer	Chaff
FEU425	10	80	277	1	-	0.2	26	General occupation layer	Chaff
FEU219	10	92	559	3	4	-	78	House	Chaff
FEU244	10	10	764	0.2	-	-	1	Pit	Chaff
FEU350	10	199	2,200	50	16	9	504	General occupation layer	Chaff
FEU217	10	646	3,595	5	18	-	313	House	Chaff
FEU128	10	776	659	-	-	0.1	9	Layer	Chaff/Grain
FEU079	10	4	3	280	-	-	13	Container fill	Pulse
FEU342	10	5	19	0.7	-	90	9	N-W house floor	Fruit
FEU220	10	79	10	5	-	-	6	Fish house floor	Grain
FEU205	10	92	6	1	-	0.3	23	House	Grain
FEU190	10	93	47	0.6	-	0.4	7	Pit - baker house	Grain
FEU209	10	192	1	-	-	-	9	Floor between hearth	Grain
FEU083	10	198	2	-	-	-	3	Next to hearth	Grain
FEU042	10	138	59	0.2	0.3	0.1	17	General occupation layer	Grain
FEU047	10	295	-	2	-	-	4	General occupation layer	Grain
FEU328	10	352	2	-	-	-	1	House	Grain
FEU092	10	252	163	-	-	-	3	House	Grain
FEU206	10	729	259	0.4	2	-	12	General occupation layer	Grain
FEU207	10	871	424	1	-	1	36	Fish house	Grain
FEU316	10	464	3	0.1	-	-	298	Yard	Grain
FEU013	10	57	46	0.3	-	0.1	4	Pit	Grain/Chaff
FEU403	10	60	39	0.2	0.8	0.2	11	General occupation layer	Grain/Chaff
FEU019	10	63	4	5	-	0.2	54	Pit	Grain/Weeds
FEU237	10	11	34	0.6	-	0.1	68	Pit	Weeds
FEU138	10	21	22	2	0.7	0.1	70	Pit	Weeds
FEU483	10	28	5	0.2	-	6	87	N-W house	Weeds
FEU408	10	20	45	2	1.5	0.1	61	General occupation layer	Weeds
FEU477	10	21	34	-	-	3	98	General occupation layer	Weeds
FEU396	10	8	2	0.2	-	2	161	General occupation layer	Weeds
FEU353	10	41	1	0.2	-	-	384	General occupation layer	Weeds
FEU485	10	159	7	0.4	0.1	0.3	927	North house	Weeds

Table 5.4. Density per litre of main plant categories, given for samples with a seed density of > 100 per litre: Late Bronze Age Feudvar

Period	LBA	
No of sites	1	
No. of samples	524	
GRAIN		
Hordeum vulgare		97%
Triticum dicoccum		73%
Triticum monococcum		99%
T. monococcum 2-g		1%
Triticum spelta		2%
T. aestivum/durum		9%
"New glume wheat"		-
cf. *Secale cereale*		63%
Avena sativa		-
Panicum miliaceum		31%
Setaria italica		-
CHAFF		
Hordeum vulgare rachis		22%
Triticum dicoccum g/b		61%
Triticum monococcum g/b		96%
Triticum spelta g/b		9%
"New glume wheat" g/b		-
T.aestivum/durum rachis		5%
PULSES		
Lathyrus sativus		4%
Lens culinaris		64%
Pisum sativum		22%
Vicia ervilia		40%
Vicia faba		1%
OIL PLANTS		
Linum usitatissimum		4%
Camelina sativa		20%

Table 5.5. Presence/absence of crops per site and taxa frequency (i.e. percentage of samples for each phase, with each crop): Late Bronze Age Feudvar (Abbreviations: LBA = Late Bronze Age, Shaded boxes = species present at site)

Period	M/LN	CA	BA
No. sites	8	9	5
No .of samples	352	155	582
GRAIN			
Hordeum vulgare	11%	8%	87%
Triticum dicoccum	24%	16%	66%
Triticum monococcum	21%	28%	90%
T. monococcum 2-g	1%	1%	1%
Triticum spelta	4%	3%	2%
T. aestivum/durum	2%	3%	8%
"New glume wheat"	-	-	-
Secale cereale	2%	1%	56%
Avena sativa	-	-	1%
Panicum miliaceum	0.3%	1%	30%
Setaria italica	0.3%	2%	0.3%
CHAFF			
Hordeum vulgare rachis	1%	-	19%
Triticum dicoccum g/b	12%	6%	66%
Triticum monococcum g/b	9%	10%	87%
Triticum spelta g/b	2%	1%	8%
"New glume wheat" g/b	3%	-	-
T.aestivum/durum rachis	0.3%	1%	4%
PULSES			
Lathyrus sativus	1%	1%	3%
Lens culinaris	5%	1%	57%
Pisum sativum	3%	6%	20%
Vicia ervilia	1%	-	36%
Vicia faba	-	-	1%
OIL PLANTS			
Linum usitatissimum	3%	8%	4%
Camelina sativa	-	-	18%

Table 5.6. Frequency of each crop per period: All 18 Croatian sites and LBA Feudvar

Stage	Ratio	Crop processing stage	
		High value	Low value
1	Cereal straw nodes: grains	By-product from early processing stage	Grain product
2	Glume wheat glume bases: grains	By-product from late processing stage	Grain product
3	Free threshing cereal rachis internodes: grains (barley, durum and bread wheat)	By-product from early processing stage	Grain product
4	Weed seeds: cereal grains	By-product from late processing stage	Grain product
5	Small: large weed seeds	By-product from sieving	Product from sieving or by-product of hand cleaning
6	Number of crop items per litre of deposit	Rapid/single deposition (usually result of accident)	Slow/repeated deposition (usually day-to-day activity)

Table 6.1. The grain, chaff and weed ratios used to identify crop processing stages and their interpretation. After Van der Veen 1992: chapter 7 and Van der Veen and Jones 2006: 223, Table 2. The 'high' and 'low' value for ratios 1-3 refers to the degree to which they differ from the complete cereal plant. Ratios 4-6 refer to the relative value compared to other samples within the site/region/period.

Species	Length	Width	Jones (1984)	Van der Veen (1992)	Peña-Chocarro (1999)	Bogaard (2002)	Group A >3mm <2.5mm)	Group B >2.5mm <2mm)
Adonis sp.	4.13	2.96					BFH	BFH
Agrimonia eupatoria	3.87	2.09				BHH	BHH	BHH
Agrimonia odorata	3.93	2.57					BHH	BHH
Agrimonia sp.	3.9	2.33					BHH	BHH
Agrostemma githago	4.21	3.14		BFH	BFH	BFH	BFH	BFH
Ajuga chamaepitys	3.95	1.54					BFH	BFH
Allium sp.	3.27	2.01					BHH	BHH
Althaea officinalis	3.98	3.5					BFH	BFH
Anagallis arvensis	1.29	1.02					SHH	SHH
Anethum sp.	4.14	2.21					BFH	BFH
Anthemis tinctoria	2.29	1.1					SFH	SFH
Anthemis sp.	2.07	1.01			SHH		SFH	SFH
Aphanes sp.	1.01	0.71					SFH	SFH
Asperula arvensis	2.34	2.28			BFH		SFH	IBT
Atriplex hastate	2.27	1.77		SFH		SFH	SFH	SFH
Atriplex patula	2.18	2.03		SFH		SFH	SFH	IBT
Avena fatua	7.9	2.24		BFH			BFH	BFH
Avena sp.	8.25	2.37		BFH	BHH		BFH	BFH
cf. *Barbarea* sp.	1.9	1.29					SHH	SHH
Berteroa sp.	1.94	1.47					SHH	SHH
Bromus arvensis	5.78	0.98				BFH	BFH	BFH
Bromus mollis type	6.88	2.26		BFH		BFH	BFH	BFH
Bromus secalinus	6.61	2.15		BFH		BFH	BFH	BFH
Bromus sp.	5.58	1.68					BFH	BFH
Bupleurum rotundifolium	3.51	1.51					BHH	BHH
Carduus sp.	4.21	1.78					BFH	BFH
Carex vulpina	1.88	1.33					SFH	SFH
Carex subsp. *Eucarex*	3.75	1.59					BFH	BFH
Carex subsp. *Vignea*	2.15	1.12					SFH	IBT
Carthamus lanatus	6.98	4.43					BFH	BFH
Centaurea sp.	3.89	1.78					BFH	BFH
Cerastium sp.	0.69	1.33			SFH		SFH	SFH
Chenopodium album	1.69	1.54		SFH		SFH	SFH	SFH
Chenopodium glaucum/rubrum	0.9	0.82				SFH	SFH	SFH
Chenopodium hybridum	1.89	1.73				BFH	SFH	SFH
Chenopodium polyspermum	1.16	1.07				SFH	SFH	SFH
Chenopodium sp.	1.41	1.29		SFH	SFH	SFH	SFH	SFH
Cichorium intybus	3.8	1	SHH				BHH	BHH
Conringia sp.	2.96	1.56					IBT	BHH

Table 6.2. Classification of wild/weed taxa into physical weed categories per author, (BFH= big free heavy, BHH = big headed heavy, SFH = small free heavy, SFL = small free light, SHH = small headed heavy, SHL = small headed light)

Species	Length	Width	Jones (1984)	Van der Veen (1992)	Peña-Chocarro (1999)	Bogaard (2002)	Group A >3mm <2.5mm)	Group B >2.5mm <2mm)
Conringia orientalis	2.96	1.56					IBT	BHH
Consolida sp.	2.3	1.69			SFH		SFH	IBT
Convolvulus arvensis	4.17	3.09					BHH	BHH
Coronilla sp.	3.9	0.9			SHH		BHH	BHH
Cyperus sp.	1.24	0.58					SFH	SFH
Daucus sp.	4.4	2.83			BFH		BFH	BFH
Dianthus sp.	1.81	1.26					SFL	SFL
Digitaria sp.	1.74	0.82					SFH	SFH
Echinochloa crus-galli	1.66	1.39				SFH	SFH	SFH
Echium sp.	2.98	1.8					SFH	SFH
Euphorbia helioscopia	2.35	1.77					SFH	IBT
Euphorbia sp.	2.34	1.64			SFH		SFH	IBT
Euphorbia palustris	3.25	3.03					BFH	BFH
Galeopsis sp.	2.95	2.16		BFH			IBT	BFH
Galium aparine	4.13	3.75	BFH	BFH		BFH	BFH	BFH
Galium spurium	2.62	2.33				SFH	IBT	BFH
Galium sp.	2.05	1.77			SFH		SFH	SFH
Geranium sp.	2.56	1.53			SFH		IBT	BFH
Glaucium corniculatum	0.81	0.74					SHH	SHH
Hyoscyamus niger	1.61	1.31		SFH		SFH	SFH	SFH
Hypericum sp.	0.9	0.37					SFL	SFL
Juncus sp.	0.57	0.29					SFL	SFL
Kickxia cf. *spuria*	1.37	0.78					SHH	SHH
Knautia sp.	4.8	2					BFH	BFH
Lactuca sp.	4.26	1.27					BFH	BFH
Lallemantia iberica	4	1.5					BFH	BFH
Lapsana communis	4.06	1.09					BFH	BFH
Luzula sp.	1.75	1.01					SFH	SFH
Legousia sp.	1.35	0.81					SFH	SFH
Leontodon cf. *hispidus*	6.01	0.83					BFH	BFH
Lithospermum arvense	2.92	2.05	SFH				IBT	BFH
Lithospermum officinale	3.27	2.49					BFH	BFH
Lolium cf. remotum	3.96	1.34					BFH	BFH
Lolium temulentum	5.03	2.29	BFH				BFH	BFH
Lolium sp.	4.36	1.63			BFH		BFH	BFH
Malva sylvestris	1.95	1.78	SHH			SHH	SHH	SHH
Malva sp.	2.43	2.18				SHH	BHH	IBT
Mentha sp.	0.77	0.6					SFL	SFL
Neslia paniculata	2.95	2.49					IBT	BFH
Onopordum acanthium	5.81	3.2					BFH	BFH
Papaver dubium	0.8	0.62				SHL	SHL	SHL
Papaver somniferum	0.89	0.68					SHL	SHL

Table 6.2. (Continued)

Species	Length	Width	Jones (1984)	Van der Veen (1992)	Peña-Chocarro (1999)	Bogaard (2002)	Group A >3mm <2.5mm)	Group B >2.5mm <2mm)
Pastinaca sativa	5.49	4.66				BFH	BFH	BFH
Petrorhagia saxifraga	1.38	0.91					SFL	SFL
Phragmites australis	1.46	0.51					SFH	SFH
Picris hieracioides	4.34	1.13				SFH	BFH	BFH
Plantago lanceolata	3.01	1.42		SFH		SHH	BFH	BFH
Plantago sp.	2.13	1.04			SHL		SFH	IBT
Polygonum aviculare	3	1.79		SFH		BFH	BFH	BFH
Polygonum convolvulus	3.64	2.69		BFH		BFH	BFH	BFH
Polygonum hydropiperoide	2.5	2					SFH	BFH
Polygonum lapathifolium	3.15	2.54		SFH		BFH	BFH	BFH
Polygonum persicaria	2.91	1.98		SFH		BFH	IBT	BFH
Portulaca oleracea	1.33	1.16					SHH	SHH
Potamogeton sp.	3.12	2.15					BFH	BFH
Ranunculus acris type	3.56	2.32					BFH	BFH
Rorippa type	0.89	0.68					SHL	SHL
Rumex crispus type	2.5	1.63				SFH	SFH	BFH
Rumex sp.	2.48	1.4		SFH	SFH	SFH	SFH	IBT
Schoenoplectus lacustris	3.2	2.17					BFH	BFH
Scirpus sp.	1.65	1.12					SFH	SFH
Scleranthus annuus	2.14	1.07					SHH	IBT
Scrophularia sp.	1.03	0.68					SHH	SHH
Setaria viridis	1.63	1.07				SFH	SFH	SFH
Sherardia arvensis	2.84	1.37	SFH				IBT	BFH
Silene sp.	1.15	0.97				SHH	SHH	SHH
Sisymbrium officinale	1.4	0.83				SFH	SFH	SFH
Solanum nigrum	2.24	1.5				SFH	SFH	IBT
Spergula sp.	1.59	1.47					SFH	SFH
Stachys annua	1.95	1.56					SFH	SFH
Stellaria media	1.27	1.17		SFH			SFH	SFH
Teucrium sp.	1.64	1.24			SFH		SFH	SFH
Thymelaea passerina	1.79	1					SFH	SFH
Trifolium sp.	1.67	1.21			SHH	SFH	SFH	SFH
Torilis arvensis	4.67	3.16					BFH	BFH
Urtica dioica	1.27	0.91				SFH	SFH	SFH
Valerianella dentata	2.99	1.5				SFH	IBT	BFH
Verbascum sp.	1.04	0.67			SFH	SFL	SFL	SFL
Verbena officinalis	1.82	0.66				SFH	SFH	SFH
Veronica sp.	1.29	0.94					SFL	SFL
Vicia sp.	3.52	3.06				BFH	BFH	BFH

Table 6.2. (Continued)

Cereal	Avg. length (mm)	Avg. width (mm)
Hordeum vulgare	8.00	3.37
Triticum aestivum/durum	7.00-9.00	3.50
Triticum dicoccum	7.50	2.50
Triticum monococcum	7.50	2.75
Triticum spelta	8.56	2.84
Secale cereale	8.95	3.48
Avena sativa	8.95	2.92
Panicum miliaceum	2.29	2.19

Table 6.3. The average length and width (mm) of grain per cereal species. Measurements from Cappers *et al.* 2006

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Ratio stage	*Species*	*Ratio*	*Value*	*Low value*	*High value*
2	Einkorn glume base: grain	2:1	2	< 0.4	> 2.2
2	Emmer glume base: grain	2:2	1	< 0.6	> 1.5
2	Spelt glume base: grain	2:2	1	< 0.6	> 1.5
3	Bread/durum wheat rachis: grain	1:2-6	0.2-0.6	< 0.1	> 1
3	Barley rachis: grain	1:3	0.3	< 0.2	> 1
3	Rye rachis: grain	1:3	0.3	< 0.2	> 1
2	Broomcorn millet spikelet: grain	1:1	1	< 0.6	> 1.5
4	Weed: grain		1	< 0.8	> 1.2
5	Small: large weed		1	< 0.8	> 1.2

Table 6.4. Ratio table for crop processing analysis, showing the whole plant ratio per cereal, the grain, chaff and weed ratio values and what constitutes a low and high value.

	Spikelets – sieved	Spikelets- unsieved	Fine sieving by-product- sieved	Fine sieving by-product- unsieved	Product - sieved	Product - unsieved	Total
Einkorn	21 (64)	22 (32)	79	87 (3)	103 (4)	26 (4)	445
Einkorn/Emmer	-	-	1	-	-	-	1
Einkorn/Barley	-	-	-	-	3 (5)	-	8
Einkorn/Barley/ Bread/ durum wheat	-	-	(2)	-	-	-	2
Emmer	-	-	3	-	2	-	5
Barley	-	-	-	-	12	2	14
Barley/broomcorn millet	-	-	-	-	1	-	1
Broomcorn millet	-	-	-	-	2 (1)	(3)	6
Rye	-	-	-	-	1	1	2
Total	85	54	85	90	134	36	484

Table 6.6. Summary of the number of samples identified for each crop processing stage, based on the ratio analysis. ( ) = tentative identifications: Late Bronze Age Feudvar

Species	Code	Species	Code
Agrostemma githago	AGROGIT	*Panicum miliaceum*	PANIMIL
Ajuga chamaepitys	AJUGCHA	*Plantago lanceolata*	PLANLAN
Allium sp.	ALLISPE	Polygonaceae	POLYGON
Atriplex patula type	ATRIPAT	*Polygonum aviculare*	POLYAVI
Bromus arvensis	BROMARV	*Polygonum convolvulus*	POLYCON
Bromus sp.	BROMSPE	*Polygonum persicaria* t	POLYPER
Bupleurum rotundifolium	BUPLROT	*Portulaca oleracea*	PORTOLE
Caryophyllaceae	CARYOPH	*Rumex crispus* type	RUMECRI
cf. *Secale cereale*	SECACEG	*Schoenoplectus lacustris*	SCHOLAC
Chenopodium hybridum	CHENHYB	*Setaria viridis*	SETAVIR
Chenopodium sp.	CHENSPE	*Sherardia arvensis*	SHERARV
Conringia orientalis	CONRORI	*Silene* sp.	SILESPE
Cruciferae	CRUCIFE	*Solanum nigrum*	SOLANIG
Cyperaceae	CYPERAC	*T. aestivum/durum*	TRITAED
Digitaria sp.	DIGISPE	*Teucrium* sp.	TEUCSPE
Echinochloa crus-galli	ECHICRG	*Thymelaea passerina*	THYMPAS
Euphorbia palustris	EUPHPAL	*Trifolium* sp.	TRIFSPE
Galium spurium	GALISPU	*Triticum dicoccum*	TRITDIC
Glaucium corniculatum	GLAUCOR	*Triticum dic* g/b	TRITDIG
Gramineae	GRAMINE	*Triticum monococcum*	TRITMOT
Hordeum vulgare	HORDSAS	*Triticum mon* g/b	TRITMOG
Hordeum vulgare rachis	HORDSRS	*Triticum spelta*	TRITSPL
Hyoscyamus niger	HYOSNIG	*Triticum spelta* g/b	TRISPLG
Labiatae	LABIATA	*Verbena officinalis*	VERBOFF
Lolium sp.	LOLISPE	*Vicia* sp.	VICISPE
Malva sp.	MALVSPE		

Table 6.7. Species codes used in the correspondence analysis of the archaeobotanical data: Late Bronze Age Feudvar

		Einkorn	Einkorn/Emmer	Einkorn/Barley	Einkorn/Barley/ Bread/durum	Emmer	Barley	Barley/Broomcorn millet	Broomcorn millet	Rye	Total Ratio	Total CA
Spikelets - sieved	Ratio	21 (64)	-	-	-	-	-	-	-	-	85	
	CA	82	-	-	-	-	-	-	-	-		82
Spikelets- unsieved	Ratio	22 (32)	-	-	-	-	-	-	-	-	54	
	CA	57	-	-	-	-	-	-	-	-		57
Fine sieving by-product- sieved	Ratio	79	1	-	(2)	3	-	-	-	-	85	
	CA	79	1	-	2	3	-	-	-	-		85
Fine sieving by-product- unsieved	Ratio	87 (3)	-	-	-	-	-	-	-	-	90	
	CA	90	-	-	-	-	-	-	-	-		90
Product - sieved	Ratio	103 (4)	-	3 (5)	-	2	12	1	2 (1)	1	134	
	CA	107	-	8	-	2	12	1	3	1		134
Product - unsieved	Ratio	26 (4)	-	-	-	-	2	-	(3)	1	36	
	CA	30	-	-	-	-	2	-	3	1		36
Total	Ratio	445	1	8	2	5	14	1	6	2	484	
	CA	445	1	8	2	5	14	1	6	2		484

Table 6.8. Summary of the number of samples identified for each crop processing stage from the ratio analysis and after correspondence analysis. ( ) = tentative identifications: Late Bronze Age Feudvar

Chenopodium sp. content	USP	UFS	UP
> 90%		FEU135 FEU165	
> 70%	FEU023 FEU136 FEU208 FEU233 FEU468	FEU005 FEU006 FEU041 FEU053 FEU070 FEU094 FEU182 FEU279 FEU395	FEU396 FEU461

Table 6.9. Samples with > 90% and >70% *Chenopodium* sp. content per identified crop processing group. USP= Unsieved spikelets, UFS = Unsieved fine sieving by-products, UP= Unsieved products

Feature type	Spikelets	Fine sieving by-products	Products	Total no. of samples
Container fill	27%	64%	9%	11
General occupation layer	29%	38%	33%	253
Hearth	22%	50%	28%	18
House	33%	33%	34%	94
Miscellaneous	15%	46%	38%	13
Pit	27%	33%	40%	70
Street	15%	15%	69%	13
Yard	33%	8%	58%	12
Total no. of samples	139	175	170	484

Table 6.10. Percentage of samples per feature type based on their crop processing identifications: LBA Feudvar

Block	Container fill	General occupation layer	Hearth	House	Pit	Street	Yard	Total no. of samples
1	-	55%	-	35%	10%	-	-	20
2	-	39%	-	33%	28%	-	-	18
3	3%	59%	13%	15%	10%	-	-	39
4	-	43%	9%	18%	25%	5%	-	44
5	10%	65%	2%	18%	5%	2%	-	62
6	-	43%	10%	30%	7%	10%	-	60
7	-	56%	-	34%	3%	6%	-	32
8	3%	69%	-	19%	9%	-	-	32
9	-	64%	-	4%	20%	-	12%	25
10	-	60%	-	10%	10%	-	20%	20
11	-	33%	-	13%	33%	7%	13%	15
12	-	70%	-	-	20%	-	10%	20
13	11%	32%	-	21%	32%	5%	-	19
14	-	64%	-	18%	18%	-	-	33
15	-	29%	29%	29%	14%	-	-	7
16	14%	73%	-	9%	9%	-	-	11

Table 6.11. Percentage of samples per block in relation to feature type: LBA Feudvar

	Container fill	General occupation layer	Hearth	House	Miscellaneous	Pit	Street	Yard	Total no. of samples
Einkorn	10	241	14	82	12	62	13	11	445
Emmer	-	1	1	1	-	1	-	1	5
Barley	-	4	3	6	-	1	-	-	14
Broomcorn millet and Rye	-	2	-	1	1	4	-	-	8
Mix	1	5	-	4	-	2	-	-	12
Total no. of samples	11	253	18	94	13	70	13	12	484

Table 6.12. The number of samples identified to each cereal per feature type: LBA Feudvar

	Container fill	General occupation layer	Hearth	House	Pit	Street	Yard	Total no. of items
Barley grain	1%	52%	4%	30%	9%	2%	1%	15102
Barley rachis	-	45%	-	50%	3%	1%	-	1232
Einkorn grain	1%	35%	1%	40%	6%	3%	1%	73491
Einkorn glume base	1%	39%	1%	39%	11%	1%	-	135994
Emmer grain	1%	26%	48%	11%	10%	1%	2%	4208
Emmer glume base	1%	51%	1%	33%	9%	1%	1%	6602
Bread/durum grain	-	89%	-	2%	2%	-	-	471
cf. Rye	1%	42%	-	45%	4%	1%	1%	3264
Broomcorn millet	-	23%	1%	3%	63%	-	1%	2660
Weeds	1%	50%	2%	30%	12%	1%	1%	62220

Table 6.13. Percentage of each cereal per feature type: LBA Feudvar

House	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Barley grain	2%	2%	4%	10%	4%	2%	7%	16%	5%	-	-	-	6%	23%	-	-
Barley rachis	-	-	-	-	-	-	-	-	1%	-	-	-	-	-	-	-
Einkorn grain	26%	19%	19%	23%	26%	55%	30%	25%	14%	-	-	-	24%	8%	-	-
Einkorn glume base	27%	40%	17%	32%	47%	38%	26%	23%	21%	-	-	-	41%	13%	-	-
Emmer grain	1%	2%	1%	1%	2%	-	1%	-	5%	-	-	-	6%	-	-	-
Emmer glume base	1%	3%	1%	3%	1%	-	-	1%	-	-	-	-	9%	-	-	-
Broomcorn millet grain	-	1%	1%	-	2%	1%	-	-	-	-	-	-	-	1%	-	-
cf. Rye grain	1%	1%	3%	1%	1%	-	-	1%	12%	-	-	-	-	-	-	-
Weeds	41%	32%	54%	30%	16%	4%	36%	34%	43%	-	-	-	15%	55%	-	-
Total no. of seeds	866	530	720	412	438	5,058	1,069	398	161	-	-	-	93	167	-	-
Pit																
Barley grain	7%	4%	2%	2%	-	3%	7%	3%	4%	-	-	31%	12%	4%	-	-
Barley rachis	1%	1%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Einkorn grain	24%	14%	8%	23%	-	53%	33%	26%	20%	-	-	19%	17%	8%	-	-
Einkorn glume base	29%	21%	16%	31%	-	35%	24%	37%	19%	-	-	38%	23%	8%	-	-
Emmer grain	11%	3%	1%	1%	-	2%	1%	3%	15%	-	-	2%	-	-	-	-
Emmer glume base	4%	10%	1%	4%	-	-	-	8%	14%	-	-	-	-	-	-	-
Broomcorn millet grain	1%	1%	4%	-	-	-	12%	-	-	-	-	2%	4%	2%	-	-
cf. Rye grain	2%	2%	-	-	-	-	4%	1%	-	-	-	-	-	1%	-	-
Weeds	23%	45%	67%	39%	-	6%	18%	22%	27%	-	-	9%	44%	76%	-	-
Total no. of seeds	497	135	1,789	647	-	1,657	304	174	250	-	-	173	464	190	-	-

Table 6.14. Percentage of each cereal per block for house and pit features from samples identified as spikelets: LBA Feudvar

House	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Barley grain	-	4%	3%	6%	2%	7%	1%	1%	-	-	4%	-	4%	16%	5%	2%
Barley rachis	-	-	1%	-	-	-	1%	-	-	-	1%	-	-	-	-	-
Einkorn grain	3%	14%	8%	13%	21%	13%	13%	6%	-	-	13%	-	10%	12%	7%	4%
Einkorn glume base	8%	54%	56%	35%	61%	62%	78%	2%	-	-	63%	-	31%	2%	50%	-
Emmer grain	1%	1%	4%	1%	1%	1%	0%	6%	-	-	0%	-	1%	3%	1%	-
Emmer glume base	1%	1%	1%	7%	1%	2%	0%	77%	-	-	2%	-	-	-	26%	-
Broomcorn millet grain	-	-	-	-	-	-	-	-	-	-	2%	-	-	-	-	-
cf. Rye grain	-	1%	-	1%	-	-	1%	-	-	-	3%	-	1%	-	2%	-
Weeds	87%	24%	28%	38%	14%	15%	6%	8%	-	-	12%	-	53%	67%	9%	95%
Total no. of seeds	774	1,050	335	204	649	1,743	52,720	2,192	-	-	231	-	236	89	853	55
Pit	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Barley grain	-	-	1%	3%	-	1%	-	13%	0%	5%	1%	11%	2%	6%	15%	-
Barley rachis	-	1%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Einkorn grain	-	7%	2%	11%	-	4%	-	12%	1%	13%	13%	8%	5%	12%	14%	-
Einkorn glume base	-	82%	23%	29%	-	88%	-	51%	95%	36%	71%	39%	16%	45%	49%	-
Emmer grain	-	1%	1%	1%	-	1%	-	0%	1%	0%	0%	1%	3%	1%	2%	-
Emmer glume base	-	1%	2%	1%	-	1%	-	3%	0%	1%	1%	2%	18%		3%	-
Broomcorn millet grain	-	1%		1%	-		-	1%	-	-	-	-	-	2%	-	-
cf. Rye grain	-			1%	-		-	2%	-	1%	1%	-	2%	-	1%	-
Weeds	-	8%	69%	53%	-	5%	-	19%	2%	44%	14%	39%	54%	34%	16%	-
Total no. of seeds	-	1,659	207	439	-	520	-	75	8,907	318	260	2,049	1,242	194	152	-

Table 6.15. Percentage of each cereal per block for house and pit features from samples identified as fine sieving by-products: LBA Feudvar

House	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Barley grain	-	-	11%	5%	5%	16%	2%	19%	-	16%	5%	-	2%	54%	-	-
Barley rachis	-	-	-	-	-	-	-	-	-	1%	-	-	-	-	-	-
Einkorn grain	-	-	18%	62%	38%	43%	87%	28%	-	34%	32%	-	26%	6%	-	-
Einkorn glume base	-	-		29%	6%	11%	2%	17%	-	11%	5%	-	8%	9%	-	-
Emmer grain	-	-	-	1%	-	2%	-	1%	-	6%	6%	-	-	-	-	-
Emmer glume base	-	-	-	-	-	2%	-	2%	-	6%	-	-	-	-	-	-
Broomcorn millet grain	-	-	-	-	-	1%	-	0%	-	1%	-	-	-	-	-	-
cf. Rye grain	-	-	3%	-	13%	1%	1%	0%	-	2%	3%	-	-	-	-	-
Weeds	-	-	68%	3%	37%	24%	8%	33%	-	24%	50%	-	64%	30%	-	-
Total no. of seeds	-	-	12,213	15,828	3,198	1,163	4,438	1,023	-	142	101	-	154	806	-	-
Pit	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Barley grain	1%	7%	-	16%	6%	11%	-	18%	12%	5%	17%	-	-	2%	-	7%
Barley rachis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Einkorn grain	61%	6%	-	30%	46%	62%	-	39%	41%	22%	18%	-	-	6%	-	28%
Einkorn glume base	16%	19%	-	11%	15%	13%	-	7%	1%	12%	7%	-	-	20%	-	18%
Emmer grain	2%	1%	-	1%	1%	3%	-	2%	8%	1%	3%	-	-	1%	-	2%
Emmer glume base	-	2%	-	3%	-	-	-	11%	3%	15%	1%	-	-	2%	-	3%
Broomcorn millet grain	1%	32%	-	1%	-	-	-	2%	1%	1%	13%	-	-	45%	-	8%
cf. Rye grain	1%	-	-	1%	1%	-	-	2%	2%	2%	1%	-	-	-	-	2%
Weeds	17%	33%	-	37%	31%	11%	-	20%	32%	41%	40%	-	-	25%	-	32%
Total no. of seeds	352	506	-	1,620	878	238	-	106	125	146	1,490	-	-	2,437	-	77

Table 6.16. Percentage of each cereal per block for house and pit features from samples identified as products: LBA Feudvar

Crop processing groups	Original no. of species present	No. of species in >10% of samples	Total no. of samples	No. of samples with >25 weed seeds
Spikelets - sieved	84	16 (19%)	83	51 (61%)
Spikelets - unsieved	89	27 (30%)	56	54 (96%)
Fine sieving by-product- sieved	89	16 (18%)	85	59 (69%)
Fine sieving by-product- unsieved	94	22 (23%)	90	83 (92%)
Products - sieved	96	18 (19%)	134	86 (64%)
Products - unsieved	80	30 (38%)	36	35 (97%)

Table 7.1. The number of species present in >10% of each of the six crop processing groups and the number of samples with >25 weed seeds: LBA Feudvar

Spikelets - unsieved	Fine sieving by-products - unsieved	Products - unsieved
FEU023	FEU005	FEU396
FEU136	FEU006	FEU461
FEU208	FEU041	
FEU233	FEU053	
FEU468	FEU070	
	FEU094	
	FEU135	
	FEU165	
	FEU182	
	FEU279	
	FEU395	

Table 7.2. Samples with >70% *Chenopodium* sp. content within the unsieved spikelets, fine sieving by-product and product groups: LBA Feudvar

Taxa	Taxa code	Light (L)		Temperature (T)		Continentality (K)		Moisture (F)		Reaction (R)		Nitrogen (N)	
		BOR95	ELL79	BOR95	ELL79	BOR95	ELL79	BOR95	ELL79	BOR95	ELL79	BOR95	ELL79
Agrostemma githago	AGROGIT	7	7	6	x	5	x	5	x	6	x	5	x
Ajuga chamaepitys	AJUGCHA	8	7	8	8	2	2	3	4	8	9	2	2
Allium sp.	ALLISPE	*7*	*7*	*7*	*5*	*5*	*5*	*4*	*4*	*7*	*7*	*4*	*4*
Atriplex patula	ATRIPAT	7	6	5	6	4	x	5	5	7	7	4	7
Bromus arvensis	BROMARV	7	6	6	x	4	4	4	4	8	8	5	4
Bromus sp.	BROMSPE	*7*	*6*	*6*	*6*	*3*	*3*	*4*	*x*	*7*	*6*	*5*	*x*
Bupleurum rotundifolium	BUPLROT	8	8	7	7	4	4	3	3	8	9	4	4
Chenopodium hybridum	CHENHYB	7	7	6	6	7	7	6	5	8	8	8	8
Chenopodium sp.	CHENSPE	*7*	*8*	*6*	*6*	*7*	*7*	*6*	*6*	*8*	*x*	*8*	*8*
Conringia orientalis	CONRORI	7	7	6	6	5	5	3	3	9	9	4	4
Digitaria sp.	DGISPE	*7*	7	*7*	7	*4*	4	*4*	4	*5*	4	*4*	4
Echinochloa crus-galli	ECHICRG	8	6	7	7	5	5	7	5	7	x	8	8
Euphorbia palustris	EUPHPAL	8	8	6	6	6	6	9	8	8	8	5	x
Galium spurium	GALISPU	7	7	6	x	5	5	5	5	7	8	*5*	5
Glaucium corniculatum	GLAUCOR	9	7	8	7	6	6	4	4	8	9	4	4
Hyoscyamus niger	HYOSNIG	8	8	6	6	4	x	4	4	7	7	9	9
Lolium sp.	LOLISPE	*7*	*7*	*7*	*7*	*4*	*4*	*4*	*5*	*8*	*6*	*4*	*x*
Malva sp.	MALVSPE	*8*	*8*	*7*	*6*	*5*	*5*	*4*	*4*	*7*	*7*	*8*	*7*
Plantago lanceolata	PLANLAN	7	6	5	x	3	3	4	x	6	x	5	x
Polygonum aviculare	POLYAVI	9	7	5	x	3	x	4	x	6	x	5	x
Polygonum convolvulus	POLYCON	7	7	5	x	3	x	5	x	5	x	3	x
Polygonum persicaria	POLYPER	6	6	5	5	3	3	7	3	6	x	7	7
Portulaca oleracea	PORTOLE	7	7	8	8	3	3	4	4	7	7	7	7
Rumex crispus type	RUMECRI	7	7	5	5	3	3	6	7	6	x	7	6
Setaria viridis	SETAVIR	7	7	6	6	5	x	4	4	7	x	7	7
Sherardia arvensis	SHERARV	6	6	6	6	3	3	5	5	8	8	5	5
Silene sp.	SILESPE	*8*	*8*	*7*	*5*	*5*	*4*	*3*	*4*	*7*	*7*	*3*	*3*
Solanum nigrum	SOLANIG	7	7	6	6	3	3	6	5	7	7	8	8
Teucrium sp.	TEUCSPE	*8*	*7*	*6*	*6*	*4*	*4*	*4*	*3*	*8*	*7*	*2*	*2*
Thymelaea passerina	THYMPAS	8	7	7	7	6	6	4	4	8	8	4	4
Trifolium sp.	TRIFSPE	*8*	*7*	*6*	*5*	*5*	*4*	*4*	*4*	*7*	*6*	*3*	*3*
Verbena officinalis	VERBOFF	9	9	6	6	3	3	4	5	8	7	6	7
Vicia sp.	VICISPE	*7*	*7*	*6*	*6*	*5*	*4*	*4*	*4*	*6*	*6*	*4*	*4*

Table 7.3. Ecological indicator values per species and genus. After Borhidi 1995 (BOR95) and Ellenberg 1979 (ELL79). italics i.e. *6* = uncertain, X = indifferent

Taxa	Taxa code	Height (cm)	Annual (A)/ Biennial (B)/ Perennial (P)	Summer (S)/ Winter (W) annuals
Agrostemma githago	AGROGIT	30-100	A	W
Ajuga chamaepitys	AJUGCHA	10-40	A, B	S
Allium sp.	ALLISPE	20-100	P	
Atriplex patula type	ATRIPAT	30-150	A	S
Bromus arvensis	BROMARV	30-100	A, B	W
Bromus sp.	BROMSPE	30-120	A, B	W
Bupleurum rotundifolium	BUPLROT	10-60	A	W
Chenopodium hybridum	CHENHYB	30-100	A	S
Chenopodium sp.	CHENSPE	30-150	A	S
Conringia orientalis	CONRORI	10-60	A	W
Digitaria sp.	DGISPE	10-60	A	S
Echinochloa crus-galli	ECHICRG	30-100	A	S
Euphorbia palustris	EUPHPAL	50-150	P	
Galium spurium	GALISPU	40-150	A	S/W
Glaucium corniculatum	GLAUCOR	30-40	A, B	S
Hyoscyamus niger	HYOSNIG	20-100	A, B	S
Lolium sp.	LOLISPE	30-120	A	S
Malva sp.	MALVSPE	30-200	P	
Plantago lanceolata	PLANLAN	10-50	P (with rhizome)	
Polygonum aviculare	POLYAVI	10-50	A	S
Polygonum convolvulus	POLYCON	>100	A	S
Polygonum persicaria	POLYPER	20-60	A	S
Portulaca oleracea	PORTOLE	<50	A	S
Rumex crispus type	RUMECRI	30-150	P	
Setaria viridis	SETAVIR	10-100	A	S
Sherardia arvensis	SHERARV	>40	A	W
Silene sp.	SILESPE	5-100	A, B, P	
Solanum nigrum	SOLANIG	10-70	A	S
Teucrium sp.	TEUCSPE	10-60	A, P	
Thymelaea passerina	THYMPAS	10-40	A	?
Trifolium sp.	TRIFSPE	5-60	A, P	
Verbena officinalis	VERBOFF	30-60	P	
Vicia sp.	VICISPE	20-120	A, B, P	

Table 7.4. The height, life cycle and germination times of each species: LBA Feudvar. After Bojnanský and Fargaová 2007; Ellenberg *et al.* 1991; Häfliger and Brun-Hool 1968–1977.

Phytosociological Class	Species
Chenopodietea	*Atriplex patula*
	Bromus arvensis
	Chenopodium hybridum
	Digitaria sp. (various)
	Echinochloa crus-galli
	Hyoscyamus niger
	Polygonum aviculare
	Polygonum persicaria
	Portulaca oleracea
	Setaria viridis
	Solanum nigrum
	Verbena officinalis
Secalinetea	*Agrostemma githago*
	Ajuga chamaepitys
	Bupleurum rotundifolium
	Conringia orientalis
	Galium spurium
	Glaucium corniculatum
	Sherardia arvensis
	Thymelaea passerine
Molinio-Arrhenatheretea	*Plantago lanceolata*
Plantaginetea	*Rumex crispus*

Table 7.5. Character species identified within Feudvar assemblage under the Phytosociological Classes. After Ellenberg 1979

	Romania	Hungary	Bosnia Herzegovina	Croatia	Serbia	Total no. of records
Mid/Late Neolithic	3	49	10	1	7	70
Copper Age	1	26	-	2	1	30
Bronze Age	8	55	-	2	4	69
Total no. of records	12	130	10	5	12	168

Table 8.2. Number of records per country and period: Carpathian Basin

	Mid/Late Neolithic	Copper Age	Bronze Age	Total no. of records
No. of records with species presence/absence only	20	2	10	19%
No. of records with presence/absence and the overall no. of remains per site	46	27	57	77%
No. of records with full sample details	4	1	2	4%
Total no. of records	70	30	69	169

Table 8.3. The level of information available for each record per period: Carpathian Basin

	Romania (n=12)	Hungary (n=130)	Bosnia Herzegovina (n=10)	Croatia (n=5)	Serbia (n=12)	Total no. of crops (n=169)
Mid/Late Neolithic	13	15	10	4	9	16
Copper Age	6	10	-	1	8	10
Bronze Age	11	16	-	8	13	16

Table 8.4. Number of crops identified per country and period: Carpathian Basin (n= total no. of records per country)

	Romania (n=12)	Hungary (n=130)	Bosnia Herzegovina (n=10)	Croatia (n=5)	Serbia (n=12)	Total no. of crops (n=169)
Mid/Late Neolithic	10	10	10	2	12	20
Copper Age	2	4	-	1	2	6
Bronze Age	2	8	-	3	12	15

Table 8.5. Number of fruits/nuts identified per country and period: Carpathian Basin (n= total no. of records per country)

	Romania (n=12)	Hungary (n=130)	Bosnia Herzegovina (n=10)	Croatia (n=5)	Serbia (n=12)	Total no. of crops (n=169)
Mid/Late Neolithic	41	110	34	2	23	188
Copper Age	-	24	-	8	22	44
Bronze Age	11	149	-	4	30	155

Table 8.6. Number of wild/weed species identified per country and period: Carpathian Basin (n= total no. of records per country)

		Romania (n=12)	Hungary (n=130)	Bosnia Herzegovina (n=10)	Croatia (n=5)	Serbia (n=12)	Total no. (n=169)
Mid/Late Neolithic	Tell	2	8	5	-	6	21
	Flat	1	41	5	-	1	48
	Cave	-	-	-	1	-	1
Copper Age	Tell	-	1	-		1	2
	Flat	-	25	-	1	-	26
	Cave	1	-	-	1	-	2
Bronze Age	Tell	7	18	-	1	4	30
	Flat	1	37	-	1	-	39
	Cave	-	-	-	-	-	-

Table 8.7. Number of records identified as a tell, flat or cave settlement for each country per period (n= total no. of records per country)

Period	M/LN	CA	BA	Total
No. of records	78	39	73	190
GRAIN				
Hordeum vulgare	48%	60%	65%	56%
Triticum dicoccum	63%	58%	65%	62%
Triticum monococcum	54%	45%	51%	51%
Triticum spelta	14%	13%	19%	15%
T. aestivum/durum	19%	23%	41%	27%
"New glume wheat"	4%	-	1%	1%
Secale cereale	3%	5%	14%	4%
Avena sativa	-	-	1%	1%
Panicum miliaceum	17%	15%	38%	24%
Setaria italica	1%	8%	1%	4%
CHAFF				
Hordeum vulgare rachis	11%	8%	7%	9%
Triticum dicoccum g/b	19%	13%	36%	24%
Triticum monococcum g/b	17%	15%	34%	23%
Triticum spelta g/b	6%	13%	11%	8%
"New glume wheat" g/b	4%	3%	1%	3%
T.aestivum/durum rachis	1%	5%	5%	4%
PULSES				
Lathyrus sativus	10%	-	7%	7%
Lens culinaris	31%	10%	35%	28%
Pisum sativum	27%	8%	28%	24%
Vicia ervilia	5%	5%	19%	10%
Vicia faba	4%	-	11%	6%
Cicer arietinum	-	-	1%	1%
OIL PLANTS				
Camelina sativa	1%	-	7%	3%
Linum usitatissimum	11%	15%	4%	9%
Papaver somniferum	-	-	1%	1%

Table 8.8. Frequency of crop species per record for each period: Carpathian Basin

Period	Romania	Hungary	Bosnia Herzegovina	Croatia	Serbia
No. of records	2	49	10	9	10
GRAIN					
Hordeum vulgare	50%	57%	70%	56%	27%
Triticum dicoccum	50%	55%	100%	78%	55%
Triticum monococcum	100%	39%	80%	100%	55%
Triticum spelta	50%	14%	-	33%	-
T. aestivum/durum	50%	24%	20%	44%	18%
"New glume wheat"	100%	2%	-	-	-
Secale cereale	50%	4%	-	11%	-
Avena sativa	-	-	-	-	-
Panicum miliaceum	50%	16%	30%	11%	9%
Setaria italica	-	2%	-	11%	-
CHAFF					
Hordeum vulgare rachis	50%	12%	-	22%	9%
Triticum dicoccum g/b	50%	12%	-	22%	9%
Triticum monococcum g/b	50%	2%	80%	44%	9%
Triticum spelta g/b	-	2%	10%	44%	-
"New glume wheat" g/b	-	-	-	44%	-
T.aestivum/durum rachis	50%	-	-	-	-
PULSES					
Lathyrus sativus	-	8%	10%	22%	9%
Lens culinaris	50%	24%	40%	56%	27%
Pisum sativum	50%	27%	30%	22%	27%
Vicia ervilia	50%	2%	-	22%	-
Vicia faba	50%	-	-	-	-
Cicer arietinum	-	-	-	-	-
OIL PLANTS					
Camelina sativa	-	2%	-	-	-
Linum usitatissimum	50%	6%	30%	22%	9%
Papaver somniferum	-	-	-	-	-

Table 8.9. Frequency of crop species per country: Mid/Late Neolithic Carpathian Basin

Period	Romania	Hungary	Bosnia Herzegovina	Croatia	Serbia
No. of records	2	26	0	11	1
GRAIN					
Hordeum vulgare	-	81%	-	55%	100%
Triticum dicoccum	50%	50%	-	64%	100%
Triticum monococcum	100%	27%	-	64%	100%
Triticum spelta	50%	8%	-	18%	-
T. aestivum/durum	100%	15%	-	36%	100%
"New glume wheat"	-	-	-	-	-
Secale cereale	-	4%	-	18%	-
Avena sativa	-	-	-	-	-
Panicum miliaceum	50%	8%	-	18%	100%
Setaria italica	-	-	-	18%	-
CHAFF					
Hordeum vulgare rachis	-	8%	-	-	-
Triticum dicoccum g/b	-	-	-	36%	-
Triticum monococcum g/b	-	-	-	45%	-
Triticum spelta g/b	-	-	-	18%	-
"New glume wheat" g/b	-	-	-	9%	-
T.aestivum/durum rachis	-	-	-	9%	-
PULSES					
Lathyrus sativus	-	-	-		
Lens culinaris	-	4%	-	9%	100%
Pisum sativum	50%	4%	-	9%	-
Vicia ervilia	-	-	-	9%	100%
Vicia faba	-	-	-	-	-
Cicer arietinum	-	-	-	-	-
OIL PLANTS					
Camelina sativa	-	-	-	-	-
Linum usitatissimum	-	4%	-	27%	100%
Papaver somniferum	-	-	-	-	-

Table 8.10. Frequency of crop species per country: Copper Age Carpathian Basin

Period	Romania	Hungary	Bosnia Herzegovina	Croatia	Serbia
No. of records	9	55	0	6	3
GRAIN					
Hordeum vulgare	67%	91%	-	33%	67%
Triticum dicoccum	67%	65%	-	33%	100%
Triticum monococcum	67%	49%	-	17%	100%
Triticum spelta	11%	20%	-	-	33%
T. aestivum/durum	44%	36%	-	17%	100%
"New glume wheat"	-	-	-	-	-
Secale cereale	11%	15%	-	-	-
Avena sativa	-	-	-	17%	-
Panicum miliaceum	22%	35%	-	67%	67%
Setaria italica	-	-	-	17%	-
CHAFF					
Hordeum vulgare rachis	-	8%	-	-	-
Triticum dicoccum g/b	-	44%	-	-	67%
Triticum monococcum g/b	11%	38%	-	-	67%
Triticum spelta g/b	-	13%	-	-	-
"New glume wheat" g/b	-	-	-	-	33%
T.aestivum/durum rachis	-	-	-	-	-
PULSES					
Lathyrus sativus	-	5%	-	17%	-
Lens culinaris	11%	36%	-	17%	100%
Pisum sativum	11%	27%	-	17%	100%
Vicia ervilia	11%	15%	-	17%	100%
Vicia faba	11%	9%	-	17%	-
Cicer arietinum	-	2%	-	-	-
OIL PLANTS					
Camelina sativa	-	4%	-	-	67%
Linum usitatissimum	-	2%	-	-	33%
Papaver somniferum	-	2%	-	-	-

Table 8.11. Frequency of crop species per country: Bronze Age Carpathian Basin

Phase	Site	No. of samples	Average sample size	Median seed density per litre (not inc. indet)	100: total no. per sample	300: total no. per sample
MN	VIRBRE	5	11	0.1	1000	3000
LN	IVAGAJ	14	11	0.1	1000	3000
CA	PAJVEL	23	11	0.1	1000	3000
LN/CA/BA	TOMPAL	55	11	0.2	500	1500
LN	CISMAV*	34	8	0.2	500	1500
LBA	MACCRI*	25	11	0.2	500	1500
LBA	ORUVES*	2	11	0.2	500	1500
LN	SOPOT*	144	20	0.3	333	1000
CA	JURSTV	12	11	0.3	333	1000
LBA	CRIOST*	3	11	0.3	333	1000
CA	VIRBAT	3	11	0.4	250	750
CA	ĐAKFRA	29	11	0.7	143	429
CA	POTOCA	1	55	1	100	300
CA	VUCEDO	35	11	1	100	300
LN	TURPEC*	22	14	2	50	150
LN/CA	SLAVCA*	97	11	2	50	150
CA	RAVNOK*	60	11	2	50	150
CA	VINMAG*	4	54	8	13	38

Table 10.1. The ideal sample volume for each site (based on the median seed density not including unidentified fragments) to achieve 100 and 300 seeds per sample: All 18 Croatian sites
* 250 micron sieve used

Table 4.7. Number of species identified per sample: Mid/Late Neolithic Croatia

Unique sample no.	Trench/Block	Original sample no.	Stratigraphic unit (SJ)	Square	Sample vol. (l)	Feature type	Level (m)	Preservation scale	Charcoal density (cm³)	Plant density per litre	Fraction (%)	INDETERMINATE	Total identified items
CISM01	A	16	3	1	9.0	General	97,84-97,60	5	0.5	0.6	100	26	**5**
CISM02	A	19	3	2	6.5	General	97,85-97,62	5	0.4	0.5	100	10	**3**
CISM03	A	22	3	3	7.0	General	97,87-97,64	N/A	0.4	0	100		**0**
CISM04	A	26	3	4	6.0	Fireplace	97,89-97,58	N/A	0.6	0	100	3	**0**
CISM05	A	41	3	5	5.5	General	97,83-97,49	5	0.2	0.2	100	9	**1**
CISM06	A	44	14	6	8.0	Fireplace	97,87-97,65	4	0.6	0.1	100		**1**
CISM07	A	30	17	2	7.0	Pit Fill	97,61-96,94	5	0.4	0.4	100	1	**3**
CISM08	A	34	18	3	6.5	Pit Fill	97,60-96,84	4	0.9	2.9	100	18	**19**
CISM09	A	25	19	1,2	5.0	Pit Fill	97,64-97,32	4	0.5	0.8	100	12	**4**
CISM10	A	48	20	6	5.0	Fireplace	97,66-97,58	3	0.1	0.2	100	5	**1**
CISM11	A	37	23	4	5.0	Pit Fill	97,68-96,65	5	0.8	0.2	100	3	**1**
CISM12	A	49	23, 23a	6	5.0	Pit Fill	97,07-96,97	4	0.5	12.8	100	56	**64**
CISM13	A	61	24	6	7.0	Pit Fill	97,70-97,36	5	0.6	0.1	100	4	**1**
CISM14	A	62	32	6	5.0	Pit Fill	97,39-97,34	N/A	0.2	0	100		**0**
CISM15	A	70	33	6	3.5	Pit Fill	97,38-96,85	N/A	1.7	0	100		**0**
CISM16	A	84	33	6	2.5	Pit Fill	96,85	N/A	0.3	0.0	100	3	**0**
CISM17	A	50		6	4.0	Fireplace	97,63-97,55	N/A	0.3	0	100	1	**0**
CISM18	B	63	3	2	7.0	General	97,80-97,54	4	0.4	0.3	100	3	**2**
CISM19	B	72	3	3	5.0	House floor	97,86-97,63	4	0.5	2.6	100	71	**13**
CISM20	C	93	45	1	7	Pit fill		4	0.3	0.1	100	2	**1**
CISM21	C	94	45	1	10	Pit fill		5	0.3	0.2	100	8	**2**
CISM22	C	90	46	1	6	Fireplace in a pit		N/A	0.1	0	100		**0**
CISM23	C	91	46	3	7	Fireplace in a pit		3	0.1	0.1	100	1	**1**
CISM24	C	92	46	3	7	Fireplace in a pit		4	0.1	0.1	100	4	**1**
CISM25	C	97	46	6	8	Pit fill		5	0.5	0.3	100		**2**
CISM26	C	98	46	6	6	Pit fill		1	0.3	0.3	100		**2**
CISM27	D	112	41	2-8	10	Pit fill		N/A	0.1	0	100		**0**
CISM28	D	117	41	2-4	16	Pit fill		5	0.3	0.2	100		**3**
CISM29	D	118	41	9	13	Pit fill		5	0.8	0.6	100	16	**8**
CISM30	D	119	41	9	19	Pit fill		4	0.5	0.4	100	9	**7**
CISM31	D	121	41	10	14	Pit fill		4	0.1	0.1	100	1	**1**
CISM32	D	122	41	10	12	Pit fill		3	0.2	0.3	100		**4**
CISM33	D	110	57	1	13	Pit fill		3	0.2	0.1	100	3	**1**
CISM34	D	111	57	1	10	Pit fill		3	0.1	0.1	100		**1**
IVAG01		113	37	W35-36	11	Pit		N/A	0	0	100		**0**
IVAG02		71	41		11	Pit - large full of bone & pot		5	0.1	0.3	100	1	**3**
IVAG03		135	41	Y33, Z38, Z39	11	Pit		5	0	0.5	100	16	**6**
IVAG04		104	90	S35	11	Pit		N/A	0	0	100		**0**
IVAG05		46	144	U38	11	Pit		N/A	0	0.0	100		**0**
IVAG06		218	219	X,Y31	11	Pit		N/A	0	0	100		**0**
IVAG07		195	247	D29	11	Pit		5	0	0.3	100		**3**
IVAG08		208	263	A32	11	Pit		5	0	0.4	100	6	**4**
IVAG09		202	279	Y38	11	Pit		N/A	0.2	0.0	100	1	**0**
IVAG10		150	281	E,F36	11	Pit		5	0	0.1	100		**1**
IVAG11		143	289	D,E35	11	Pit		5	0	0.1	100	12	**1**
IVAG12		397	340		11	Pit		5	0	0.2	100	3	**2**
IVAG13		282	388	V22	11	Pit		N/A	0	0	100		**0**
IVAG14		295	393		11	Pit		3	0	0.2	100		**2**
RAVN01	1		10-11	S/5b	11	General occupation layer		3	0.9	1.2	100	19	**13**
RAVN02	1	90	22	S/23a	22	General occupation layer		4	0.1	0.5	100	30	**12**
RAVN03	1	94	22	S/23a	33	General occupation layer		4	0.1	0.5	100	24	**16**
RAVN04	1	11	22	S/23c	11	General occupation layer		3	0.5	1.2	100	25	**13**
RAVN05	1	12	22	S/23c	11	General occupation layer		5	0	0.5	100	32	**5**
RAVN06	1	13	22	S/23c	11	General occupation layer		4	0.3	0.6	100	96	**7**
RAVN07	1	14	22	S/23c	11	General occupation layer		5	0.2	1.7	100	40	**19**
RAVN08	1	15	22	S/23c	11	General occupation layer		4	0	0.5	100	9	**6**
RAVN09	1	16	22	S/23c	11	General occupation layer		5	0.6	1.5	100	31	**16**
RAVN10	1	17	22	S/23c	11	General occupation layer		4	0.2	0.5	100	10	**5**
RAVN11	1	18	22	S/23c	11	General occupation layer		3	0.3	0.5	100	6	**5**
RAVN12	1	82	22	S/23c	22	General occupation layer		2	1.1	23.7	100	472	**521**
RAVN13	1	38	22	S/23d	11	General occupation layer		3	0.3	3.9	100	90	**43**
RAVN14	1	86	22	S/23d	22	General occupation layer		3	0.6	6.7	100	59	**147**
RAVN15	1	88	22	S/23d	11	General occupation layer		5	1.5	3.2	100	43	**35**
RAVN16	1	92	22	S/23d	22	General occupation layer		3	0.3	2.6	100	47	**58**
RAVN17	1		22	S/24a,d	11	General occupation layer	2,78-2,95	4	0.7	1.1	100	16	**12**
RAVN18	1	10	22		11	General occupation layer		3	0.4	4.6	100	76	**51**
RAVN19	1	97	30	J/24a,b	22	Pit		5	0	0.3	100	13	**7**
RAVN20	1		41	S/22a	11	Pit		5	0.4	1.9	100	8	**21**
RAVN21	1		42	S/22b	22	Pit		5	0	0.7	100	28	**15**
RAVN22	1		44-45	S/23c	11	Pit	2,91-3,27	4	0.1	2.2	100	20	**24**
RAVN23	1		46-47	S/23c	11	Pit	3,05-3,33	4	0	1.0	100		**11**
RAVN24	1		48-49	S/23b	11	Pit	3,01-3,22	5	0	0.5	100	1	**6**
RAVN25	1		53	T/23d	11	Pit		5	0.1	0.3	100		**3**
RAVN26	1		54	T/24b	22	Pit		4	0.1	3.8	100	20	**84**
RAVN27	1		54	T/24c	11	Pit		5	0.1	6.3	100	34	**69**
RAVN28	1		55	T/22a	11	Pit		4	0.4	2.5	100	38	**27**
RAVN29	1		55	T/22b	22	Pit	2,77-2,87	3	0.1	4.7	100	57	**103**
RAVN30	1		55	T/23a	11	Pit		3	0.5	4.1	100	17	**45**
RAVN31	1		55	T/23b	33	Pit		3	0.1	2.2	100	116	**71**
RAVN32	1		55	T/24b	11	Pit		4	0.1	0.8	100	5	**9**
RAVN33	1		56-57	S/23a	11	Pit		5	0.2	1.8	100	16	**20**
RAVN34	1		59-60	S/22a	11	Pit		4	0.1	2.7	100	17	**30**
RAVN35	1		79-80	S/23d	11	Pit	3,42-3,57	5	0	1.9	100	14	**21**
RAVN36	1		88-89	T/22b	11	Pit	3,44-3,63	N/A	0	0.0	100		**0**
RAVN37	2	21	24	J/24a	11	Pit		4	0.4	9.1	100	36	**100**
RAVN38	2	22	24	J/24c	11	Pit		4	0.3	4.2	100	20	**46**
RAVN39	2	23	24	J/24c	11	Pit		3	0.4	5.7	100	13	**63**
RAVN40	2	19	24		11	Pit		4	0.4	5.0	100	15	**55**
RAVN41	2	19	26		11	Pit		5	0.2	1.5	100	13	**16**
RAVN42	2	32	28	J/24c	11	Pit		5	0.5	16.8	100	38	**185**
RAVN43	2	44	30	J/24a	11	Pit		4	0.1	0.7	100	16	**8**
RAVN44	2	48	30	J/24a	11	Pit		5	0.1	0.5	100	2	**6**
RAVN45	2	49	30	J/24a	11	Pit		5	0.1	0.5	100	4	**5**
RAVN46	2	50	30	J/24a	11	Pit		4	0.2	0.7	100	19	**8**
RAVN47	2	52	30	J/24a	11	Pit		5	0.3	1.5	100	19	**16**
RAVN48	2	76	30	J/24a	22	Pit		5	0.2	0.2	100	6	**5**
RAVN49	2	34	30	J/24a,b	11	Pit		4	0.2	0.9	100	2	**10**
RAVN50	2	35	30	J/24a,b	11	Pit		4	0.1	2.1	100	25	**23**
RAVN51	2	36	30	J/24a,b	11	Pit		5	0.2	0.8	100	7	**9**
RAVN52	2	40	30	J/24a,b	11	Pit		4	0.4	3.8	100	25	**42**
RAVN53	2	41	30	J/24a,b	11	Pit		5	0.2	0.1	100	3	**1**
RAVN54	2	42	30	J/24a,b	11	Pit		N/A	0	0.0	100		**0**
RAVN55	2	37	32	J/24c,d	11	Pit		5	0.1	0.8	100	6	**9**
RAVN56	2	33		J/24c,d	11	General occupation layer		5	0.3	0.2	100	5	**2**
RAVN57	2	66	37	J/24a	22	Pit		5	0.2	0.8	100	14	**17**
SLAV01	1	1	1	A8/8	11	Pit		N/A	0	0.0	100		**0**
SLAV02	1		2	D/4	11	Pit		5	0.6	12.0	100		**132**
SLAV03	1		14	C/1	11	Pit	238,10	5	1.5	1.7	100	63	**19**
SLAV04	1		14	D/1	11	Pit	238,15	5	0.5	3.3	100	22	**36**
SLAV05	1	36	25	A3/A4	11	Pit		5	1.5	1.3	100	15	**14**
SLAV06	1		27	A2	11	Pit	233,12	5	0.6	0.6	100	13	**7**
SLAV07	1	152	31	C/5	11	Pit	237,76	4	0.5	3.1	100	20	**34**
SLAV08	1		54	A10	11	Pit	238,31-238,4	5	0.1	0.5	100	4	**6**
SLAV09	1	3	54	C/7	11	Pit	237,69	4	0.5	1.8	100	18	**20**
SLAV10	1	5	54	F/2	11	Pit	237,69	N/A	0.4	0.0	100		**0**
SLAV11	1	17	59	E/8	11	Pit	238,10	4	0.1	1.1	100	13	**12**
SLAV12	1	32	59	E/8,9	11	Pit	237,05	5	0	0.0	100	7	**0**
SLAV13	1	46	80	E,F/1	11	Pit		4	0.5	6.5	100	96	**72**
SLAV14	1	47	80	E,F/1	11	Pit		5	0.9	3.4	100	62	**37**
SLAV15	1	64	80	F/1	11	Pit	236,49	3	1.5	0.8	100		**9**
SLAV16	1	76	91	C/4	11	Pit	237,44-237,2	3	0.2	6.5	100	21	**72**
SLAV17	1	33	91	E/2	11	Pit		4	0	0.2	100	3	**2**
SLAV18	1	75	91	E3	11	Pit	237,93-237,1	5	0.1	0.1	100	1	**1**
SLAV19	1		91	E4,5	11	Pit		5	0.6	1.9	100	25	**21**
SLAV20	1	80	91	L/5	11	Pit	237,53-237,3	4	0.5	7.0	100	18	**77**
SLAV21	1	18	94	GF/8	11	Pit	237,62	3	2.3	8.6	100	25	**95**
SLAV22	1	36	95	A,B/8	11	Pit	237,81-238,3	5	0.9	2.3	100	36	**25**
SLAV23	1	2	95		11	Pit	237,881-237,	4	1.5	5.5	100	54	**60**
SLAV24	1	56	98	C/8	11	Pit	237,95-237,7	5	0.1	0.2	100	7	**2**
SLAV25	1	51	104	A/8,9	11	Pit	238,05-237,9	4	0.1	1.7	100	41	**19**
SLAV26	1	110	110	A6	11	Pit	236,41	4	0.4	4.2	100	8	**46**
SLAV27	1	111	110	A6	11	Pit	237,02-236,6	3	0.4	10.4	100	37	**114**
SLAV28	1	112	110	E,F/5	11	Pit	237,05	2	0	0.2	100		**2**
SLAV29	1	168	123	F/6	11	Pit	238,03-237,9	4	2.5	15	50	41	**165**
SLAV30	1	169	123	F/6	11	Pit	237,87	4	1.8	39	50	130	**425**
SLAV31	1	125	123		11	Pit		5	0.5	0.6	100	27	**7**
SLAV32	1	135	126		11	Pit	237,92	4	0.4	13	100	17	**141**
SLAV33	1	163	158	F/4	11	Pit	236,56	5	1.7	5.2	100	40	**57**
SLAV34	1		158	G,F4,5	11	Pit		N/A	0	0.0	100		**0**
SLAV35	1	1	181	HI/14-ZZ/7	11	Pit		5	0.2	2.8	100	26	**31**
SLAV36	1		14/4	D/2	11	Pit	238,15	4	0.7	1.2	100	27	**13**
SLAV37	1	79	105-107	E/1	11	Pit	235,96-236,1	4	0.5	25.2	100	65	**277**
SLAV38	1		1a	B/5,6	11	Pit	239,45	N/A	0	0.0	100		**0**
SLAV39	1	9	22,23	G7	11	Pit	239,28-238,7	4	0.3	8.1	100	31	**89**
SLAV40	1			A/5	11	Pit		2	0	0.1	100		**1**
SLAV41	1	174		H/1,13-Z/6	11	Pit		5	0.3	0.2	100	7	**2**
SLAV42	2	134	6	A/10	11	Pit	237,46	5	0.5	4.9	100	70	**54**
SLAV43	2		14	C/2	11	Pit	238,17-238,0	3	0.6	0.6	100	15	**7**
SLAV44	2		14	C/2	11	Pit	238,83	5	0.7	1.5	100	17	**16**
SLAV45	2		14	C/2	11	Pit		4	0.9	0.9	100	28	**10**
SLAV46	2		14	C/2	11	Pit		4	0.1	3.2	100	24	**35**
SLAV47	2		14	C/3	11	Pit	238,54-238,2	N/A	0	0.0	100		**0**
SLAV48	2		21		11	Pit	239,29	5	1.4	0.6	100	21	**7**
SLAV49	2		37	B/1,2	11	Pit		5	0.3	1.7	100	17	**19**
SLAV50	2	26	37	D/1	11	Pit	238,89	2	0.1	3.8	100	12	**42**
SLAV51	2		37		11	Pit		5	0.5	1.1	100	6	**12**
SLAV52	2	186	163	G/4	11	Pit	239,65-239,5	2	0.5	2.9	100	23	**32**
SLAV53	2	186	164	B/5	11	Pit		N/A	0	0.0	100		**0**
SLAV54	2	179	165	B/3	11	Pit		5	0.1	0.2	100	9	**2**
SLAV55	2	215	179	A5	11	Pit		4	1.2	2.0	100	46	**22**
SLAV56	2		(44),45	D/3,4	11	Pit	239,17	3	0	0.3	100		**3**
SLAV57	2			B/1	11	Pit		4	0.1	1	100	7	**6**
SLAV58	3	44	14	VIII	11	Pit	239,07-238,8	4	2.1	2.3	50	9	**25**
SLAV59	3	44	14	VIII	11	Pit	239,07-238,8	5	1.4	0.5	50	7	**6**
SLAV60	3		14	VIII	11	Pit		4	0.8	8.6	100	55	**95**
SLAV61	3		14		11	Pit		5	1.1	3.8	100	54	**42**
SLAV62	3	50		VII	11	Pit	238,74-238,8	4	0.4	1.9	100	19	**21**
SLAV63	3	50		VII	11	Pit		5	0.1	1.5	100	19	**16**
SLAV64			2	C,D/4	11	Pit		4	0.5	18.4	100	52	**202**
SLAV65		4-5	14		11	Pit		5	2.3	4.9	50	94	**54**
SLAV66			25	0/50,0/67	11	Pit	238,76	4	0.3	2.4	100	10	**26**
SLAV67		4	55		11	Pit	238,22-238,0	4	0.5	1.0	100	6	**11**
SLAV68		127		A4,5,7	11	Pit	238,24-238,1	5	1.4	0.9	100	33	**10**
SLAV69				D/1	11	Pit	238,29-238,1	N/A		0.0	100		**0**
SLAV70		129			11	Pit		4	1.7	47.2	100	329	**519**
SLAV71		153			11	Pit		5	0.3	0.0	100	27	**0**
SLAV72		157			11	Pit		4	0.5	17.9	100	41	**197**

Table 4.7. Number of species identified per sample: Mid/Late Neolithic Croatia

Unique sample no.	Trench/Block	Original sample no.	Stratigraphic unit (SJ)	Square	Sample vol. (l)	Feature type	Level (m)	Preservation scale	Charcoal density (cm³)	Plant density per litre	Fraction (%)
SLAV73		181			11	Pit		2	0	3.5	100
SLAV74		182			11	Pit		2	0	0.6	100
SLAV75		216			11	Pit		5	0.5	3.5	100
SOP001	1	13	4	A5	20	House area	1,61-1,74	4	0.0	0.1	100
SOP002	1	15	4	C2	20	House area	1,59-1,77	5	0.0	0.1	100
SOP003	1	16	4	A5	20	House area	1,78	N/A	0.0	0.0	100
SOP004	1	12	5	A5	20	House area	2,11	5	0.1	0.8	100
SOP005	1	11	6	A5	20	House	2,35	5	0.0	0.2	100
SOP006	1	61	28	A2	20	Pit	2,58-3,39	4	0.1	0.2	100
SOP007	1	64	28	A3	20	Pit	3,08-3,47	5	0.0	0.2	100
SOP008	1	62	29	C 1,2; D 1,2	20	Pit	2,90-3,06	5	0.1	0.3	100
SOP009	1	63	29	C/D 1/2	20	Pit	2,90-3,06	4	0.0	0.3	100

Unique sample no.	GRAIN	*Hordeum vulgare hulled*	*Hordeum vulgare var. nud*	*Triticum dicoccum*	*Triticum monococcum*	*T. monococcum* 2-g	*Triticum mono/dicoc*	*Triticum spelta*	*Triticum* cf. *spelta*	*T. aestivum/durum*	*T. spelta/new glume whea*	*Triticum* spp.	*Secale cereale*	*Secale* cf. *cereale*	cf. *Secale* sp.	*Avena* sp.	Cerealia indet.	*Panicum miliaceum*	cf. *Panicum miliaceum*	*Setaria italica*
SLAV73					1															
SLAV74																				
SLAV75																				
SOP001																				
SOP002																				
SOP003																				
SOP004							2										2			
SOP005							1										1			
SOP006					1							1					2			
SOP007				1													1			
SOP008																	2			
SOP009												1					2			

Unique sample no.	CHAFF	*Hordeum vulgare* rachis	*T. dicoccum* g/b	*T. monococcum* g/b	*T. mono/dicoc/ 'new' g/b*	*Triticum spelta* g/b	cf. *Triticum spelta* g/b	"New glume wheat" g/b	cf. "New glume wheat" g/b	*Triticum* sp. g/b	T.aestivum/durum rachis	Cerealia rachis	PULSES	*Lathyrus sativus*	*Lens culinaris*	cf. *Lens culinaris*	*Pisum sativum*	*Pisum* cf. *sativum*	*Vicia ervilia*	Large legumes indet.	OIL PLANTS	*Linum usitatissimum*	*Linum* sp.	FRUITS	*Cornus mas*	*Physalis alkekengi*	*Prunus* sp.	*Rosa* sp.	*Rosa canina*	*Rubus fruticosus*	*Sambucus ebulus*	Indet Fruit
SLAV73										37																						
SLAV74																																
SLAV75										38															1							
SOP001		1																														
SOP002										1																						
SOP003																																
SOP004				1					2	9																						
SOP005															1																	
SOP006																																
SOP007				2																												
SOP008				1						2																						
SOP009										1																1						

Unique sample no.	WILD/WEED SPECIES	cf. *Astragalus cicer*	*Ajuga reptans*	Asteraceae	*Bromus* sp.	*Carex* sp.	*Cerastium* sp.	Chenopodiaceae	Chenopodiaceae - mineral	*Chenopodium album*	*Chenopodium* sp.	Compositae	*Coronilla varia*	Cyperaceae	*Echinochloa crus-galli*	*Galium aparine*	*Galium* sp.	Gramineae large	Gramineae small	*Hyoscyamus* sp.	*Lolium* sp.	*Medicago sativa*	*Papaver* sp.	*Phleum* sp.	*Phalaris/Phleum* sp.	*Polygonum* sp.	*Potentilla* sp.	*Rumex* sp.	*Rumex/Polygonum* sp.	*Setaria viridis*	cf. *Sherardia arvensis*	small seeded legumes	large seeded legume	*Solanaceae*	*Solanum* sp.	*Teucrium* sp.	*Trifolium* sp.	*Trigonella* sp.	*Urtica urens*	*Urtica dioica*	*Urtica* sp.	INDETERMINATE	Total identified items
SLAV73																													1														**39**
SLAV74												3						2											1												1		**7**
SLAV75																																										31	**39**
SOP001																																										2	**1**
SOP002																																										5	**1**
SOP003																																											**0**
SOP004																																										60	**16**
SOP005																																										6	**3**
SOP006																																											**4**
SOP007																																										10	**4**
SOP008																																										15	**5**
SOP009								1																																		10	**6**

Table 4.10. Number of species identified per sample: Copper Age Croatia

Unique sample no.	Trench/Block	Original sample no.	Stratigraphic unit (SJ)	Square	Sample vol. (l)	Feature type	Level (m)	Preservation scale	Charcoal density (cm^3)	Plant density per litre	Fraction (%)	GRAIN	Hordeum vulgare hulled	Hordeum vulgare var. nudum	Triticum dicoccum	Triticum monococcum	T. monococcum 2-g	Triticum mono/dicoc	Triticum spelta	Triticum cf. spelta	T. aestivum/durum	Triticum spp.	Secale cereale	Cerealia indet.	Panicum miliaceum	Setaria italica	CHAFF	T. dicoccum g/b	T. monococcum g/b	T. mono/dicoc 'new' g/b	Triticum spelta g/b	Triticum sp. g/b	T. aestivum/durum rachis	Cerealia rachis	Straw	PULSES	Lathyrus sativus	Lens culinaris	cf. Lens culinaris	Pisum sativum	Vicia ervilia	Large legumes indet.	OIL PLANTS	Linum usitatissimum	Linum cf. usitatissimum	Linum sp.	FRUITS	Cornus mas	Corylus sp.	Physalis alkekengi	Prunus cf. spinosa	Rubus fruticosus	Rubus sp.	Sambucus ebulus	Indet Fruit	WILD/WEED SPECIES	Ajuga reptans	Agrostemma githago	Asteraceae	Bromus sp.	Carex sp.	cf. Carpinus betulus	Chenopodiaceae/Caryophyllaceae	Chenopodium sp.	Chenopodium album	cf. Convolvulus arvensis	Cyperaceae	Festuca sp.	Galium aparine	Galium sp.	Gramineae large	Gramineae small	Hypericum sp.	Lolium sp.	Mentha sp.	Phalaris sp.	Phalaris/Phleum sp.	Phleum sp.	Plantago lanceolata	Plantago sp.	Poa sp.	Polygonum sp.	Polygonum aviculare	Potentilla sp.	Rumex sp.	Rumex/Polygonum sp.	Setaria viridis	Silene sp.	Salvia sp.	small seeded legumes	Solanaceae	Teucrium sp.	Teucrium chamaedrys	Trifolium sp.	Urtica sp.	Verbena officinalis	Viola sp.	INDETERMINATE	Total identified items
DAKF01		20	19		11	Pit		4	11	2.4	100					7						12		5	1																								1																																																		33	26
DAKF02		31	19		11	Pit		4	10	1.1	100					3								3								1																				1	1							1																										1					1							24	12
DAKF03		546	43	F51	2.5	Pit		N/A	-	0.0	100																																																																																							0
DAKF04		547	43	F51	11	Pit		5	11	0.7	100											2		3																																																								1									2											30	8
DAKF05		106	49	C44	11	Pit		5	6	0.1	100													1																																																																							11	1
DAKF06		19	160		11	Pit		5	7.2	0.5	100			2										2																								1																																																	10	5
DAKF07		108	160		11	Pit		4	6	0.5	100			1								1		1																		1																																																				1							7	5
DAKF08		146	160	A51	11	Pit		5	1.7	0.1	100													1																																																																								1	1
DAKF09		232	160	A,B,Z50, 51	5.5	Pit		5	7	1.8	100													4																1										1									2																							1						1											34	10
DAKF10		240	160	A,B,Z50, 51	11	Pit		5	-	1.7	100					4		1				3		3						2													1												1							3																							1																62	19
DAKF11		538	160	Y50/51	11	Pit		5	8	0.3	100													1																1																1																																												15	3
DAKF12		147	181	Z40	11	Pit		5	12	0.4	100			1										2																								1																																																	11	4
DAKF13		149	207	Z44	11	Pit		5	45	0.7	100											1		4																1											1																																					1												22	8
DAKF14		288	249	X49, 50	5.5	Pit		5	50	2.0	100					4		1						6																																																																								18	11
DAKF15		578	267	D54	5.5	Pit		4	0.5	0.7	100													1																										1																							1																1											5	4
DAKF16		271	293	A54,55	11	Pit		5	-	1.3	100					2					1			9																																														1				1																								47	14
DAKF17		94	357	C42, 43	11	Pit		N/A	1	0.0	100																																																																																							0
DAKF18		131	369	D43	11	Pit		5	44	0.7	100					3		1						2																														1																	1																											11	8
DAKF19		174	469	Y43	5.5	Pit		4	43	3.1	100					2								1																2										1													1			1								1															4	2				2									23	17
DAKF20		192	469	Y43	11	Pit		5	-	1.0	100					2								3						1																1							3		1																																																24	11
DAKF21		596	599	A66	35	Pot fill		N/A	-	0.0	100																																																																																							0
DAKF22		253	659	Z50, 51	11	Pit		5	-	1.0	100				1	1								4																					1																												3												1																23	11
DAKF23		257	659	Z50, 51	5.5	Pit		5	-	0.5	100											2		1																																																																									8	3
DAKF24		915	659	Y,Z51	11	Pit		3	-	2.7	100				2	5		1				1		9					2																															9																															1									25	30
DAKF25		308	662	V57	5.5	Pit		5	-	0.4	100													2																																																																						7	2
DAKF26		311	692	T54	11	Pit		5	-	0.8	100													8																					1																																																					10	9
DAKF27		291	705	U40	11	Pit		4	-	3.7	100					1		2						11					9									1	2		6		2							2										3		1																							1																60	41
DAKF28		553	900	F51	11	Pit		5	-	0.5	100				1									2																										1																1						1																											24	6
DAKF29		903	1038	Y,Z50	11	Pit		5	-	0.5	100					1								1																																				1											2																											9	5
JURS01		18	41		11	Pit		N/A	0.1	0.0	100																																																																																						0
JURS02		6	55		11	Pit		5	0	0.5	100													2							1	2																																																																		5
JURS03		26	105		11	Pit		5	0	0.3	100													3																																																																						5	3
JURS04		33	147		11	Pit		5	0.5	1.0	100				1									3				1																					5			1																																																35	11
JURS05		120	173		11	Pit		N/A	0	0.0	100																																																																																			0
JURS06		16	200		11	Pit		N/A	0.1	0.0	100																																																																																		4	0
JURS07		72	217		11	Pit		5	0	0.4	100													2								2																																																																		3	4
JURS08		139	259		11	Pit		5	0	0.0	100																																																																																		4	0
JURS09		69	263		11	Pit		N/A	0	0.0	100																																																																																			0
JURS10		116	289		11	Pit		5	0.2	0.6	100				4									3																																																																						1	7
JURS11		138	341		11	Pit		5	0	0.9	100													10																																																																						5	10
JURS12		61	401		11	Pit		5	0	0.5	100				1									5																																																																						4	6
PAJV01		50	6		11	Pit	1,38	4	0	0.2	100													1																																												1																											1	2
PAJV02		118	8	V27,26	11	Pit		5	0	0.3	100													3																																																																							7	3
PAJV03		18	14		11	Pit		5	0.1	0.5	100			2										3																																																																								8	5
PAJV04		1	24		11	Pit		N/A	0	0.0	100																																																																																			0
PAJV05		139	38	Q27	11	Ditch		N/A	0	0.0	100																																																																																			0
PAJV06		161	38		11	Ditch		5	0	0.1	100													1																																																																						5	1
PAJV07		134	40		11	Pit		3	0.5	0.3	100							1				2																																																																										3
PAJV08		28	56	O22	11	Pit		4	0	0.1	100													1																																																																							1
PAJV09		154	76		11	Pit		N/A	0	0.0	100																																																																																			0
PAJV10		152	80		11	Ditch		5	0	0.0	100																																																																																		13	0
PAJV11		208	88		11	Ditch		5	0.5	0.0	100																																																																																		3	0
PAJV12		66	90		11	Pit		5	0.2	0.2	100																																																							1	1																											12	2
PAJV13		74	111		11	Pit		5	0	0.1	100													1																																																																					8	1
PAJV14		92	117	M33, M34	11	Pit		N/A	0	0.0	100																																																																																			0
PAJV15		107	123		11	Pit		N/A	0	0.0	100																																																																																			0
PAJV16		84	132	V27	11	Pit	4,39	N/A	0	0.0	100																																																																																			0
PAJV17		85	133	V27	11	Pit	4,40	5	0	0.1	100													1																																																																					5	1
PAJV18		142	139		11	Pit		5	0	0.1	100													1																																																																							1
PAJV19		147	148	J28	11	Pit		5	0	0.1	100													1																																																																						1	1
PAJV20		163	148		11	Pit		4	0	0.1	100													1																																																																							1
PAJV21		155	156		11	Pit		N/A	0	0.0	100																																																																																			1	0
PAJV22		200	183		11	Pit		5	0	0.1	100													1																																																																					8	1
PAJV23		14			11	Pit		5	0.1	0.1	100			1																																																																																					9	1
POTOC1		6	5		55	Mass grave		5	-	1.3	100			1	7	1						2	1	51		1		3				1										1																													1																											377	70
SLAV01	1		23	D3	11	Pit		2	0.3	0.2	100																			1		1																																																																			2
SLAV02	1		23		11	Pit	2,39.28	4	0.3	5.5	100													2					6			52		1																																																															40	61
SLAV03	1	7	454	AB/13-15	11	Pit		4	1.6	2.4	100													8				4	2	8		3																																																					1																38	26
SLAV04	1	8	454	AB/13-15	11	Pit		4	1.6	3.0	100				1	2						1		8					1			18																			1											1																																									29	33
SLAV05	1	11	454		11	Pit		4	0.1	0.2	100																	1		1																																																																					1	2
SLAV06	1	21	454		11	Pit		N/A	2.5	0	50																																																																																					0
SLAV07	1	9	456	AB/10	11	Pit		5	2.3	1.6	100													9					4			5																																																																			68	18
SLAV08	1	10	456	AB/10	11	Pit		4	4.5	3.6	100				2	1						3		9					3	21																															1																																									44	40
SLAV09	1	13	458	X/10	11	Pit		5	0.3	3.9	100											1		1								40																		1																																																				40	43
SLAV10	1/2	18	594	A/11	11	Pit		4	2.3	1.1	50											1		4								6																																																						1															19	12
SLAV11	1/1	25	596	D/4	11	Pit		3	0.1	1.3	100																					12																					2																																																		19	14
SLAV12	1		696	H/22	11	Pit		4	0.6	1.9	100				1							1		4								14																																	1																																					19	21
SLAV13	1		696	H22	11	Pit		2	0.1	3.8	100																		12			27			2																																																																				1	27	42
SLAV14	1/10	30	700	BC/20	11	Pit	2,69	5	0.1	0.1	100													1																																																																						7	1
SLAV15	1/10	34	700	BC/20,21	11	Pit		4	0.9	4.9	100											1		9				2		12	1	26																			1																																									2											46	54
SLAV16	1/10	38	700	AB/20,21	11	Pit		5	0.8	1.3	100																					13																														1																																									18	14
SLAV17	2	148	163	E,D/5	11	Pit		5	0.0	0	100																																																																																					1	0
SLAV18	2	177	163	D/4	11	Pit	2,40.11-2,39.91	N/A	0.2	0	100																																																																																					0
SLAV19	2		172	C/5	11	Pit		5	0.6	3.4	100													4					1			31																												1																																										25	37
SLAV20	2		172	C5	11	Pit		2	0.6	1.8	100					1								1								15														1			1																								1																											6	20
SLAV21	2		710	CB/5,6	11	Pit		5	1.7	0.8	100							2						6								1																																																																					1	9
SLAV22	2		710	CB/5,6	11	Pit		3	2.1	1.5	100				1	1						1		5				3				5																																																																							29	16
TOMP02		36	231		11	Pit		N/A	0.0	0.0	100																																																																																				0
TOMP03		84	231	N295,296	11	Pit		5	0.0	2.0	100				1							3		14																									1	2																							1																											10	22
TOMP04		58	252	B,C398	22	Pit - lots of bone		4	0.0	0.5	100				1		1					2		5																																1																		1																												13	11
TOMP05		65	310		11	Pit		3	0.0	1.8	100													5																									1		1				1	8															4																														10	20
TOMP06		72	310	T,U291	11	Pit		5	0.0	0.8	100													3																														1																2		3																											20	9
TOMP07		125	480	W299	11	Pit		5	0.0	0.1	100													1																																																																						1
TOMP08		140	480		11	Pit		5	0.0	0.4	100							1						3																																																																						3	4
TOMP09		105	482	X299	11	Pit		5	0.0	0.5	100					1								5																																																																					5	6
TOMP10		117	482		11	Pit		N/A	0.0	0.0	100																																																																																			0
TOMP11		332	803		11	Pit		5	0.1	0.0	100																																																																																			0
TOMP12		360	815		11	Pit		N/A	0.2	0.0	100																																																																																			0
TOMP13		574	928		11	Pit		N/A	0.0	0.0	100																																																																																		0
TOMP14		552	930		11	Pit		4	0.1	0.2	100													1																										1																																																			2
TOMP15		480	1198		11	Pit		5	0.1	0.3	100													2								1																																																																				2	3
TOMP16		511	1198		11	Pit		N/A	0.1	0.0	100																																																																																		0
TOMP17		583	1198		11	Pit		N/A	0.0	0.0	100																																																																																		0
TOMP18		428	1310		11	Pit		5	0.0	0.2	100													2																																																																						2	2
TOMP19		538	1481		11	Pit		5	0.2	6.1	100													8				2				56		1																																																																		50	67
TOMP20		581	1483		11	Pit		5	0.0	0.1	100																					1																																																																					2	1
TOMP21		689	1639		11	Pit		N/A	0.0	0.0	100																																																																																		0
TOMP22		713	1641		11	Pit		5	0.2	1.0	100			1										5				2	1			2																																																																				25	11
TOMP23		718	1746		11	Pit		5	0.0	0.0	100																																																																																			2	0
TOMP24		746	1801		11	Pit		5	0.4	0.3	100													2								1																																																																			9	3
TOMP25		558	1874		11	Pit		5	0.5	0.2	100													1																																					1																																									4	2
TOMP26		760	1883		11	Pit		5	0.1	1.1	100										2			10																																																																												5	12
TOMP27		768	1917		11	Pit		5	0.1	1.1	100											3		5								2																		1												1																																										17	12
VBAT01	I	1	13		11	Pit		5	-	0.0	100																																																																																					6	0
VBAT02	VII	37	108		11	Pit		4	-	0.9	100											1							1			8																																																																						7	10
VBAT03	IV	38	121		11	Pit		5	-	0.4	100													2				2																																																																										19	4
VINM01	1		47/48		53	Pit	1.99	3	1.9	7.0	100		1	2	2	14		3	1			4		8								3													14															1	1	228					45					2		29	1							8					1		1						1							2	340	372
VINM02	1		47/48		85	Pit	1.93	3	1.1	8.4	100			5	19	11		1	5			22	1	34																					3				2		5				3				1		27				108	437							12	2	1	1				2					1								5		2				1		700	711
VINM03	1		47/48		48	Pit	2.96-3.28	4	3	11.3	100		2	4	85	23		27	8		11	20		56																					27						3											115	1				7		1					149																				5									850	544
VINM04	1		49/50		30	Pit	1.93	4	1.5	3.5	100		2	1	19	5		1	2		5	5		14	2																		1		3																	11					24							10																				1									320	106
VUCE01		146	11	97	11	Layer		3	1.4	0.8	100		1		1	4																																																								2																1											4	9
VUCE02		148	11	98	11	Layer		3	0.9	1.3	100					2						1		5																					1										1						1	1										1																				1							7	14
VUCE03		174	11		11	Layer		4	1	0.5	100				1	2						2		1																																																																													18	6
VUCE04		175	11		11	Layer		5	0.4	0.6	100		1									1		5																																																																											28	7
VUCE05		157	14	99	11	Pit		5	0.9	0.0	100																																																																																			5	0
VUCE06		107	47		11	House		4	0.2	0.0	100																																																																																			2	0
VUCE07		139	50	95	11	House		5	0.1	0.1	100																																																																								1										6	1
VUCE08		103	54		11	House		3	0.6	3.5	100					11								27																																																																			1								39
VUCE09		109	54		11	House		5	3.2	13.6	100				2	6			1			25		114																																														2																									395	150
VUCE10		130	54	69	11	House		4	14	29.3	100				4	50		5				60		197																					2																										1			1					1		1																					1100	322
VUCE11		132	54	70	11	House		4	0.5	1.5	100							1				1		2					2												1														1						3																				1								3							1					27	16
VUCE12		133	54		11	House		4	2.3	0.3	100					1																											1																			1																																										8	3
VUCE13		112	54a		11	House		5	0.2	0.5	100				1	2	1							2																																																																												5	6
VUCE14		115	54a		11	House		5	1	1.5	100			1		1						2		9																										1				1																																										1							22	16
VUCE15		116	54a		11	House		4	0.3	0.4	100															1																			1																											1											1																4	4
VUCE16		118	54a	79	11	House		4	0.1	0.5	100													1		2																																																												2												1							7	6
VUCE17		134	54a	80	11	House		3	0.1	0.6	100					2								4																																														1																															7
VUCE18		142	54a	70	11	House		3	0.8	1.8	100					5				1		2		3					2	2																															2				1								1	1																												17	20
VUCE19		143	54a	89,90	11	House		5	0.1	0.1	100													1																																																																											6	1
VUCE20		141	56a	72	11	House		N/A	0	0	100																																																																																					0
VUCE21		104	56		11	House		2	0.5	39.5	100		3	2	4	91		24				37		263						4																													1														2	1					2						1																1	435
VUCE22		108	56		11	House		5	0.5	1.5	100					7		2				1		4					2																															1																																									37	17
VUCE23		114	56		11	House		5	1	1.6	100					5		4						5																																																									1				1										1	1				62	18
VUCE24		121	56	62	11	House		4	0.1	0.5	100					1						2																																																	2											1																12	6
VUCE25		126	56	81-83	11	House		5	0.5	0.9	100					2								4																																									1																									2						1				15	10
VUCE26		127	56	51-53	11	House		5	1.4	0.5	100											1		2									1																								1		1																																											10	6
VUCE27		129	56	72	11	House		3	0.5	0.6	100					3					1			2																1																																																													10	7
VUCE28		135	56	81	11	House		4	0.1	0.1	100																													1																																																												2	1
VUCE29		185	57	67,68	11	House		3	0.4	1.3	100					3						2		3																																	1																			1		1						2						1									14	14
VUCE30		159	83	62,64	11	Burnt wall frags of SJ 57		2	2.4	20.1	100				7	85		48				37		32					1																													4		4																															2		1						210	221
VUCE31		160	83	62,63	11	Burnt wall frags of SJ 57		3	0.3	7.1	100					28		9						41																																																																													78
VUCE32		161	83	72	11	Burnt wall frags of SJ 57		3	0.5	6.5	100					19		12						37					2																													1														1																												72
VUCE33		162	88	99	11	Layer (connected to SJ 11)		4	0	0.3	100											1		1																1																																																														3
VUCE34		167	88	99	11	Layer (connected to SJ 11)		3	0.3	3.0	100					6						1								1															1																14						1						2		1		1		1														3	1						32	33
VUCE35		177	95		11	Layer below SJ 11		5	0.5	2.1	100				2							2		5		1																			1															3											3							1				1			1	2						1						100	23
Total identified items													10	24	171	431	2	147	17	1	20	273	2	###	3	5		20	51	53	2	349	1	2	2		1	2	0	15	0	7		56	1	0		17	2	21	1	4	1	10	10		1	12	1	431	5	1	1	109	516	1	1	1	9	7	227	7	3	3	1	4	1	14	1	1	2	11	2	3	1	6	13	4	1	17	1	8	5	3	1	1	3	6,137	4,385

Table 4.13. Number of species identified per sample: Bronze Age Croatia

Unique sample no.	Trench/Block	Original sample no.	Stratigraphic unit (SJ)	Square	Sample vol. (l)	Feature type	Level (m)	Preservation scale	Charcoal density (cm^3)	Plant density per litre	Fraction (%)	GRAIN	*Hordeum vulgare* var. *nudum*	*Triticum dicoccum*	*Triticum mono/dicoc*	*T. aestivum/durum*	*Triticum* spp.	*Avena sativa*	Cerealia indet.	*Panicum miliaceum*	*Setaria italica*	CHAFF	*Triticum* sp. g/b	*Avena sativa* floret base	Straw	PULSES	*Lens culinaris*	FRUITS	*Cornus mas*	*Prunus spinosa*	*Vitis vinifera*	WILD/WEED SPECIES	*Bromus* sp.	*Carex* sp.	Chenopodiaceae	Cyperaceae	*Digitaria sanguinalis*	Gramineae large	Gramineae small	Lamiaceae	*Papaver* sp.	*Phleum* sp.	*Plantago* sp.	*Polygonum* sp.	*Prunella vulgaris*	*Scirpus* sp.	*Setaria* sp.	small seeded legumes	INDETERMINATE	Total identified items
MACC01	1	9	2	G5	11	General occupation layer		5	0.7	0.5	100							1		1	1																					1		1					33	**5**
MACC02		47	2	P/10	11	General occupation layer		5	4.3	0.2	100								1																1														3	**2**
MACC03			3	L/20	11	General occupation layer		3	0.5	0.4	100								1	1										1				1															1	**4**
MACC04	1	33	3	S/4	11	General occupation layer		N/A	0	0	100																																							**0**
MACC05	1		7	A/12	11	General occupation layer		4	0.8	0.2	100						1													1																			2	**2**
MACC06			24	O/10	11	General occupation layer		N/A	0.4	0	100																																							**0**
MACC07		48	24	O/9	11	General occupation layer		3	0.5	0.2	100																												2											**2**
MACC08	1	16	32	H/8	11	General occupation layer		N/A	1.0	0	100																																							**0**
MACC09	1	12	37	K/8	11	General occupation layer		2	0.6	16	100							162	1					5									2				1	2		1			1	1	1					**177**
MACC10	1	19	43	M/2-3	11	General occupation layer		5	0.8	0.3	100										3																												10	**3**
MACC11	1	14	45	M/7	11	General occupation layer		2	0.6	0.4	100							3																				1											2	**4**
MACC12	1		46	S/1	11	General occupation layer		N/A	0	0	100																																							**0**
MACC13	1	18	57	J/14-5	11	General occupation layer		1	0.6	17	100			1				176	1					8												1		1										1	150	**189**
MACC14	1	20	67	Y/7	11	General occupation layer		N/A	0	0	100																																							**0**
MACC15	1	21	67	Y/7	11	General occupation layer		N/A	0	0	100																																							**0**
MACC16	1	25	71	R/7-8	11	Pit		4	1.9	0.3	100																							1					1					1						**3**
MACC17	1	24	71	S/7-8	11	Pit		N/A	4.4	0	100																																							**0**
MACC18			71		44	Pit		4	3.7	0.4	100									5							1											3			1			1		1	1	3	21	**16**
MACC19	1	26	75	R/4	11	General occupation layer		N/A	0	0	100																																							**0**
MACC20		51	85	M/20	11	General occupation layer		4	0.3	0.2	100									1			1																											**2**
MACC21		52	85	N/19	11	General occupation layer		5	0.1	0.2	100							1		1																													3	**2**
MACC22		39	99	M/10	11	General occupation layer		4	1.0	0.2	100								1	1																													1	**2**
MACC23		54	102	J/18	11	General occupation layer		N/A	0.2	0	100																																							**0**
MACC24		50	103	O/13	11	General occupation layer		N/A	0	0	100																																							**0**
MACC25			105	P/10	11	General occupation layer		N/A	0.3	0	100																																							**0**
CRIOS1	1	18	51	L/9d	11	General occupation layer		4	0.1	0.1	100								1																															**1**
CRIOS2	1	19	53	M/106	11	General occupation layer		4	0.1	0.3	100									1																	1							1						**3**
CRIOS3	1	30	55	M/106	11	General occupation layer		4	0.5	1.5	100									15																		1											4	**16**
ORUVE1		38	25/26		11	Pit		4	0.1	0.3	100																		1					2																**3**
ORUVE2		39	27/28	A/1	11	Pit		4	0.1	0.1	100									1																													5	**1**
TOMP28		11/1	70		11	Pit		4	-	0.1	100																				1																			**1**
TOMP29		11/2	70		11	Pit		N/A	-	0	100																																							**0**
TOMP30		8	70		11	Pit		5	-	0	100																																							**0**
TOMP31		20	70		11	Pit		2	-	0.3	100								3																														8	**3**
TOMP32		6	75		11	Pit		5	-	0.1	100								1																															**1**
TOMP33		10	124		11	Pit		5	-	0	100																																							**0**
TOMP34		88	223	O,P296-97	11	Pit		5	-	0.2	100																		2																					**2**
TOMP35		112	223	O,P292	11	Pit		N/A	-	0	100																																							**0**
TOMP36		116	223	O,P297	11	Pit		5	-	0	100																																						2	**0**
TOMP37		56	229	C395-96, D396	11	Pit		5	-	0.2	100								2																														14	**2**
TOMP38		43	229		11	Pit		N/A	-	0	100																																							**0**
TOMP39		481	229		11	Pit		4	-	0.7	100		3			1			3																							1							9	**8**
TOMP40		73	236	X,Y293	11	Pit		5	-	0	100																																						4	**0**
TOMP41		89	236	Y,Z293	11	Pit		N/A	-	0	100																																							**0**
TOMP42		66	236	Y,Z293	11	Pit		5	-	0.5	100								5																1														28	**6**
TOMP43		108	236	Y,Z293	11	Pit		N/A	-	0	100																																							**0**
TOMP44		126	236	Y,Z293	11	Pit		5	-	0.2	100								2																														2	**2**
TOMP45		138	236		11	Pit		N/A	-	0	100																																							**0**
TOMP46		143	236		11	Pit		N/A	-	0	100																																							**0**
TOMP47		146	236		11	Pit		5	-	0	100																																						1	**0**
TOMP48		69	268	W292	11	Pit		5	-	0.2	100								2																															**2**
TOMP49		78	268	W292	11	Pit		5	-	0.2	100								2																														4	**2**
TOMP50		81	268	W292	11	Pit		5	-	0.1	100								1																														4	**1**
TOMP51		112	484	U298	11	Pit		4	-	0.2	100				1										1																									**2**
TOMP52		148	537		11	Pit		5	-	0.4	100								4																														15	**4**
TOMP53		470	1057		11	Pit		N/A	0	0	100																																							**0**
TOMP54		471	1057		11	Pit		N/A	0	0	100																																							**0**
TOMP55		774	1463		11	Pit		N/A	0	0	100																																							**0**
Total identified items													**3**	**1**	**1**	**1**	**1**	**343**	**31**	**27**	**4**		**1**	**13**	**1**		**1**		**3**	**2**	**1**		**2**	**4**	**2**	**1**	**2**	**8**	**3**	**1**	**1**	**2**	**1**	**5**	**1**	**1**	**1**	**4**	**326**	**473**

Table 6.5. Results of crop processing (ratio and correspondence analysis) per sample with > 50 identifications: Late Bronze Age Feudvar

	Unique sample no.	FEU116	FEU123	FEU125	FEU131	FEU14	FEU141	FEU142	FEU144	FEU149	FEU157	FEU158	FEU191	FEU194	FEU199	FEU204	FEU205	FEU206	FEU207	FEU209	FEU212	FEU218	FEU220	FEU221	FEU234	FEU238	FEU240	FEU241	FEU242	FEU246	FEU247	FEU252	FEU254	FEU263	FEU268	FEU269	FEU273	FEU274	FEU289
	Feature type	Pit	House	House	House	General deposit	Street	Street	Street	Hearth	House	Miscellaneous	Pit	Street	House	House	House	General deposit	House	House	Pit	House	House	General deposit	Pit	Miscellaneous	General deposit	Pit	Miscellaneous	Pit	Street	Yard	House	Pit	Yard	General deposit	Yard	Yard	Yard
Ratio 2	*Triticum monococcum* g/b		48	48	12	8	186	42	52	12	11	118	32	14	64	232	53	2,572	4,234	14	58	58	92	52	48	11	26	1	26	14	16	18	12	16	2	42		2	12
	Triticum monococcum	37	141	141	26	26	440	608	124	268	110	264	147	27	240	565	846	7,260	8,256	1,918	216	190	779	155	78	29	65	52	72	22	51	106	35	48	39	70	39	35	97
	GlumMono/GrainMono	**0**	**0.3**	**0.3**	**0.5**	**0.3**	**0.4**	**0.1**	**0.4**	**0.04**	**0.1**	**0.4**	**0.2**	**0.5**	**0.3**	**0.4**	**0.1**	**0.4**	**0.5**	**0.01**	**0.3**	**0.3**	**0.1**	**0.3**	**0.6**	**0.4**	**0.4**	**0.02**	**0.4**	**0.6**	**0.3**	**0.2**	**0.3**	**0.3**	**0.1**	**0.6**	**0**	**0.1**	**0.1**
	Interpretation	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
	T. monococcum 2 grain																																						
	GlumMono2/GrainMono2																																						
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b			19	2	2					2				4	4		12					8		4	4	44	4	34	2	3	4	4		1		4		8
	Triticum dicoccum		2	2	2		1	2		4	8	6	7		4	9	33	16	51		8		6	5	17	7	9	10	5	1	4	4	3	19	5	4	1	20	1
	GlumDicoc/GrainDicoc		**-**	**-**	**-**	**-**	**-**	**-**		**-**	**-**	**-**	**-**		**-**	**-**	**0**	**0.8**	**0**		**-**		**-**	**-**	**-**	**-**	**5**	**-**	**6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	SP	P	-	-	-	-	-	-	-	FS	-	FS	-	-	-	-	-	-	-	-	-	-
Ratio 3	*Hordeum vulgare* rachis						1				4						4		2		1				1														1
	Hordeum vulgare vulgare	2	95		12	11	98	87	15	87	39		26	7	27	46	39	12	398		4	1	1	1	23	6	19	15		5	9	22	8		7	14	4	5	15
	RachisHord/GrainHord	**-**	**0**		**-**	**-**	**0**	**0**	**-**	**0**	**0.1**		**0**	**-**	**0**	**0**	**0.1**	**-**	**0**		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**		**-**	**-**	**-**	**-**		**-**	**-**	**-**	**-**	**-**
	Interpretation	-	P	-	-	-	P	P	-	P	P	-	P	-	P	P	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum spelta* g/b																	4									2												
	Triticum spelta																	3								2	1											2	
	GlumSpelt/GrainSpelt																	**-**								**-**	**-**											**-**	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis																																						
	T. aestivum/durum												1					1							1	2	2												
	RachisAest/GrainAest												**-**					**-**							**-**	**-**	**-**												
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	2	4	4	1			2			2					5	2	2	1	1	2	4	2	1	3	1	3	2		1		5			1		4		
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*	13				3					7								1		4				2			1	10	6						1		2	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 4	Weeds	8	76	75	36	9	173	41	17	110	50	3	22	14	68	103	207	118	352	84	59	111	58	17	49	41	57	37	61	24	19	38	13	31	21	23	21	15	33
	Grains	54	242	147	41	40	539	699	139	359	166	270	181	34	271	625	920	7,294	8,707	1,919	234	195	788	162	124	47	100	80	87	36	64	136	47	67	53	89	49	64	113
	Weed/Grain	**0.1**	**0.3**	**0.5**	**0.9**	**0.2**	**0.3**	**0.1**	**0.1**	**0.3**	**0.3**	**0**	**0.1**	**0.4**	**0.3**	**0.2**	**0.2**	**0**	**0**	**0**	**0.3**	**0.6**	**0.1**	**0.1**	**0.4**	**0.9**	**0.6**	**0.5**	**0.7**	**0.7**	**0.3**	**0.3**	**0.3**	**0.5**	**0.4**	**0.3**	**0.4**	**0.2**	**0.3**
	Interpretation	P	P	P	E	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	E	P	P	P	P	P	P	P	P	P	P	P	P	P
Ratio 5	1) SML A																																						
	1) IBT A LRG + LRG A																																						
	1) SML/LRG WEED A																																						
	Interpretation A1																																						
Ratio 5	2) IBT A SML + SML A																																						
	2) LRG A																																						
	2) SML/LRG WEED A																																						
	Interpretation A2																																						
Ratio 5	3) SML B	4	37	36	24	4	24	26	7	47	35	1	16	3	25	59	136	20	270	73	46	23	45	4	42	28	39	21	38	16	7	28	6	20	8	20	14	9	27
	3) IBT B LRG + LRG B	4	39	39	12	5	149	15	10	63	15	2	6	11	43	44	71	98	82	11	13	88	13	13	7	13	18	16	23	8	12	10	7	11	13	3	7	6	6
	3) SML/LRG WEED B	**-**	**0.9**	**0.9**	2	**-**	**0.2**	**2**	**-**	**0.7**	**2**	**-**	**-**	-	**0.6**	**1.3**	**2**	**0.2**	**3**	**7**	**4**	**0.3**	**3**	**-**	**6**	**2**	**2**	**1.3**	**2**	-	**-**	**3**	-	**2**	-	**-**	-	-	**5**
	Interpretation B3	-	E	E	FS	-	HP	FS	-	HP	FS	-	-	-	HP	FS	FS	P	FS	FS	FS	HP	FS	-	FS	FS	FS	FS	FS	-	-	FS	-	FS	-	-	-	-	FS
Ratio 5	4) IBT B SML + SML B	4	39	38	25	4	24	26	7	47	35	1	16	3	25	59	141	20	270	73	46	23	45	4	42	28	39	21	38	16	7	29	6	21	8	20	14	10	27
	4) LRG B	4	37	37	11	5	149	15	10	63	15	2	6	11	43	44	66	98	82	11	13	88	13	13	7	13	18	16	23	8	12	9	7	10	13	3	7	5	6
	4) SML/LRG WEED B	**-**	**1.1**	**1**	2	**-**	**0.2**	**2**	**-**	**0.7**	**2**	**-**	**-**	-	**0.6**	**1.3**	**2**	**0.2**	**3**	**7**	**4**	**0.3**	**3**	**-**	**6**	**2**	**2**	**1.3**	**2**	-	**-**	**3**	-	**2**	-	**-**	-	-	**5**
	Interpretation B4	-	E	E	FS	-	HP	FS	-	HP	FS	-	-	-	HP	HP	FS	P	FS	FS	FS	HP	FS	-	FS	FS	FS	FS	FS	-	-	FS	-	FS	-	-	-	-	FS
	Total id's	62	366	289	91	59	899	782	208	481	233	391	235	62	407	964	1,184	10,000	13,295	2,017	352	364	946	231	226	103	229	122	208	76	102	196	76	114	77	154	74	81	167
Ratio 6	Density	6	37	29	9	6	90	78	21	48	23	39	24	6	41	96	118	1,000	1,330	202	35	36	95	23	23	10	23	12	21	8	10	20	8	11	8	15	7	8	17
Interpretation code - Ratio results		**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**
Interpretation code - After CA		**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**
Weed categories (After Jones 1984)																																							
SFL	Winnowing																1		1																				
BHH	Coarse sieving by-product		2	2			3	1								2	6					1		3			1								1			2	
SHH	Coarse sieving by-product		1	1	1					3							1				1				1														
SHL	Coarse sieving by-product																																						
SFH	Fine sieving by-product	4	38	37	24	4	24	26	7	46	35	1	16	3	25	59	137	20	269	73	45	23	45	4	41	28	39	21	38	16	7	29	6	21	8	20	14	9	28
BFH	Fine sieving by-product	4	30	30	11	5	146	13	10	44	15	2	5	11	43	42	58	62	61	11	11	85	13	10	7	13	14	13	21	6	9	9	7	10	10	2	7	3	5
IBT			5	5				1		17			1				4	36	21		2	2					3	3	2	2	3				2	1		1	

KEY

E	Equal numbers of items	PU (B)	Unsieved barley product
FS	Fine sieving	PU (B,R)	Unsieved barley and rye product
HP	Hand picked	PU (P)?	Possible unsieved millet product
SP	Spikelets	PU (E)?	Possible unsieved einkorn product
P	Products	SFS (E)	Sieved einkorn fine sieving by-product
PS (E)	Sieved einkorn product	SFS (E, Em)	Sieved einkorn and emmer fine sieving by-product
PS (B)	sieved barley product	SFS (Em)	Sieved emmer fine sieving by-product
PS (B, M)	sieved barley and millet product	SP (E)?	Possible einkorn spikelets
PS (E, B)	sieved barley and einkorn product	SSP (E)	Sieved einkorn spikelets
PS (Em)	Sieved emmer product	SSP (E)?	Sieved einkorn spikelets with possible under represented glume bases
PS (M)	Sieved millet product	UFS (E)	Unsieved einkorn fine sieving by-product
PS (M)?	Possible sieved millet product	USP (E)	Unsieved einkorn spikelets
PS (R)	Sieved rye product	USP (E)?	Unsieved einkorn spikelets with possible under represented glume bases
PS (E)?	Possible sieved einkorn product		
PU (E)	Unsieved einkorn product		

Table 6.5. Results of crop processing

	Unique sample no.	FEU328	FEU330	FEU333	FEU336	FEU337	FEU338	FEU339	FEU340	FEU341	FEU343	FEU354	FEU356	FEU357	FEU363	FEU364	FEU371	FEU372	FEU375	FEU377	FEU379	FEU381	FEU383	FEU384	FEU386	FEU389	FEU398	FEU419	FEU42	FEU424	FEU426	FEU445	FEU448	FEU449	FEU450	FEU451	FEU453	FEU454	FEU455	FEU463
	Feature type	House	General deposit	General deposit	General deposit	House	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	Street	General deposit	General deposit	Miscellaneous	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit
	Triticum monococcum g/b	18	58	148	13	54	44	4	46	134	49	16	9	4	12	74	14	5	14	29	42	12	18	12	11	2	17	4	592	22	84	1	3	2	22	56	8	16	12	12
Ratio 2	*Triticum monococcum*	3,524	195	444	91	148	218	101	94	285	288	42	64	45	68	176	72	219	99	80	119	26	53	45	100	161	90	22	1,377	58	172	47	58	28	84	92	71	40	29	284
	GlumMono/GrainMono	0.01	0.3	0.3	0.1	0.4	0.2	0.04	0.5	0.5	0.2	0.4	0.1	0.1	0.2	0.4	0.2	0.02	0.1	0.4	0.4	0.5	0.3	0.3	0.1	0.01	0.2	0.2	0.4	0.4	0.5	0.02	0.1	0.1	0.3	0.6	0.1	0.4	0.4	0.04
	Interpretation	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
	T. monococcum 2 grain																																							
	GlumMono2/GrainMono2																																							
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Triticum dicoccum g/b		34	6	8	1			26		14	2	4	2		1	32		2	3	6		2	4	22		52	2	2			2	2	2		1				2
Ratio 2	*Triticum dicoccum*		1		6	2	6	14	3	5	2	12	2	1		4	7	1	4	8	9	1	1	8	7	1	18	1	4	2	6	1			2	10				3
	GlumDicoc/GrainDicoc		33	-	-	-	-	-	8	-	-	-	-	-		-	5	-	-	-	-	-	-	-	3	-	3	-	-	-	-	-	-	-	-	-				-
	Interpretation	-	FS	-	-	-	-	-	FS	-	-	-	-	-	-	-	FS	-	-	-	-	-	-	-	FS	-	FS	-	-	-	-	-	-	-	-	-	-	-	-	-
	Hordeum vulgare rachis				1						1	2																								1	3			
Ratio 3	*Hordeum vulgare vulgare*		1	8	18	48	7	3	10	13	7	20	14	5	16	35	11	16	1	23	24	6	1	18	31	1	36	6	2	15	43	16	24	12	14	21	19	10	11	21
	RachisHord/GrainHord		-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	0	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-
	Interpretation	-	-	-	-	P	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	P	-	P	-	-	-	P	-	-	-	-	-	-	-	-	-
	Triticum spelta g/b																																			2				
Ratio 2	*Triticum spelta*																																							
	GlumSpelt/GrainSpelt																																			-				
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	T.aestivum/durum rachis																										4									2				
Ratio 3	*T. aestivum/durum*				1							2					1			4			1																	
	RachisAest/GrainAest				-							-					-			-			-				-									-				
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	1	4	6		1		3		1	2	2	1	2		4	1	4	1	7	1	1	9	2	1	9	1		1	5		5		2	11	2	16	1	1	4
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*				29	5						4										1					46					2			1	33				
	Interpretation	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-
	Weeds	7	171	101	43	75	63	63	45	117	71	66	50	24	26	30	42	99	27	96	32	32	48	64	21	19	89	20	161	34	48	23	20	8	32	50	37	30	10	43
Ratio 4	Grains	3,525	201	458	145	205	231	120	108	304	299	81	82	53	84	219	92	240	105	122	153	35	65	73	139	172	191	29	1,384	81	220	70	82	42	112	158	106	51	41	312
	Weed/Grain	0	0.9	0.2	0.3	0.4	0.3	0.5	0.4	0.4	0.2	0.8	0.6	0.5	0.3	0.1	0.5	0.4	0.3	0.8	0.2	0.9	0.7	0.9	0.2	0.1	0.5	0.7	0.1	0.4	0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.6	0.2	0.1
	Interpretation	P	E	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	E	P	E	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
	1) SML A																										53													
Ratio 5	1) IBT A LRG + LRG A																										36													
	1) SML/LRG WEED A																										1.5													
	Interpretation A1																										FS													
	2) IBT A SML + SML A																										55													
Ratio 5	2) LRG A																										34													
	2) SML/LRG WEED A																										1.6													
	Interpretation A2																										FS													
	3) SML B	0	16	23	19	55	23	25	24	102	55	39	18	8	18	8	16	49	20	47	12	18	39	54	10	5	52	5	150	15	39	9	9	7	8	14	12	9	2	6
Ratio 5	3) IBT B LRG + LRG B	7	155	78	24	20	40	38	21	15	16	27	32	16	8	22	26	50	7	49	20	14	9	10	11	14	37	15	11	19	9	14	11	1	24	36	25	21	8	37
	3) SML/LRG WEED B	-	0.1	0.3	0.8	3	0.6	0.7	1.1	7	3	1.4	0.6	-	2	0.4	0.6	1	3	1	0.6	1.3	4	5	-	-	1.4	-	14	0.8	4	-	-	-	0.3	0.4	0.5	0.4	-	0.2
	Interpretation B3	-	HP	HP	E	FS	HP	HP	E	FS	FS	FS	HP	-	FS	HP	HP	E	FS	E	HP	FS	FS	FS	-	-	FS	-	FS	E	FS	-	-	-	HP	HP	HP	SP	-	HP
	4) IBT B SML + SML B	0	17	23	20	56	24	25	24	102	55	39	18	8	18	8	17	49	20	48	13	18	39	54	10	5	54	6	150	15	40	9	9	7	9	14	12	9	2	6
Ratio 5	4) LRG B	7	154	78	23	19	39	38	21	15	16	27	32	16	8	22	25	50	7	48	19	14	9	10	11	14	35	14	11	19	8	14	11	1	23	36	25	21	8	37
	4) SML/LRG WEED B	-	0.1	0.3	0.9	3	0.6	0.7	1.1	7	3	1.4	0.6	-	2	0.4	0.7	1	3	1	0.7	1.3	4	5	-	-	1.5	-	14	0.8	5	-	-	-	0.4	0.4	0.5	0.4	-	0.2
	Interpretation B4	-	HP	HP	E	FS	HP	HP	E	FS	FS	FS	HP	-	FS	HP	HP	E	FS	E	HP	FS	FS	FS	-	-	FS	-	FS	E	FS	-	-	-	HP	HP	HP	SP	-	HP
	Total id's	3,550	464	713	210	335	338	187	225	555	434	167	145	83	122	324	180	344	148	250	233	79	133	153	193	193	353	55	2,139	137	352	96	107	54	166	270	154	97	63	369
Ratio 6	Density	355	46	71	21	34	34	19	23	56	43	17	15	8	12	32	18	34	15	25	23	8	13	15	19	19	35	6	214	14	35	10	11	5	17	27	15	10	6	37
Interpretation code - Ratio results		PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)
Interpretation code - After CA		PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)	PS (E)
Weed categories (After Jones 1984)																																								
SFL	Winnowing							1																																
BHH	Coarse sieving by-product	1	3	3	1		1		1			1	1	1	2	1		4		2	2		1	2			2			1	1		1		2	1	4	3	1	
SHH	Coarse sieving by-product		1			1	1					1								2							1			1										
SHL	Coarse sieving by-product				2		1																																	
SFH	Fine sieving by-product		18	24	17	55	21	24	24	102	55	38	19	8	18	8	17	49	20	46	13	18	39	54	10	5	52	6	150	14	40	9	9	7	9	14	12	9	2	6
BFH	Fine sieving by-product	6	147	74	22	19	38	37	19	15	16	25	30	15	6	20	24	46	6	43	15	12	7	7	11	12	32	13	11	17	5	14	9	1	21	34	21	15	6	37
IBT			2		1		1	1	1			1				1	1		1	3	2	2	1	1		2	2	1		1	2		1			1		3	1	

Table 6.5. Results of crop processing

	Unique sample no.	FEU466	FEU471	FEU472	FEU475	FEU476	FEU486	FEU488	FEU490	FEU491	FEU494	FEU495	FEU496	FEU499	FEU500	FEU507	FEU516	FEU517	FEU60	FEU61	FEU7	FEU82	FEU87	FEU93	FEU325	FEU443	FEU27	FEU1	FEU2	FEU47	FEU59	FEU91	FEU68	FEU156	FEU193	FEU518	FEU67	FEU69	FEU175	FEU18
	Feature type	General deposit	General deposit	General deposit	Street	General deposit	General deposit	General deposit	General deposit	General deposit	Pit	Pit	Pit	General deposit	Pit	General deposit	General deposit	General deposit	General deposit	General deposit	Miscellaneous	Street	Pit	House	House	General deposit	General deposit	Hearth	Hearth	General deposit	General deposit	Hearth	House	House	Pit	General deposit	House	House	House	Pit
Ratio 2	*Triticum monococcum* g/b	8	28	62	22	8	21	84	36	44	58	12	58	2	142	12	28	4	4	2	154	2	7	12	22	18	14		6	4	3	1	36	44	12	16	18		94	2
	Triticum monococcum	77	81	224	34	58	384	136	586	91	148	166	90	105	229	87	56	210	38	42	258	233	42	49	23	27	27	3	3	3	17	16	13	190	56	13	5	4	21	16
	GlumMono/GrainMono	**0.1**	**0.3**	**0.3**	**0.6**	**0.1**	**0.1**	**0.6**	**0.1**	**0.5**	**0.4**	**0.1**	**0.6**	**0.02**	**0.6**	**0.1**	**0.5**	**0.02**	**0.1**	**0.05**	**0.6**	**0.01**	**0.2**	**0.2**	**1.0**	**0.7**	**0.5**	-	-	-	-	-	**2.8**	**0.2**	**0.2**	**1.2**	-	-	**4.5**	-
	Interpretation	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	SP?	SP?	P	-	-	-	-	-	FS	P	P	SP	-	-	FS	-
	T. monococcum 2 grain																																							
	GlumMono2/GrainMono2																																							
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b		2	3	2	4	8		36	6		1	2	16	24						6	36	12			2	2				2			2		2		2	8	4
	Triticum dicoccum	5		33	2	6	8	2	30	2	6		3	3	5			1	4		6	7	2	1	1	1	9			1		1	3	5	1	3			4	20
	GlumDicoc/GrainDicoc	-	-	**0.1**	-	-	-	-	**1.2**	-	-	-	-	-	**5**			-	-		-	**5**	-	-	-	-	-			-	-	-	-	-	-	-		-	-	-
	Interpretation	-	-	P	-	-	-	-	SP	-	-	-	-	-	FS	-	-	-	-	-	-	FS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*Hordeum vulgare* rachis			1			3																											1	3	1			1	1
	Hordeum vulgare vulgare	21	10	44	14	9	36	8	35	23	36	4	16	21	11	20	11	19	5	4	8		19	18		5	14	211	149	2,943	45	21	134	270	186	40	259	44	163	201
	RachisHord/GrainHord	-	-	**0**	-	-	**0.1**	-	**0**	-	**0**	-	-	-	-	-	-	-	-	-	-		-	-		-	-	**0**	**0**	**0**	**0**	-	**0**	**0**	**0**	**0**	**0**	0	**0**	**0**
	Interpretation	-	-	P	-	-	P	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	P	P	-	P	P	P	P	P	P	P	P
Ratio 2	*Triticum spelta* g/b			4																																			2	
	Triticum spelta																													1									1	
	GlumSpelt/GrainSpelt			-																										-									-	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis																																							
	T. aestivum/durum			2										2																				1						2
	RachisAest/GrainAest			-										-																				-						-
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	9	3	2	1	4	36	3	5	12	1	5		1	2	3	2	1	1		3		2		1	4		1		1					1	5			1	
	Interpretation	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*			6		5	1			2				2		21					3		2								6				2		1			197
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Ratio 4	Weeds	37	35	63	38	25	188	101	93	43	74	135	29	41	152	26	25	20	5	13	49	40	17	5	8	21	3	10	8	33	27	10	133	25	94	25	69	13	141	242
	Grains	112	94	311	51	81	464	150	656	130	191	176	109	135	247	132	69	231	48	46	278	240	66	68	25	37	50	215	152	2,949	68	39	150	466	246	62	265	48	190	436
	Weed/Grain	**0.3**	**0.4**	**0.2**	**0.7**	**0.3**	**0.4**	**0.7**	**0.1**	**0.3**	**0.4**	**0.8**	**0.3**	**0.3**	**0.6**	**0.2**	**0.4**	**0.1**	**0.1**	**0.3**	**0.2**	**0.2**	**0.3**	**0.1**	**0.3**	**0.6**	**0.1**	**0.0**	**0.1**	**0**	**0.4**	**0.3**	**0.9**	**0.1**	**0.4**	**0.4**	**0.3**	**0.3**	**0.7**	**0.6**
	Interpretation	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	E	P	P	P	P	P	P	P
Ratio 5	1) SML A																											5	3	8	21	0	129	4	87		37	11	118	202
	1) IBT A LRG + LRG A																											5	5	25	6	10	4	21	7		32	2	23	40
	1) SML/LRG WEED A																											-	-	**0.3**	**4**	-	**32**	**0.2**			**1.2**	-		**5**
	Interpretation A1																											-	-	HP	FS	-	FS	HP			E	-		FS
Ratio 5	2) IBT A SML + SML A																											5	3	8	21	5	130	5	88		37	11	120	213
	2) LRG A																											5	5	25	6	5	3	20	6		32	2	21	29
	2) SML/LRG WEED A																											-	-	**0.3**	**4**	-	**32**	**0.3**			**1.2**	-		**7**
	Interpretation A2																											-	-	HP	FS	-	FS	HP			E	-		FS
Ratio 5	3) SML B	12	14	25	12	10	25	52	48	28	53	77	13	30	102	12	10	13	1	6	32	20	11	4	4	1	0							4		15				202
	3) IBT B LRG + LRG B	25	21	38	26	15	163	49	45	15	21	58	16	11	50	14	15	7	4	7	17	20	6	1	4	20	3							21		10				40
	3) SML/LRG WEED B	**0.5**	**0.7**	**0.7**	**0.5**	**0.7**	**0.2**	**1.1**	**1.1**	**2**	**3**	**1.3**	**0.8**	**3**	**2**	**0.9**	**0.7**	-	-	-	**2**	**1**	-	-	-	-	-							**0.2**		**2**				**5**
	Interpretation B3	HP	HP	HP	HP	HP	HP	E	E	FS	FS	FS	E	FS	FS	E	HP	-	-	-	FS	E	-	-	-	-	-							HP		FS				FS
Ratio 5	4) IBT B SML + SML B	12	14	25	13	10	29	52	48	29	53	79	13	31	102	12	11	14	1	6	33	20	11	4	4	1	0							4		15				202
	4) LRG B	25	21	38	25	15	159	49	45	14	21	56	16	10	50	14	14	6	4	7	16	20	6	1	4	20	3							21		10				40
	4) SML/LRG WEED B	**0.5**	**0.7**	**0.7**	**0.5**	**0.7**	**0.2**	**1.1**	**1.1**	**2**	**3**	**1.4**	**0.8**	**3**	**2**	**0.9**	**0.8**	-	-	-	**2**	**1**	-	-	-	-	-							**0.2**		**2**				**5**
	Interpretation B4	HP	HP	HP	HP	HP	HP	E	E	FS	FS	FS	E	FS	FS	E	E	-	-	-	FS	E	-	-	-	-	-							HP		FS				FS
	Total id's	157	159	444	113	118	684	335	821	223	323	324	198	194	565	170	122	255	57	61	487	318	102	85	55	78	69	225	166	2,986	100	50	319	538	355	106	352	63	436	685
Ratio 6	Density	16	16	44	11	12	68	34	82	22	32	32	20	19	57	17	12	26	6	6	49	32	10	9	6	8	7	23	17	299	10	5	32	54	36	11	35	6	44	69
Interpretation code - Ratio results		**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B, P)**
Interpretation code - After CA		**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B)**	**PS (B, P)**
Weed categories (After Jones 1984)																																								
SFL	Winnowing					2	1																																	4
BHH	Coarse sieving by-product	3	2	4	4	1	4		1		1	7	2	2		1	4				1									1					1				2	2
SHH	Coarse sieving by-product			1			1		17				1		1		1	1			4																		1	
SHL	Coarse sieving by-product														1																								1	
SFH	Fine sieving by-product	12	14	24	13	8	27	52	31	29	53	77	12	31	100	12	10	13	1	6	29	20	11	4	4	1	1	5	3	8	21		129	4	87	15	37	11	116	198
BFH	Fine sieving by-product	21	17	30	21	14	154	49	44	14	20	51	14	8	50	12	10	6	4	7	2	20	6	1	4	20	1	5	5	24	6	5	3	20	5	9	32	2	19	27
IBT		1	2	4			1									1					13						1					5	1	1	1	1			2	11

Table 6.5. Results of crop processing

	Unique sample no.	FEU253	FEU30	FEU29	FEU508	FEU117	FEU177	FEU187	FEU54	FEU83	FEU316	FEU402	FEU13	FEU49	FEU21	FEU143	FEU183	FEU293	FEU505	FEU119	FEU121	FEU150	FEU153	FEU213	FEU245	FEU251	FEU264	FEU271	FEU280	FEU284	FEU326	FEU331	FEU345	FEU392	FEU396	FEU4	FEU45	FEU460	FEU461	FEU481
	Feature type	House	General deposit	General deposit	Container fill	Pit	General deposit	House	General deposit	Hearth	Yard	General deposit	Pit	Pit	Miscellaneous	Street	House	Pit	General deposit	Pit	Pit	Pit	Miscellaneous	General deposit	Pit	Yard	House	House	Pit	Pit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	House	General deposit	General deposit
	Triticum monococcum g/b	3	8	8	6	1	14	2	7	16	28	2	424	92	48	7	4	12	22	13	9	6	8	1	18	1	12	5	14	36	16	3	5	6	14		16	22	1	14
Ratio 2	*Triticum monococcum*	13	8	42	10	39	45	32	21	5	98	6	27	17	32	15	16	10	36	59	42	31	20	25	33	29	41	32	75	105	66	65	26	25	60	36	40	136	63	108
	GlumMono/GrainMono	-	-	**0.2**	-	**0.03**	**0.3**	**0.1**	**0.3**	-	**0.3**	-	**15.7**	**5.4**	**1.5**	-	-	-	**0.6**	**0.2**	**0.2**	**0.2**	**0.4**	**0.04**	**0.6**	**0.03**	**0.3**	**0.2**	**0.2**	**0.3**	**0.2**	**0.05**	**0.2**	**0.2**	**0.2**	**0**	**0.4**	**0.2**	**0.02**	**0.1**
	Interpretation	-	-	P	-	P	P	P	P	-	P	-	FS	FS	SP?	-	-	-	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
	T. monococcum 2 grain						1																																	
	GlumMono2/GrainMono2						-																																	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Triticum dicoccum g/b	4		6		2	8	2	6	2	5		36	6				2	4	2	12	4		2	22	4			6	2	2	4		6	1	2		4		2
Ratio 2	*Triticum dicoccum*	5	5	7	1	1	6	6	2	1,975	4,543		3	5	4	2		3	1	3	2	3	1		1	3		6	2	2		1		2	7		11	4	4	3
	GlumDicoc/GrainDicoc	-	-	-	-	-	-	-	-	**0.001**	**0.001**		**12**	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-	-		-	-	-	-	-	-	-
	Interpretation	-	-	-	-	-	-	-	-	P	P	-	FS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Hordeum vulgare rachis	1					1		9						3	1						1								1	3						1	2		1
Ratio 3	*Hordeum vulgare vulgare*	14	10	49	14	23	61	24	27	2		2	3	16	91	9	7	6	19	15	10	3	2	1	8	1	3	5	6	19	17	3	9	3	15	17	10	76	17	53
	RachisHord/GrainHord	-	-	**0**	-	-	**0**	-	**0.3**	-		-	-	-	**0**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**	-	**0**
	Interpretation	-	-	P	-	-	P	-	SP	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	P
	Triticum spelta g/b												4																											
Ratio 2	*Triticum spelta*		3					2																																
	GlumSpelt/GrainSpelt		-					-					-																											
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	T.aestivum/durum rachis								1												1			7																
Ratio 3	*T. aestivum/durum*					1	2								1										1															
	RachisAest/GrainAest					-	-		-						-						-			-	-															
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	2			1		1		9					1	177				1	1	2	5		3	2	1		3	2	9	13	9		4		4		25		2
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Ratio 2	*Panicum miliaceum*	2				2	7		1			114	552	101	7		3	4				1			2	1						2	1				1	2		
	Interpretation	-	-	-	-	-	-	-	-	-	-	P	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Weeds	19	20	8	14	12	31	19	32	25	2,983	10	40	57	115	21	24	13	60	84	173	50	32	63	58	78	67	52	109	186	153	77	73	27	1,596	122	276	249	685	220
Ratio 4	Grains	37	26	98	27	67	123	64	60	1,982	4,641	122	585	140	313	26	26	23	58	79	56	43	23	29	47	35	44	46	84	136	97	80	36	35	82	57	61	242	84	166
	Weed/Grain	**0.5**	**0.8**	**0.1**	**0.5**	**0.2**	**0.3**	**0.3**	**0.5**	**0.01**	**0.6**	**0.1**	**0**	**0.4**	**0.4**	**0.8**	**0.9**	**0.6**	**1**	**1.1**	**3**	**1.2**	**1.4**	**2**	**1.2**	**2**	**2**	**1.1**	**1.3**	**1.4**	**2**	**1**	**2**	**0.8**	**19**	**2**	**5**	**1**	**8**	**1.3**
	Interpretation	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	E	P	E	E	FS	FS	FS	FS	FS	FS	FS	E	FS	FS	FS	E	FS	P	FS	FS	FS	E	FS	FS
	1) SML A	13	11	6	1										3	10	12	5																						
Ratio 5	1) IBT A LRG + LRG A	6	9	2	13										112	11	12	8																						
	1) SML/LRG WEED A	-	-	-	-										**0.03**	-	-	-																						
	Interpretation A1	-	-	-	-										HP	-	-	-																						
	2) IBT A SML + SML A	13	12	6	1										3	11	13	6																						
Ratio 5	2) LRG A	6	8	2	13										112	10	11	7																						
	2) SML/LRG WEED A	-	-	-	-										**0.03**	-	-	-																						
	Interpretation A2	-	-	-	-										HP	-	-	-																						
	3) SML B	13	11	6	1	7	20	13	18	6	2,914	9	31	48		10	12	5	16	67	152	28	18	22	45	67	31	36	91	161	16	11	47	12	1,313	91	233	47	678	174
Ratio 5	3) IBT B LRG + LRG B	6	9	2	13	5	11	6	14	19	69	1	9	9		11	12	8	44	17	21	22	14	41	13	11	36	16	18	25	137	66	26	15	283	31	43	202	7	46
	3) SML/LRG WEED B	-	-	-	-	-	**2**	-	**1.3**	**0.3**	**42**	-	**3**	**5**		-	-	-	**0.4**	**4**	**7**	**1.3**	1.3	**0.5**	**3**	**6**	**0.9**	**2**	**5**	**6**	**0.1**	**0.2**	**2**	0.8	**5**	**3**	**5**	**0.2**	**97**	**4**
	Interpretation B3	-	-	-	-	-	FS	-	FS	HP	FS	-	FS	FS		-	-	-	HP	FS	FS	FS	FS	HP	FS	FS	E	FS	FS	FS	HP	HP	FS	E	FS	FS	FS	HP	FS	FS
	4) IBT B SML + SML B	13	11	6	1	7	20	13	18	6	2,914	9	31	48		10	12	5	17	67	153	28	19	23	45	69	32	37	92	163	16	11	48	12	1,315	92	233	48	679	175
Ratio 5	4) LRG B	6	9	2	13	5	11	6	14	19	69	1	9	9		11	12	8	43	17	20	22	13	40	13	9	35	15	17	23	137	66	25	15	281	30	43	201	6	45
	4) SML/LRG WEED B	-	-	-	-	-	**2**	-	**1.3**	**0.3**	**42**	-	**3**	**5**		-	-	-	**0.4**	**4**	**8**	**1.3**	1.5	**0.6**	**3**	**8**	**0.9**	**2**	**5**	**7**	**0.1**	**0.2**	**2**	0.8	**5**	**3**	**5**	**0.2**	**113**	**4**
	Interpretation B4	-	-	-	-	-	FS	-	FS	HP	FS	-	FS	FS		-	-	-	HP	FS	FS	HP	SP	HP	FS	FS	E	FS	FS	FS	HP	HP	FS	E	FS	FS	FS	HP	FS	FS
	Total id's	64	54	120	47	82	177	87	115	2,025	7,657	134	1,089	295	479	55	54	50	144	178	251	104	63	102	145	118	123	103	213	361	271	164	114	74	1,693	181	354	519	770	403
Ratio 6	Density	6	5	12	5	8	18	9	12	203	766	13	109	30	48	6	5	5	14	18	25	10	6	10	15	12	12	10	21	36	27	16	11	7	169	18	35	52	77	40
Interpretation code - Ratio results		**PS (E, B)**	**PS (E, B)**	**PS (E, B)**	**PS (E, B)?**	**PS (E, B)?**	**PS (E, B)?**	**PS (E, B)?**	**PS (E, B)?**	**PS (Em)**	**PS (Em)**	**PS (P)**	**PS (P)**	**PS (P)?**	**PS (R)**	**PS (E)?**	**PS (E)?**	**PS (E)?**	**PS (E)?**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**
Interpretation code - After CA		**PS (E, B)**	**PS (E, B)**	**PS (E, B)**	**PS (E, B)**	**PS (E, B)**	**PS (E, B)**	**PS (E, B)**	**PS (E, B)**	**PS (Em)**	**PS (Em)**	**PS (P)**	**PS (P)**	**PS (P)**	**PS (R)**	**PS (E)**	**PS (E)**	**PS (E)**	**PS (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**
Weed categories (After Jones 1984)																																								
SFL	Winnowing																1								1						1									
BHH	Coarse sieving by-product				1		1				31		2						3	1				2		1	10	2	1	1		1	2	1	4	2		12		
SHH	Coarse sieving by-product						1				1				1	1								1						1						2		3		
SHL	Coarse sieving by-product																											3			1									
SFH	Fine sieving by-product	13	11	6	1	7	19	13	18	6	2,913	9	31	48	2	9	11	5	17	67	153	28	19	21	44	68	31	33	92	162	14	11	48	12	1,315	90	233	45	679	175
BFH	Fine sieving by-product	6	8	2	12	5	10	5	14	19	38	1	6	7	112	10	11	7	36	15	14	18	13	39	12	9	24	13	15	21	136	64	23	14	277	28	36	186	6	43
IBT			1					1					1	2		1	1	1	4	1	6	4			1		2	1	1	1	1	1					7	3		2

Table 6.5. Results of crop processing

	Unique sample no.	FEU482	FEU484	FEU506	FEU176	FEU390	FEU353	FEU485	FEU17	FEU50	FEU19	FEU483	FEU203	FEU346	FEU446	FEU478	FEU122	FEU126	FEU140	FEU146	FEU159	FEU160	FEU166	FEU167	FEU168	FEU173	FEU180	FEU186	FEU189	FEU195	FEU196	FEU214	FEU215	FEU222	FEU235	FEU236	FEU243	FEU244	FEU248	FEU249
	Feature type	General deposit	General deposit	General deposit	House	General deposit	General deposit	House	General deposit	Pit	Pit	House	House	General deposit	General deposit	House	Pit	House	Pit	Pit	House	General deposit	House	Hearth	Hearth	House	Hearth	House	House	Hearth	Hearth	General deposit	Pit	House	Miscellaneous	Miscellaneous	Miscellaneous	Pit	Street	House
Ratio 2	*Triticum monococcum* g/b	19	32	8	18	14	8	32		3	36	46	4	24	48	2	458	394	696	38	168	98	412	476	116	348	88	72	58	498	378	258	656	334	182	152	372	7,618	316	146
	Triticum monococcum	81	82	44	28	29	33	230	13	14	56	181	11	105	113	78	22	21	40	9	64	25	105	29	27	104	17	19	15	127	52	90	70	102	73	55	58	60	18	30
	GlumMono/GrainMono	**0.2**	**0.4**	**0.2**	**0.6**	**0.5**	**0.2**	**0.1**	-	-	**0.6**	**0.3**	-	**0.2**	**0.4**	**0.03**	**21.2**	**19.2**	**17.4**	**4.3**	**2.6**	**4.0**	**3.9**	**16.3**	**4.3**	**3.3**	**5.2**	**3.8**	**3.9**	**3.9**	**7.2**	**2.9**	**9.4**	**3.3**	**2.5**	**2.7**	**6.4**	**126.7**	**17.5**	**4.9**
	Interpretation	P	P	P	P	P	P	P	-	-	P?	P	-	P	P	P	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
	T. monococcum 2 grain																														1		1							
	GlumMono2/GrainMono2																														-		-							
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b			2	4					2		2	4	2	1	2	4	12	8	2	3	4	8			4		6	8	1	24	28	4	4	12	14	76	16	14	4
	Triticum dicoccum	7		1				1	1	1		4		6	5	1	5	1	2		1	1	9	5	3	10		3		4	5	2	10	6	4	1	16	20	6	1
	GlumDicoc/GrainDicoc	-		-	-			-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	**5**	**12**	-	-	-	-	**5**	**0.8**	-	-
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	FS	FS	-	-	-	-	FS	SP	-	-
Ratio 3	*Hordeum vulgare* rachis	1				1	6	38			2	5	1	1				1	12				1	1		4							3	1			1			3
	Hordeum vulgare vulgare	65	12	27	6	13	376	1,358	4	18	38	73	9	13	7	21	4	2	1	10	17	5	28	1	6	83	3	14	2	7	4	11	3	10	19	13	20	18	10	8
	RachisHord/GrainHord	**0**	-	**0**	-	-	**0.02**	**0.03**	-	-	**0.1**	**0.1**	-	-	-	-	-	-	-	-	-	-	**0**	-	-	**0**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Interpretation	P	-	P	-	-	P	P	-	-	P	P	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum spelta* g/b										2							2	2				8											2		2	1	8		
	Triticum spelta																																	1			1			
	GlumSpelt/GrainSpelt										-							-	-				-											-		-	-	-		
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis										3								5																		2			
	T. aestivum/durum															1					1											1		1		1	12			1
	RachisAest/GrainAest										-					-			-		-											-		-		-	-			-
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	11	45	25	1	12	155	368	1		3	378	1		2	31				1		6	4		1	2	1	4		1	2	2	7	1	6	5			5	6
	Interpretation	-	P	P	-	-	P	P	-	-	-	P	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*		2		1				23	63	534			4					14	1				1				1		4	2		1		6	2		4	2	5
	Interpretation	-	-	-	-	-	-	-	P	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 4	Weeds	267	256	102	81	191	3,567	7,522	40	105	529	491	23	100	127	104	26	14	68	13	38	30	129	34	17	116	17	30	13	37	23	37	28	43	61	35	26	7	39	29
	Grains	163	141	97	36	54	564	1,957	42	96	631	636	21	128	127	132	30	24	57	21	83	36	146	36	37	199	21	40	17	144	66	106	93	121	109	78	108	102	42	51
	Weed/Grain	**2**	**2**	**1.1**	**2**	**4**	**6**	**4**	**1**	**1.1**	**0.8**	**0.8**	**1.1**	**0.8**	**1**	**0.8**	**0.9**	**0.6**	**1.2**	**0.6**	**0.5**	**0.8**	**0.9**	**0.9**	**0.5**	**0.6**	**0.8**	**0.8**	**0.8**	**0.3**	**0.3**	**0.3**	**0.3**	**0.4**	**0.6**	**0.4**	**0.2**	**0.1**	**0.9**	**0.6**
	Interpretation	FS	FS	E	FS	FS	FS	FS	E	E	P	P	E	P	E	P	E	P	FS	P	P	P	E	E	P	P	P	P	P	P	P	P	P	P	P	P	P	P	E	P
Ratio 5	1) SML A						1,769	2,646				103																												
	1) IBT A LRG + LRG A						1,798	4,876				388																												
	1) SML/LRG WEED A						**1**	**0.5**				**0.3**																												
	Interpretation A1						E	HP				HP																												
Ratio 5	2) IBT A SML + SML A						1,773	2,666				111																												
	2) LRG A						1,794	4,856				380																												
	2) SML/LRG WEED A						**1**	**0.5**				**0.3**																												
	Interpretation A2						E	HP				HP																												
Ratio 5	3) SML B	68	80	33	69	101			32	99	419		11	83	94	19	17	3	50	9	17	10	76	16	5	76	11	16	7	12	6	15	6	1	49	20	17	0	21	22
	3) IBT B LRG + LRG B	199	176	69	12	90			8	6	110		12	17	33	85	9	11	18	4	21	20	53	18	12	40	6	14	6	25	17	22	22	42	12	15	9	7	18	7
	3) SML/LRG WEED B	**0.3**	**0.5**	**0.5**	**6**	**1.1**			4	**17**	**4**		-	**5**	**3**	**0.2**	**2**	-	**3**	-	**0.8**	**0.5**	**1.4**	**0.9**	-	**2**	-	**1.1**	-	**0.5**	-	**0.7**	**0.3**	**0.02**	**4**	**1.3**	**2**	-	**1.2**	**3**
	Interpretation B3	HP	HP	HP	FS	E			FS	FS	FS		-	FS	FS	HP	FS	-	FS	-	E	FS	FS	E	-	FS	-	E	-	HP	-	HP	HP	HP	FS	FS	FS	-	E	FS
Ratio 5	4) IBT B SML + SML B	70	82	33	70	101			32	103	425		11	83	97	20	17	4	50	9	18	11	79	16	5	77	11	17	7	12	6	15	6	1	49	21	17	1	21	22
	4) LRG B	197	174	69	11	90			8	2	104		12	17	30	84	9	10	18	4	20	19	50	18	12	39	6	13	6	25	17	22	22	42	12	14	9	6	18	7
	4) SML/LRG WEED B	**0.4**	**0.5**	**0.5**	**6**	**1.1**			4	**52**	**4**		-	**5**	**3**	**0.2**	**2**	-	**3**	-	**0.9**	**0.6**	**2**	**0.9**	-	**2**	-	**1.3**	-	**0.5**	-	**0.7**	**0.3**	**0.02**	**4**	**2**	**2**	-	**1.2**	**3**
	Interpretation B4	HP	HP	HP	FS	E			FS	FS	FS		-	FS	FS	HP	FS	-	FS	-	E	FS	FS	E	-	FS	-	FS	-	HP	-	HP	HP	HP	FS	FS	FS	-	E	FS
	Total id's	450	429	209	139	260	4,145	9,549	82	206	1,203	1,180	53	255	303	240	518	447	848	74	292	168	704	547	170	671	126	148	96	680	491	429	784	505	364	281	586	7,751	411	233
Ratio 6	Density	45	43	21	14	26	415	955	8	21	120	118	5	26	30	24	52	45	85	7	29	17	70	55	17	67	13	15	10	68	49	43	78	51	36	28	59	775	41	23
Interpretation code - Ratio results		**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (B)**	**PU (B)**	**PU (P)?**	**PU (P)?**	**PU (P)?**	**PU (R)**	**PU (E)?**	**PU (E)?**	**PU (E)?**	**PU (E)?**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**
Interpretation code - After CA		**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (B)**	**PU (B)**	**PU (P)**	**PU (P)**	**PU (P)**	**PU (R)**	**PU (E)**	**PU (E)**	**PU (E)**	**PU (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**
Weed categories (After Jones 1984)																																								
SFL	Winnowing					2	1	4			1						1																							
BHH	Coarse sieving by-product	13	14	3	3	1	16	55			6	20		1		4	1	2			3			2	1	1					1			1		2	1			2
SHH	Coarse sieving by-product	2	1		2		15	79			1	1	1		2																							1		
SHL	Coarse sieving by-product			1		3	77																																	
SFH	Fine sieving by-product	68	81	32	68	96	1,676	2,563	32	103	417	102	10	83	95	20	16	4	50	9	18	11	79	16	5	78	11	17	7	12	6	15	6	1	49	21	17		21	22
BFH	Fine sieving by-product	172	160	65	6	89	1,778	4,801	8	2	90	360	12	14	30	80	8	8	17	4	17	18	44	12	9	33	5	13	5	25	14	22	22	41	12	10	7	6	17	5
IBT		12		1	2		4	20			14	8		2					1			1	6	4	2	4	1		1		2					2	1		1	

Table 6.5. Results of crop processing

	Unique sample no.	FEU26	FEU265	FEU281	FEU283	FEU291	FEU300	FEU302	FEU303	FEU308	FEU309	FEU31	FEU310	FEU311	FEU313	FEU317	FEU319	FEU32	FEU322	FEU323	FEU332	FEU334	FEU34	FEU349	FEU35	FEU351	FEU368	FEU369	FEU374	FEU385	FEU388	FEU39	FEU406	FEU411	FEU414	FEU417	FEU430	FEU438	FEU456	FEU458
	Feature type	General deposit	House	Pit	Pit	Miscellaneous	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	Pit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	Miscellaneous	House	General deposit	General deposit	General deposit	General deposit	Street	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit
Ratio 2	*Triticum monococcum* g/b	74	426	184	248	36	528	64	36	68	258	168	562	114	268	168	454	764	258	34	112	554	1,556	156	42	118	64	358	658	894	582	122	172	246	358	66	242	268	116	68
	Triticum monococcum	5	45	34	47	10	38	6	10	14	55	24	67	29	49	76	81	36	19	2	37	238	36	17	19	29	11	98	40	176	72	30	67	103	33	27	112	50	41	23
	GlumMono/GrainMono	**13.9**	**9.5**	**5.5**	**5.2**	**3.7**	**13.9**	**10.3**	**4**	**4.7**	**4.7**	**7.0**	**8.3**	**3.9**	**5.5**	**2.2**	**5.6**	**21.4**	**13.8**	**16**	**3.0**	**2.3**	**42.9**	**9.2**	**2.2**	**4.1**	**6**	**3.6**	**16.4**	**5.1**	**8.1**	**4.1**	**2.6**	**2.4**	**10.8**	**2.5**	**2.2**	**5.4**	**2.8**	**3.0**
	Interpretation	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
	T. monococcum 2 grain																																			1				
	GlumMono2/GrainMono2																																			**-**				
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b	2	218	2	16	18	14	4			2	12			4	2	6	2	172	2	4	4	136	8	2	6		4			3	14	16	2	2	26	6	28	6	2
	Triticum dicoccum	2	11		4	7	1	1	1		1	14	11		5	10	2	25	15	1		1	10	2	3	3		23	3		18	11	21	5	6	6	1	3	4	2
	GlumDicoc/GrainDicoc	**-**	**21**	**-**	**-**	**3**	**-**	**-**	-		**-**	**0.8**	**-**		**-**	**-**	**-**	**0.1**	**11**	-	**-**	**-**	**13**	**-**	-	**-**		**0.2**	**-**		**-**	**1.3**	**0.8**	**-**	**-**	**4**	**-**	**10**	**-**	**-**
	Interpretation	-	FS	-	-	FS	-	-	-	-	-	SP	-	-	-	-	-	P	FS	-	-	-	FS	-	-	-	-	P	-	-	-	FS	SP	-	-	FS	-	FS	-	-
Ratio 3	*Hordeum vulgare* rachis		1												1				1				2			1		1			5		7	1	2					
	Hordeum vulgare vulgare	57	29	1	209	6	68	19	5	4	1	14	21	4	21	18	70	2	5	17	7	17	2	1	7	9	3	47	8	39	18	25	21	2	1	8	19	22	18	9
	RachisHord/GrainHord	**0**	**0**	**-**	**0**	**-**	**0**	**-**	-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0**	**-**	**-**	-	**-**	**-**	**-**	**-**	-	**-**	-	**0**	**-**	**0**	**-**	**0**	**0.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	Interpretation	P	P	-	P	-	P	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	P	-	P	-	P	SP	-	-	-	-	-	-	-
Ratio 2	*Triticum spelta* g/b											2				2		6					24										2							
	Triticum spelta																						1																	
	GlumSpelt/GrainSpelt											**-**				**-**		**-**					**21**										**-**							
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	FS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis																			1																				
	T. aestivum/durum																															1								
	RachisAest/GrainAest																			-												**-**								
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*		13	3			1	2	1		1		1		1	6			4	2	4	1	1	5	1	2		1		5	7		5		3	1	1	3	2	8
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*	1								4		2				5														1			33		7			4		
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Ratio 4	Weeds	25	27	34	56	19	161	22	16	29	51	25	27	15	50	56	53	121	39	14	31	152	37	21	16	26	10	57	17	291	106	43	44	61	75	19	50	43	48	21
	Grains	65	98	38	261	22	109	28	17	22	59	55	101	33	76	115	153	63	42	22	48	257	51	25	31	43	14	169	51	221	115	67	147	109	50	43	134	81	65	41
	Weed/Grain	**0.4**	**0.3**	**0.9**	**0.2**	**0.9**	**1.5**	**0.8**	**0.9**	**1.3**	**0.9**	**0.5**	**0.3**	**0.5**	**0.7**	**0.5**	**0.3**	**2**	**0.9**	**0.6**	**0.6**	**0.6**	**0.7**	**0.8**	**0.5**	**0.6**	**0.7**	**0.3**	**0.3**	**1.3**	**0.9**	**0.6**	**0.3**	**0.6**	**2**	**0.4**	**0.4**	**0.5**	**0.7**	**0.5**
	Interpretation	P	P	E	P	E	FS	P	E	FS	E	P	P	P	P	P	P	FS	E	P	P	P	P	P	P	P	P	P	P	FS	E	P	P	P	FS	P	P	P	P	P
Ratio 5	1) SML A																																							
	1) IBT A LRG + LRG A																																							
	1) SML/LRG WEED A																																							
	Interpretation A1																																							
Ratio 5	2) IBT A SML + SML A																																							
	2) LRG A																																							
	2) SML/LRG WEED A																																							
	Interpretation A2																																							
Ratio 5	3) SML B	22	13	25	31	11	146	13	3	17	37	9	12	10	36	35	32	39	34	10	5	34	9	14	13	14	4	27	6	245	57	16	19	43	57	8	30	12	21	8
	3) IBT B LRG + LRG B	3	14	9	25	8	15	9	13	12	14	16	15	5	14	21	21	82	5	4	26	118	28	7	3	12	6	30	11	46	49	27	25	18	18	11	20	31	27	13
	3) SML/LRG WEED B	**7**	**0.9**	**3**	**1.2**	**-**	**10**	**-**	-	**1.4**	**3**	**0.6**	**0.8**	**-**	**3**	**2**	**2**	**0.5**	**7**	-	**0.2**	**0.3**	**0.3**	**-**	-	**1.2**	-	**0.9**	**-**	**5**	**1.2**	**0.6**	**0.8**	**2**	**3**	**-**	**2**	**0.4**	**0.8**	**-**
	Interpretation B3	FS	E	FS	E	-	FS	-	-	FS	FS	HP	E	-	FS	FS	FS	HP	FS	-	HP	HP	HP	-	-	E	-	E	-	FS	E	E	E	FS	FS	-	FS	HP	E	-
Ratio 5	4) IBT B SML + SML B	22	14	25	31	11	147	13	3	19	38	9	12	10	36	36	32	41	35	10	5	34	9	14	13	14	4	27	6	246	59	20	19	44	57	8	30	13	21	8
	4) LRG B	3	13	9	25	8	14	9	13	10	13	16	15	5	14	20	21	80	4	4	26	118	28	7	3	12	6	30	11	45	47	23	25	17	18	11	20	30	27	13
	4) SML/LRG WEED B	**7**	**1.1**	**3**	**1.2**	**-**	**11**	**-**	-	**2**	**3**	**0.6**	**0.8**	**-**	**3**	**2**	**2**	**0.5**	**9**	-	**0.2**	**0.3**	**0.3**	**-**	-	**1.2**	-	**0.9**	**-**	**5**	**1.3**	**0.9**	**0.8**	**3**	**3**	**-**	**2**	**0.4**	**0.8**	**-**
	Interpretation B4	FS	E	FS	E	-	FS	-	-	FS	FS	HP	E	-	FS	FS	FS	HP	FS	-	HP	HP	HP	-	-	E	-	E	-	FS	FS	E	E	FS	FS	-	FS	HP	E	-
	Total id's	166	770	258	581	95	812	118	69	119	370	262	690	162	399	343	666	956	512	73	195	967	1,806	210	91	194	88	589	726	1,406	811	246	388	419	487	154	432	420	235	132
Ratio 6	Density	17	77	26	58	10	81	12	7	12	37	26	69	16	40	34	67	96	51	7	20	97	181	21	9	19	9	59	73	141	81	25	39	42	49	15	43	42	24	13
Interpretation code - Ratio results		**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**
Interpretation code - After CA		**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**
Weed categories (After Jones 1984)																																								
SFL	Winnowing					1																								1										
BHH	Coarse sieving by-product					2	2		1		1		1			1					4	3						3		6	4		1		2	3	2	1	3	4
SHH	Coarse sieving by-product						7				2															3	1	2		1			1		1					
SHL	Coarse sieving by-product																																							
SFH	Fine sieving by-product	22	14	25	31	10	140	13	3	19	37	9	12	10	36	36	32	41	35	10	5	34	9	14	13	11	3	25	6	245	59	20	18	44	56	8	30	13	23	8
BFH	Fine sieving by-product	3	12	6	23	6	11	8	12	9	11	8	13	5	14	15	10	13	3	4	20	115	27	7	3	11	6	27	9	32	42	20	22	16	16	8	17	28	17	8
IBT			1	3	2		1	1		1		8	1			4	11	67	1		2		1			1			2	6	1	3	2	1			1	1	5	1

Table 6.5. Results of crop processing

Ratio	Unique sample no. / Feature type	FEU459 General deposit	FEU467 General deposit	FEU473 General deposit	FEU487 General deposit	FEU493 Container fill	FEU503 House	FEU510 General deposit	FEU511 General deposit	FEU515 General deposit	FEU519 Container fill	FEU52 Pit	FEU56 General deposit	FEU57 Miscellaneous
Ratio 2	*Triticum monococcum* g/b	82	292	124	772	486	62	576	54	712	248	74	2,522	1,456
	Triticum monococcum	28	21	23	206	100	2	24	12	73	90	21	65	236
	GlumMono/GrainMono	**2.9**	**14.1**	**5.4**	**3.8**	**4.9**	**31**	**23.9**	**4.3**	**9.8**	**2.8**	**3.6**	**38.9**	**6.2**
	Interpretation	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
	T. monococcum 2 grain													
	GlumMono2/GrainMono2													
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b	34		2	6	44		14	8	12		4	162	56
	Triticum dicoccum			34	11	13		4	3	13	1	4	5	17
	GlumDicoc/GrainDicoc	**34**		**0.1**	**-**	**3**		**-**	**-**	**0.9**	**-**	**-**	**34**	**3**
	Interpretation	FS	-	P	-	FS	-	-	-	SP	-	-	FS	FS
Ratio 3	*Hordeum vulgare* rachis	1			3	1				1			2	2
	Hordeum vulgare vulgare	24	3	10	49	2		5	9	33	35	23	16	44
	RachisHord/GrainHord	**0**	**-**	**-**	**0.1**	**-**		**-**	**-**	**0**	**0**	**-**	**-**	**0**
	Interpretation	P	-	-	P	-	-	-	-	P	P	-	-	P
Ratio 2	*Triticum spelta* g/b					2							14	2
	Triticum spelta													2
	GlumSpelt/GrainSpelt					**-**							**-**	**-**
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis									2			7	7
	T. aestivum/durum					1				1				10
	RachisAest/GrainAest					**-**				**-**			**-**	**-**
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	9		4	16	7			2	1		2		2
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*												89	203
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	P	P
Ratio 4	Weeds	45	32	21	126	69	2	30	25	74	21	26	132	396
	Grains	61	24	71	282	123	2	34	27	121	126	49	175	514
	Weed/Grain	**0.7**	**1.3**	**0.3**	**0.4**	**0.6**	**-**	**0.9**	**0.9**	**0.6**	**0.2**	**0.5**	**0.8**	**0.8**
	Interpretation	P	FS	P	P	P	-	E	E	P	P	P	P	P
Ratio 5	1) SML A													
	1) IBT A LRG + LRG A													
	1) SML/LRG WEED A													
	Interpretation A1													
Ratio 5	2) IBT A SML + SML A													
	2) LRG A													
	2) SML/LRG WEED A													
	Interpretation A2													
Ratio 5	3) SML B	3	7	9	47	27	1	18	14	50	5	5	99	113
	3) IBT B LRG + LRG B	42	25	12	79	42	1	12	11	24	16	21	33	283
	3) SML/LRG WEED B	**0.1**	**0.3**	**-**	**0.6**	**0.6**	-	**2**	**1.3**	**2**	**-**	**0.2**	**3**	**0.4**
	Interpretation B3	HP	HP	-	HP	HP	-	FS	FS	FS	-	HP	FS	HP
Ratio 5	4) IBT B SML + SML B	4	8	9	49	27	1	18	14	51	5	6	99	115
	4) LRG B	41	24	12	77	42	1	12	11	23	16	20	33	281
	4) SML/LRG WEED B	**0.1**	**0.3**	**-**	**0.6**	**0.6**	-	**2**	**1.3**	**2**	**-**	**0.3**	**3**	**0.4**
	Interpretation B4	HP	HP	-	HP	HP	-	FS	FS	FS	-	HP	FS	HP
	Total id's	223	348	218	1,189	725	66	654	114	922	395	153	3,014	2,433
Ratio 6	Density	22	35	22	119	73	7	65	11	92	40	15	301	243
Interpretation code - Ratio results		**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**
Interpretation code - After CA		**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E)**	**UFS (E)**	**UFS (E)**
Weed categories (After Jones 1984)														
SFL	Winnowing				1									
BHH	Coarse sieving by-product	1	7	1	12	2		1	1		1			1
SHH	Coarse sieving by-product			1	4					2				1
SHL	Coarse sieving by-product													
SFH	Fine sieving by-product	4	8	8	43	27	1	18	14	51	5	6	100	114
BFH	Fine sieving by-product	39	15	10	66	39	1	11	9	19	15	20	31	278
IBT		1	2	1		1			1	2			1	2

Ratio	Unique sample no. / Feature type	FEU64 General deposit	FEU74 House	FEU89 House	FEU425 General deposit	FEU65 General deposit	FEU9 Pit	FEU84 House	FEU217 House	FEU219 House	FEU129 House	FEU20 General deposit	FEU250 Yard	FEU267 House
Ratio 2	*Triticum monococcum* g/b	92	92	66	1,234	14	82	8	35,244	5,542	22	52	128	38
	Triticum monococcum	40	23	9	340	6	31	121	6,036	801	14	33	78	22
	GlumMono/GrainMono	**2.3**	**4.0**	**7.6**	**3.6**	**-**	**2.6**	**0.1**	**5.8**	**6.9**	**1.6**	**1.6**	**1.6**	**1.7**
	Interpretation	FS	FS	FS	FS	-	FS	P	FS	FS	SP	SP	SP	SP
	T. monococcum 2 grain													
	GlumMono2/GrainMono2													
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b	4			1,476	24	214	1,698		2	8	2	12	8
	Triticum dicoccum		1	7	24	3	28	133		1		8	17	5
	GlumDicoc/GrainDicoc	**-**	**-**	**-**	**60**	**8**	**8**	**13**		**-**	**-**	**-**	**0.7**	**-**
	Interpretation	-	-	-	FS	FS	FS	FS	-	-	-	-	P	-
Ratio 3	*Hordeum vulgare* rachis				3		2		525	15			1	
	Hordeum vulgare vulgare	9	4		64	13	18	9	428	118	1	7	1	5
	RachisHord/GrainHord	**-**	**-**		**0.05**	**-**	**-**	**-**	**1.2**	**0.1**	**-**	**-**	**-**	**-**
	Interpretation	-	-	-	P	-	-	-	W	P?	-	-	-	-
Ratio 2	*Triticum spelta* g/b				15									
	Triticum spelta													
	GlumSpelt/GrainSpelt				**-**									
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis				45				184	32				
	T. aestivum/durum				372									
	RachisAest/GrainAest				**0.1**				**184**	**32**				
	Interpretation	-	-	-	P?	-	-	-	W	W	-	-	-	-
Ratio 3	cf. *Secale cereale*		1		6		16		430	60	1		4	
	Interpretation	-	-	-	-	-	-	-	P	P	-	-	-	-
Ratio 2	*Panicum miliaceum*	1	1				2	1			1		11	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 4	Weeds	36	39	9	225	19	37	94	2,502	603	14	29	41	9
	Grains	50	31	16	806	22	95	264	6,894	980	17	48	111	33
	Weed/Grain	**0.7**	**1.3**	**0.6**	**0.3**	**0.9**	**0.4**	**0.4**	**0.4**	**0.6**	**0.8**	**0.6**	**0.4**	**0.3**
	Interpretation	P	FS	P	P	E	P	P	P	P	P	P	P	P
Ratio 5	1) SML A													
	1) IBT A LRG + LRG A													
	1) SML/LRG WEED A													
	Interpretation A1													
Ratio 5	2) IBT A SML + SML A													
	2) LRG A													
	2) SML/LRG WEED A													
	Interpretation A2													
Ratio 5	3) SML B	26	22	8	110	13	24	18	321	44	6	21	33	4
	3) IBT B LRG + LRG B	10	17	1	115	6	13	76	2,181	559	8	8	8	5
	3) SML/LRG WEED B	**3**	**1.3**	-	**1**	-	**2**	**0.2**	**0.1**	**0.1**	-	**3**	**4**	-
	Interpretation B3	FS	FS	-	E	-	FS	HP	HP	HP	-	FS	FS	-
Ratio 5	4) IBT B SML + SML B	26	22	8	113	13	24	18	325	44	6	21	33	4
	4) LRG B	10	17	1	112	6	13	76	2,177	559	8	8	8	5
	4) SML/LRG WEED B	**3**	**1.3**	-	**1**	-	**2**	**0.2**	**0.1**	**0.1**	-	**3**	**4**	-
	Interpretation B4	FS	FS	-	E	-	FS	HP	HP	HP	-	FS	FS	-
	Total id's	182	162	91	3,804	79	430	2,064	45,349	7,174	61	131	293	88
Ratio 6	Density	18	16	9	380	8	43	206	4,535	717	6	13	29	9
Interpretation code - Ratio results		**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E, Em)**	**SFS (Em)**	**SFS (Em)**	**SFS (Em)**	**SFS + ECP**	**SFS + ECP**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**
Interpretation code - After CA		**SFS (E)**	**SFS (E)**	**SFS (E)**	**SFS (E, Em)**	**SFS (Em)**	**SFS (Em)**	**SFS (Em)**	**SFS + ECP**	**SFS + ECP**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**
Weed categories (After Jones 1984)														
SFL	Winnowing	4			21				5	1				1
BHH	Coarse sieving by-product				3				21	7		1	1	
SHH	Coarse sieving by-product				20				9				1	
SHL	Coarse sieving by-product								132					
SFH	Fine sieving by-product	22	22	8	70	13	24	18	179	43	6	21	32	3
BFH	Fine sieving by-product	10	17	1	110	6	9	76	2,152	549	7	6	6	5
IBT					1		4		4	3	1	1	1	

Ratio	Unique sample no. / Feature type	FEU288 Pit	FEU290 Pit	FEU306 General deposit	FEU318 General deposit	FEU348 General deposit	FEU36 General deposit	FEU376 General deposit	FEU40 General deposit	FEU405 General deposit	FEU422 General deposit	FEU474 General deposit	FEU76 House	FEU78 House
Ratio 2	*Triticum monococcum* g/b	48	66	192	176	68	56	52	32	72	76	116	46	146
	Triticum monococcum	49	32	104	99	32	36	28	20	42	37	74	24	77
	GlumMono/GrainMono	**1.0**	**2.1**	**1.8**	**1.8**	**2.1**	**1.6**	**1.9**	**1.6**	**1.7**	**2.1**	**1.6**	**1.9**	**1.9**
	Interpretation	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
	T. monococcum 2 grain													
	GlumMono2/GrainMono2													
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b	36		24	6		4		2		14	6		
	Triticum dicoccum	39	4	14	5	4	2		15	7	7	4	3	3
	GlumDicoc/GrainDicoc	**0.9**	**-**	**2**	**-**	**-**	**-**		**-**	**-**	**-**	**-**	**-**	**-**
	Interpretation	SP	-	FS	-	-	-	-	-	-	-	-	-	-
Ratio 3	*Hordeum vulgare* rachis										1			
	Hordeum vulgare vulgare	9	53	7	2	5	14	3	20	36	10	8	16	1
	RachisHord/GrainHord	**-**	**0**	**-**	**-**	**-**	**-**	**-**	**-**	**0**	**-**	**-**	**-**	**-**
	Interpretation	-	P	-	-	-	-	-	-	P	-	-	-	-
Ratio 2	*Triticum spelta* g/b	6												
	Triticum spelta	1												
	GlumSpelt/GrainSpelt	**-**												
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis													
	T. aestivum/durum													1
	RachisAest/GrainAest													**-**
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	1		1	1		2	1		2	4		1	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*		3						1	13			7	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 4	Weeds	66	15	32	81	30	16	19	25	52	30	26	27	15
	Grains	99	92	126	107	41	53	32	57	100	59	87	51	83
	Weed/Grain	**0.7**	**0.2**	**0.3**	**0.8**	**0.7**	**0.3**	**0.6**	**0.4**	**0.5**	**0.5**	**0.3**	**0.5**	**0.2**
	Interpretation	P	P	P	P	P	P	P	P	P	P	P	P	P
Ratio 5	1) SML A													
	1) IBT A LRG + LRG A													
	1) SML/LRG WEED A													
	Interpretation A1													
Ratio 5	2) IBT A SML + SML A													
	2) LRG A													
	2) SML/LRG WEED A													
	Interpretation A2													
Ratio 5	3) SML B	14	6	16	62	22	4	9	12	35	12	11	19	7
	3) IBT B LRG + LRG B	52	9	16	19	8	12	10	13	17	18	15	8	8
	3) SML/LRG WEED B	**0.3**	**-**	**1**	**3**	**3**	**-**	**-**	**0.9**	**2**	**0.7**	**0.7**	**2**	**-**
	Interpretation B3	HP	-	E	FS	FS	-	-	E	FS	HP	HP	FS	-
Ratio 5	4) IBT B SML + SML B	14	6	17	62	22	8	9	12	35	12	11	19	7
	4) LRG B	52	9	15	19	8	8	10	13	17	18	15	8	8
	4) SML/LRG WEED B	**0.3**	**-**	**1.1**	**3**	**3**	**-**	**-**	**0.9**	**2**	**0.7**	**0.7**	**2**	**-**
	Interpretation B4	HP	-	E	FS	FS	-	-	E	FS	HP	HP	FS	-
	Total id's	255	173	374	370	139	129	103	116	224	180	235	124	244
Ratio 6	Density	26	17	37	37	14	13	10	12	22	18	24	12	24
Interpretation code - Ratio results		**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**
Interpretation code - After CA		**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**
Weed categories (After Jones 1984)														
SFL	Winnowing													
BHH	Coarse sieving by-product	1		1	1			2		1	2			
SHH	Coarse sieving by-product			1	4					2			1	
SHL	Coarse sieving by-product													
SFH	Fine sieving by-product	14	6	16	58	22	8	9	12	33	13	11	18	7
BFH	Fine sieving by-product	13	8	14	17	8	4	8	12	15	15	15	7	7
IBT		38	1		1		4		1	1			1	1

Table 6.5. Results of crop processing

	Unique sample no.	FEU81	FEU172	FEU197	FEU198	FEU260	FEU115	FEU124	FEU127	FEU128	FEU132	FEU133	FEU139	FEU145
	Feature type	General deposit	Pit	Hearth	General deposit	House	Hearth	House	House	Miscellaneous	House	General deposit	General deposit	Miscellaneous
Ratio 2	*Triticum monococcum* g/b	78	24	34	26	22	16	48	48	6,588	38	26	52	28
	Triticum monococcum	44	22	27	34	15	21	54	54	7,632	32	27	56	35
	GlumMono/GrainMono	**1.8**	**1.1**	**1.3**	**0.8**	**1.4**	**0.8**	**0.9**	**0.9**	**0.9**	**1.2**	**1.0**	**0.9**	**0.8**
	Interpretation	SP	SP?	SP?	SP?	SP?	SP	SP	SP	SP	SP	SP	SP	SP
	T. monococcum 2 grain									124				
	GlumMono2/GrainMono2									**0**				
	Interpretation	-	-	-	-	-	-	-	-	P	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b	2	4	4		4		6	6		2		8	2
	Triticum dicoccum		2	2	1	5	4	1	1			1		1
	GlumDicoc/GrainDicoc	-	-	-	-	-	-	-	-		-	-	-	-
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*Hordeum vulgare* rachis													
	Hordeum vulgare vulgare	8	8	14	7	3	4	32	32	2	8	14	9	14
	RachisHord/GrainHord	-	-	-	-	-	-	**0**	**0**	-	-	-	-	-
	Interpretation	-	-	-	-	-	-	P	P	-	-	-	-	-
Ratio 2	*Triticum spelta* g/b													
	Triticum spelta													
	GlumSpelt/GrainSpelt													
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis													
	T. aestivum/durum				1					1				
	RachisAest/GrainAest				-					-				
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	3	1				3	1	1		2	1	1	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*			1		1					25			17
	Interpretation	-	-	-	-	-	-	-	-	-	P	-	-	-
Ratio 4	Weeds	31	21	13	11	23	16	41	42	77	32	27	26	19
	Grains	55	34	44	43	24	32	88	88	7,759	67	43	66	67
	Weed/Grain	**0.6**	**0.6**	**0.3**	**0.3**	**1**	**0.5**	**0.5**	**0.5**	**0**	**0.5**	**0.6**	**0.4**	**0.3**
	Interpretation	P	P	P	P	E	P	P	P	P	P	P	P	P
Ratio 5	1) SML A													
	1) IBT A LRG + LRG A													
	1) SML/LRG WEED A													
	Interpretation A1													
Ratio 5	2) IBT A SML + SML A													
	2) LRG A													
	2) SML/LRG WEED A													
	Interpretation A2													
Ratio 5	3) SML B	23	14	6	6	13	3	16	17	31	24	9	15	7
	3) IBT B LRG + LRG B	8	7	7	5	10	13	25	25	46	8	18	11	12
	3) SML/LRG WEED B	**3**	-	-	-	-	-	**0.6**	**0.7**	**0.7**	**3**	**0.5**	**1.4**	-
	Interpretation B3	FS	-	-	-	-	-	HP	HP	HP	FS	HP	FS	-
Ratio 5	4) IBT B SML + SML B	23	14	6	6	13	4	16	17	33	24	9	15	7
	4) LRG B	8	7	7	5	10	12	25	25	44	8	18	11	12
	4) SML/LRG WEED B	**3**	-	-	-	-	-	**0.6**	**0.7**	**0.8**	**3**	**0.5**	**1.4**	-
	Interpretation B4	FS	-	-	-	-	-	HP	HP	E	FS	HP	FS	-
	Total id's	166	83	95	80	73	64	183	184	14,424	139	96	152	116
Ratio 6	Density	17	8	10	8	7	6	18	18	1,442	14	10	15	12
Interpretation code - Ratio results		**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**
Interpretation code - After CA		**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**
Weed categories (After Jones 1984)														
SFL	Winnowing													
BHH	Coarse sieving by-product		1	1				1	1	4			2	1
SHH	Coarse sieving by-product													1
SHL	Coarse sieving by-product				1									
SFH	Fine sieving by-product	23	14	6	5	13	4	16	17	33	24	9	16	6
BFH	Fine sieving by-product	8	6	6	5	10	11	24	24	39	7	18	8	11
IBT							1			1	1			

	Unique sample no.	FEU147	FEU151	FEU161	FEU169	FEU174	FEU179	FEU190	FEU192	FEU223	FEU24	FEU270	FEU272	FEU28
	Feature type	Pit	General deposit	House	House	Hearth	House	Pit	Street	Pit	General deposit	Yard	Yard	General deposit
Ratio 2	*Triticum monococcum* g/b	64	84	62	84	52	126	564	84	74	76	38	38	48
	Triticum monococcum	44	63	78	69	57	101	859	59	99	53	30	52	38
	GlumMono/GrainMono	**1.4**	**1.3**	**0.8**	**1.2**	**0.9**	**1.2**	**0.7**	**1.4**	**0.7**	**1.4**	**1.3**	**0.7**	**1.3**
	Interpretation	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
	T. monococcum 2 grain													
	GlumMono2/GrainMono2													
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b	14		1	4	2	1	2	2			6		8
	Triticum dicoccum	6		4	6		3	26		5		5	3	10
	GlumDicoc/GrainDicoc	-		-	-	-	-	**0.1**	-	-		-	-	-
	Interpretation	-	-	-	-	-	-	P	-	-	-	-	-	-
Ratio 3	*Hordeum vulgare* rachis									1				
	Hordeum vulgare vulgare	6	12	5	14	11	22	47	9	23	21	7	15	13
	RachisHord/GrainHord	-	-	-	-	-	-	**0**	-	-	-	-	-	-
	Interpretation	-	-	-	-	-	-	P	-	-	-	-	-	-
Ratio 2	*Triticum spelta* g/b			2										2
	Triticum spelta													3
	GlumSpelt/GrainSpelt			-										-
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis													
	T. aestivum/durum	1											1	
	RachisAest/GrainAest	-											-	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	1	1	4	2		1	4	3	12	2	1	2	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*					4				37				2
	Interpretation	-	-	-	-	-	-	-	-	P	-	-	-	-
Ratio 4	Weeds	38	18	37	64	12	27	68	28	51	35	12	13	18
	Grains	58	76	91	91	72	127	936	71	175	77	44	73	66
	Weed/Grain	**0.7**	**0.2**	**0.4**	**0.7**	**0.2**	**0.2**	**0.1**	**0.4**	**0.3**	**0.5**	**0.3**	**0.2**	**0.3**
	Interpretation	P	P	P	P	P	P	P	P	P	P	P	P	P
Ratio 5	1) SML A													
	1) IBT A LRG + LRG A													
	1) SML/LRG WEED A													
	Interpretation A1													
Ratio 5	2) IBT A SML + SML A													
	2) LRG A													
	2) SML/LRG WEED A													
	Interpretation A2													
Ratio 5	3) SML B	20	8	9	23	5	11	48	13	22	29	4	7	8
	3) IBT B LRG + LRG B	18	10	28	41	7	16	20	15	29	6	8	6	10
	3) SML/LRG WEED B	**1.1**	-	**0.3**	**0.6**	-	**0.7**	**2**	**0.9**	**0.8**	**5**	-	-	-
	Interpretation B3	E	-	HP	HP	-	HP	FS	E	E	FS	-	-	-
Ratio 5	4) IBT B SML + SML B	20	8	10	23	6	11	48	14	23	29	4	7	8
	4) LRG B	18	10	27	41	6	16	20	14	28	6	8	6	10
	4) SML/LRG WEED B	**1.1**	-	**0.4**	**0.6**	-	**0.7**	**2**	**1**	**0.8**	**5**	-	-	-
	Interpretation B4	E	-	HP	HP	-	HP	FS	E	E	FS	-	-	-
	Total id's	174	178	193	243	138	281	1,570	185	301	188	100	124	142
Ratio 6	Density	17	18	19	24	14	28	157	19	30	19	10	12	14
Interpretation code - Ratio results		**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**
Interpretation code - After CA		**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**
Weed categories (After Jones 1984)														
SFL	Winnowing													
BHH	Coarse sieving by-product		1	2	6			1		1			2	
SHH	Coarse sieving by-product				2		1							
SHL	Coarse sieving by-product													
SFH	Fine sieving by-product	20	8	10	21	6	10	48	14	23	29	4	7	8
BFH	Fine sieving by-product	15	9	25	34	6	16	18	13	25	6	8	4	9
IBT		3			1			1	1	2				1

	Unique sample no.	FEU286	FEU287	FEU304	FEU314	FEU33	FEU355	FEU358	FEU360	FEU361	FEU365	FEU366	FEU367	FEU370
	Feature type	Yard	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	Pit	General deposit
Ratio 2	*Triticum monococcum* g/b	82	72	32	74	56	66	28	88	56	156	114	144	82
	Triticum monococcum	87	48	46	80	39	71	37	80	65	236	154	119	99
	GlumMono/GrainMono	**0.9**	**1.5**	**0.7**	**0.9**	**1.4**	**0.9**	**0.7**	**1.1**	**0.9**	**0.7**	**0.7**	**1.2**	**0.8**
	Interpretation	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
	T. monococcum 2 grain													
	GlumMono2/GrainMono2													
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b	6	4		2	6	2	8		6	6		18	
	Triticum dicoccum	5	4	7	7	9	8	3	2	2	5	8	53	8
	GlumDicoc/GrainDicoc	-	-	-	-	-	-	-	-	-	-	-	**0.3**	-
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	P	-
Ratio 3	*Hordeum vulgare* rachis												3	
	Hordeum vulgare vulgare	35	17	6	24	8	16	17	60	44	12	14	34	51
	RachisHord/GrainHord	**0**	-	-	-	-	-	-	**0**	**0**	-	-	**0.1**	**0**
	Interpretation	P	-	-	-	-	-	-	P	P	-	-	P	P
Ratio 2	*Triticum spelta* g/b					2								
	Triticum spelta													
	GlumSpelt/GrainSpelt					-								
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis												1	
	T. aestivum/durum		1			2								
	RachisAest/GrainAest		-			-							-	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	1	4	6	2		1	1	2				8	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*		1			3				1		1	4	5
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 4	Weeds	37	37	17	38	13	50	14	47	10	47	38	105	58
	Grains	128	75	64	113	61	96	59	144	111	253	177	218	163
	Weed/Grain	**0.3**	**0.5**	**0.3**	**0.3**	**0.2**	**0.5**	**0.2**	**0.3**	**0.1**	**0.2**	**0.2**	**0.5**	**0.4**
	Interpretation	P	P	P	P	P	P	P	P	P	P	P	P	P
Ratio 5	1) SML A													
	1) IBT A LRG + LRG A													
	1) SML/LRG WEED A													
	Interpretation A1													
Ratio 5	2) IBT A SML + SML A													
	2) LRG A													
	2) SML/LRG WEED A													
	Interpretation A2													
Ratio 5	3) SML B	26	23	14	17	0	33	1	26	6	19	18	67	39
	3) IBT B LRG + LRG B	11	14	3	21	13	17	13	21	4	28	20	38	19
	3) SML/LRG WEED B	**2**	**2**	-	**0.8**	-	**2**	-	**1.2**	-	**0.7**	**0.9**	**2**	**2**
	Interpretation B3	FS	FS	-	E	-	FS	-	E	-	HP	E	FS	FS
Ratio 5	4) IBT B SML + SML B	26	23	14	17	0	33	1	26	6	19	19	68	40
	4) LRG B	11	14	3	21	13	17	13	21	4	28	19	37	18
	4) SML/LRG WEED B	**2**	**2**	-	**0.8**	-	**2**	-	**1.2**	-	**0.7**	**1**	**2**	**2**
	Interpretation B4	FS	FS	-	E	-	FS	-	E	-	HP	E	FS	FS
	Total id's	253	188	113	227	138	214	109	279	183	462	329	489	303
Ratio 6	Density	25	19	11	23	14	21	11	28	18	46	33	49	30
Interpretation code - Ratio results		**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**
Interpretation code - After CA		**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**
Weed categories (After Jones 1984)														
SFL	Winnowing													
BHH	Coarse sieving by-product		1		2				2		2	1	6	
SHH	Coarse sieving by-product			1									1	
SHL	Coarse sieving by-product													
SFH	Fine sieving by-product	26	23	13	17		33	1	26	6	19	19	67	40
BFH	Fine sieving by-product	11	13	3	19	6	17	6	18	2	24	17	30	12
IBT						7		7	1	2	2	1	1	6

Table 6.5. Results of crop processing

	Unique sample no.	FEU378	FEU380	FEU382	FEU387	FEU400	FEU403	FEU418	FEU423	FEU428	FEU429	FEU432	FEU44	FEU452	FEU462	FEU48	FEU480	FEU489	FEU497	FEU498	FEU504	FEU512	FEU513	FEU520	FEU522	FEU55	FEU58	FEU63	FEU86	FEU92	FEU135	FEU16	FEU165	FEU182	FEU22	FEU255	FEU258	FEU3	FEU329	FEU395
	Feature type	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	House	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	House	Container fill	House	General deposit	General deposit	General deposit	House	House	General deposit	General deposit	House	Hearth	General deposit	General deposit	General deposit	General deposit	House	Container fill
Ratio 2	*Triticum monococcum* g/b	68	52	78	164	122	388	34	76	34	72	76	32	88	66	28	162	144	42	46	34	34	46	22	28	66	52	34	92	1,634	4	2	4	4	5	2	3	12	5	14
	Triticum monococcum	66	73	58	107	158	555	47	71	35	99	53	46	106	51	23	242	119	37	54	29	25	35	28	40	45	38	33	98	2,520	12	9	11	2	15	12	19	7	15	10
	GlumMono/GrainMono	**1.0**	**0.7**	**1.4**	**1.5**	**0.8**	**0.7**	**0.7**	**1.1**	**1**	**0.7**	**1.4**	**0.7**	**0.8**	**1.3**	**1.2**	**0.7**	**1.2**	**1.1**	**0.8**	**1.2**	**1.4**	**1.3**	**0.8**	**0.7**	**1.5**	**1.4**	**1.0**	**0.9**	**0.6**	-	-	-	-	-	-	-	-	-	-
	Interpretation	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	-	-	-	-	-	-	-	-	-	-
	T. monococcum 2 grain																																							
	GlumMono2/GrainMono2																																							
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b	2		2	1		2		4		14	2			2			12	6	22	26			4	2	4	6	4	4						2	18				8
	Triticum dicoccum	6	24		1	1	18	1	1	3	5	4	2				8	21	1	3	2	7	1		4	4	3	8	1	3		2	7		7	2			1	1
	GlumDicoc/GrainDicoc	-	-	-	-	-	-	-	-	-	-	-	-		-		-	**0.6**	-	**7**	**11**	-	-	-	-	-	-	-	-	-		-	-		-	-			-	-
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	FS	FS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*Hordeum vulgare* rachis			1										2	1					2													1							
	Hordeum vulgare vulgare	17	6	13	21	37	22	5	13	4	72	1	44	17	12	37	79	56	21	27	8	8	5	6	11	22	33	12	64	1	3	7	1	1	25	3	7	22	5	1
	RachisHord/GrainHord	-	-	-	-	**0**	-	-	-	-	**0**	-	**0**	-	-	**0**	**0**	**0**	-	**0.1**	-	-	-	-	-	-	**0**	-	**0**	-	-	-	-	-	**0**	-	-	-	-	-
	Interpretation	-	-	-	-	P	-	-	-	-	P	-	P	-	-	P	P	P	-	P	-	-	-	-	-	-	P	-	P	-	-	-	-	-	P	-	-	-	-	-
Ratio 2	*Triticum spelta* g/b										4							4	2	2				2			2													
	Triticum spelta																											2	4											
	GlumSpelt/GrainSpelt										-							-	-	-				-			-	-	-											
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis																	1																						
	T. aestivum/durum																	2		2						1			1						2					
	RachisAest/GrainAest																	-		-						-			-						-					
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	3	1	5	4	7	3	2				1		4	3	2		3	4	1	2		1			1		5	2			2	1		3				5	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*	2																1		4					2	2	1	1							1			1		
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 4	Weeds	28	32	51	51	111	101	21	28	12	56	43	23	84	48	38	185	123	45	26	20	24	14	20	29	29	12	30	140	33	664	31	649	80	67	36	48	69	76	100
	Grains	93	104	76	134	203	598	56	85	42	176	59	92	127	66	62	329	203	63	92	42	39	42	33	56	75	75	61	170	2,524	15	19	21	3	52	17	26	30	26	12
	Weed/Grain	**0.3**	**0.3**	**0.7**	**0.4**	**0.5**	**0.2**	**0.4**	**0.3**	**0.3**	**0.3**	**0.7**	**0.3**	**0.7**	**0.7**	**0.6**	**0.6**	**0.6**	**0.7**	**0.3**	**0.5**	**0.6**	**0.3**	**0.6**	**0.5**	**0.4**	**0.2**	**0.5**	**0.8**	**0**	**44**	**2**	**31**	**27**	**1.3**	**2**	**2**	**2**	**3**	**8**
	Interpretation	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Ratio 5	1) SML A																																							
	1) IBT A LRG + LRG A																																							
	1) SML/LRG WEED A																																							
	Interpretation A1																																							
Ratio 5	2) IBT A SML + SML A																																							
	2) LRG A																																							
	2) SML/LRG WEED A																																							
	Interpretation A2																																							
Ratio 5	3) SML B	18	18	33	36	69	49	9	14	5	32	32	17	15	31	26	141	20	11	10	5	7	8	10	8	28	5	11	129	1	646	31	635	72	54	17	46	66	6	95
	3) IBT B LRG + LRG B	10	14	18	15	42	52	12	14	7	24	11	6	69	17	12	44	103	34	16	15	17	6	10	21	1	7	19	11	32	18	0	14	8	13	19	2	3	70	5
	3) SML/LRG WEED B	**2**	**1.3**	**2**	**2**	**2**	**0.9**	-	**1**	-	**1.3**	**3**	-	**0.2**	**2**	**2**	**3**	**0.2**	**0.3**	**0.6**	-	-	-	-	**0.4**	**28**	-	**0.6**	**12**	**0.03**	**36**	31	**45**	9	**4**	0.9	23	**22**	**0.1**	**19**
	Interpretation B3	FS	FS	FS	FS	FS	E	-	E	-	FS	FS	-	HP	FS	FS	FS	HP	HP	HP	-	-	-	-	HP	FS	-	HP	FS	HP	FS	FS	FS	FS	FS	E	FS	FS	HP	FS
Ratio 5	4) IBT B SML + SML B	18	19	34	36	69	49	9	14	5	33	34	17	15	31	26	141	27	12	10	5	7	8	10	8	28	5	11	129	1	646	31	635	72	54	17	46	66	6	96
	4) LRG B	10	13	17	15	42	52	12	14	7	23	9	6	69	17	12	44	96	33	16	15	17	6	10	21	1	7	19	11	32	18	0	14	8	13	19	2	3	70	4
	4) SML/LRG WEED B	**2**	**1.5**	**2**	**2**	**2**	**0.9**	-	**1**	-	**1.4**	**4**	-	**0.2**	**2**	**2**	**3**	**0.3**	**0.4**	**0.6**	-	-	-	-	**0.4**	**28**	-	**0.6**	**12**	**0.03**	**36**	31	**45**	9	**4**	0.9	23	**22**	**0.1**	**24**
	Interpretation B4	FS	FS	FS	FS	FS	E	-	E	-	FS	FS	-	HP	FS	FS	FS	HP	HP	HP	-	-	-	-	HP	FS	-	HP	FS	HP	FS	FS	FS	FS	FS	E	FS	FS	HP	FS
	Total id's	191	188	208	350	436	1,089	111	193	88	322	180	147	301	183	128	676	487	158	190	122	97	102	81	115	174	147	129	406	4,191	683	52	675	87	126	73	77	111	107	134
Ratio 6	Density	19	19	21	35	44	109	11	19	9	32	18	15	30	18	13	68	49	16	19	12	10	10	8	12	17	15	13	41	419	68	5	68	9	13	7	8	11	11	13
Interpretation code - Ratio results		**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**SSP (E)?**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**
Interpretation code - After CA		**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**USP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**SSP (E)**	**USP (E)**	**SSP (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**
Weed categories (After Jones 1984)																																								
SFL	Winnowing				12											4			1																	1				
BHH	Coarse sieving by-product	1				2	6		2			1		4	3	1	2	22	4	2		1	1		6								1							
SHH	Coarse sieving by-product	1	1		1						4			1				5																						
SHL	Coarse sieving by-product				1																																		2	
SFH	Fine sieving by-product	17	18	34	22	70	49	9	14	5	29	34	17	14	31	22	141	26	11	10	5	7	8	10	8	28	5	11	129	1	646	31	635	72	54	16	46	66	4	96
BFH	Fine sieving by-product	8	12	17	14	36	43	10	10	5	18	8	6	63	14	11	37	65	28	11	15	14	5	10	14	1	7	17	9	32	18		12	7	13	18	2	3	70	4
IBT		1	1		1	3	3	2	2	2	5			2			5	5	1	3		2			1			2	2				1	1		1				

Table 6.5. Results of crop processing

	Unique sample no.	FEU399	FEU407	FEU43	FEU46	FEU5	FEU509	FEU51	FEU523	FEU524	FEU6	FEU70	FEU71	FEU72	FEU79	FEU94	FEU118	FEU178	FEU188	FEU200	FEU210	FEU237	FEU239	FEU256	FEU259	FEU261	FEU266	FEU275	FEU276	FEU278	FEU279	FEU282	FEU285	FEU296	FEU298	FEU299	FEU301	FEU305	FEU307	FEU312
	Feature type	General deposit	General deposit	Hearth	Hearth	General deposit	General deposit	House	General deposit	General deposit	General deposit	House	House	General deposit	Container fill	Miscellaneous	Pit	House	House	House	General deposit	Pit	Pit	General deposit	Miscellaneous	Miscellaneous	House	Pit	Pit	Container fill	Pit	General deposit	Pit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit
	Triticum monococcum g/b	9	3	1	2	2	14	2	14	6			2			14	126	36	38	72	32	326	82	24	68	28	48	114	216	194	88	232	88	94	52	146	166	72	544	242
Ratio 2	*Triticum monococcum*	14	14	11	12	10	6	11	5	16	10	2	10	14	12	3	50	10	18	27	2	79	15	3	7	9	17	40	37	69	18	15	23	15	22	12	6	22	79	101
	GlumMono/GrainMono	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2.5**	**3.8**	**2.2**	**2.7**	**16**	**4.1**	**5.6**	**9**	**10.3**	**3.1**	**2.9**	**2.8**	**5.8**	**2.8**	**5.0**	**15.6**	**3.8**	**6.3**	**2.4**	**12.2**	**27.7**	**3.3**	**6.9**	**2.4**
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
	T. monococcum 2 grain																																							
	GlumMono2/GrainMono2																																							
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Triticum dicoccum g/b	8	6														4			14		16	4	4	2	1		4	6	4	4	12			12	1	4	4	18	2
Ratio 2	*Triticum dicoccum*	1	1	1	1			1	5				3		3		6	2	1	2		12	6	1		5	2		8	3	3	2	2		1	3	1	1	13	
	GlumDicoc/GrainDicoc	-	-	-	-			-	-				-		-		-	-	-	-		**1.4**	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	**1.4**	-
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	FS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	FS	-
	Hordeum vulgare rachis			2						1								3			1	1									1							1	1	
Ratio 3	*Hordeum vulgare vulgare*	6	5	4	5	8	14	12	7	10	1	1	14	2	12	8	14	6	15	11	4	12	2	10	4	14	2	14	9	1	3	6	11	36	4	18	68	5	11	24
	RachisHord/GrainHord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**	-	-	**0**	-	-	-
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-
	Triticum spelta g/b			2																			2				2	2	2										2	
Ratio 2	*Triticum spelta*																						1																	
	GlumSpelt/GrainSpelt			-																			-				-	-	-										-	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	T.aestivum/durum rachis														1		2										5					1		1					1	
Ratio 3	*T. aestivum/durum*																											1											2	
	RachisAest/GrainAest														-		-						-				-	-				-		-					-	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	5					14	2	1	3							2	6		1		3	13	1			2	4		3	1	11		2			2	1	8	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*			2	1			2			3			2			3	1				3							3		1	13	4					2	1	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
	Weeds	62	193	21	380	117	97	40	23	42	125	48	55	45	126	188	232	85	52	82	26	662	79	27	36	57	60	155	65	126	306	137	65	65	27	101	147	33	201	129
Ratio 4	Grains	26	21	19	19	18	34	28	17	29	14	3	27	18	27	11	75	25	34	41	6	108	38	15	11	27	22	60	58	75	26	47	40	53	27	33	77	31	114	125
	Weed/Grain	**2**	**9**	**1.1**	**20**	**7**	**3**	**1.4**	**1.4**	**1.4**	**9**	**16**	**2**	**3**	**5**	**17**	**3**	**3**	**2**	**2**	**4**	**6**	**2**	**2**	**3**	**2**	**3**	**3**	**1.1**	**2**	**12**	**3**	**2**	**1.2**	**1**	**3**	**2**	**1.1**	**2**	**1**
	Interpretation	FS	FS	E	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	E	FS	FS	FS	FS	FS	E	FS	FS	E	FS	E
	1) SML A																																							
Ratio 5	1) IBT A LRG + LRG A																																							
	1) SML/LRG WEED A																																							
	Interpretation A1																																							
	2) IBT A SML + SML A																																							
Ratio 5	2) LRG A																																							
	2) SML/LRG WEED A																																							
	Interpretation A2																																							
	3) SML B	18	108	4	272	117	17	23	2	3	122	41	51	37	9	187	174	33	29	16	11	652	64	14	22	53	39	127	31	84	292	87	59	18	23	82	130	27	169	72
Ratio 5	3) IBT B LRG + LRG B	44	85	17	108	0	80	17	21	39	3	7	4	8	117	1	58	52	23	66	15	10	15	13	14	4	21	28	34	42	14	50	6	47	4	19	17	6	32	57
	3) SML/LRG WEED B	**0.4**	**1.3**	-	**3**	**117**	**0.2**	1.4	-	0.1	**41**	6	13	5	**0.1**	**187**	**3**	**0.6**	**1.3**	**0.2**	0.7	**65**	**4**	1.1	**2**	**13**	**2**	**5**	**0.9**	**2**	**21**	**2**	**10**	**0.4**	**6**	**4**	**8**	**5**	**5**	**1.3**
	Interpretation B3	HP	FS	-	FS	FS	HP	FS	-	HP	FS	FS	FS	FS	HP	FS	FS	HP	FS	HP	HP	FS	FS	E	FS	FS	FS	FS	E	FS	FS	FS	FS	HP	FS	FS	FS	FS	FS	FS
	4) IBT B SML + SML B	22	108	4	275	117	18	23	2	3	122	41	51	37	10	187	175	34	29	18	11	652	65	14	22	53	39	134	34	85	293	88	59	18	23	82	131	27	169	72
Ratio 5	4) LRG B	40	85	17	105	0	79	17	21	39	3	7	4	8	116	1	57	51	23	64	15	10	14	13	14	4	21	21	31	41	13	49	6	47	4	19	16	6	32	57
	4) SML/LRG WEED B	**0.6**	**1.3**	-	**3**	**117**	**0.2**	1.4	-	0.1	**41**	6	13	5	**0.1**	**187**	**3**	**0.7**	**1.3**	**0.3**	0.7	**65**	**5**	1.1	**2**	**13**	**2**	**6**	**1.1**	**2**	**23**	**2**	**10**	**0.4**	**6**	**4**	**8**	**5**	**5**	**1.3**
	Interpretation B4	HP	FS	-	FS	FS	HP	FS	-	HP	FS	FS	FS	FS	HP	FS	FS	HP	FS	HP	HP	FS	FS	E	FS	FS	FS	FS	E	FS	FS	FS	FS	HP	FS	FS	FS	FS	FS	FS
	Total id's	105	223	45	401	137	145	70	54	78	139	51	84	63	154	213	439	149	124	209	65	1,113	205	70	117	113	137	335	347	399	425	429	193	213	118	281	394	141	881	498
Ratio 6	Density	11	22	5	40	14	15	7	5	8	14	5	8	6	15	21	44	15	12	21	7	111	21	7	12	11	14	34	35	40	43	43	19	21	12	28	39	14	88	50
Interpretation code - Ratio results		**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**
Interpretation code - After CA		**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**
Weed categories (After Jones 1984)																																								
SFL	Winnowing	1																	5								1			2		1				6				
BHH	Coarse sieving by-product	3							5	3							3		1	1	1	2			3			3	2	1	1	2				9	2		2	2
SHH	Coarse sieving by-product	1	15														6			1				1						2		3				2	4		1	1
SHL	Coarse sieving by-product																																	1						
SFH	Fine sieving by-product	20	93	4	275	117	18	23	2	3	122	41	51	37	10	187	168	34	24	17	11	652	65	13	22	53	38	132	33	81	292	85	59	18	23	74	127	27	168	71
BFH	Fine sieving by-product	36	83	16	70		75	15	14	31	3	7	4	8	116	1	47	49	21	62	13	7	14	13	11	4	20	19	28	39	13	40	6	45	4	10	14	6	30	52
IBT		1	2	1	35		4	2	2	5							8	2	1	1	1	1					1	1	2	1		6		1						3

Table 6.5. Results of crop processing

	Unique sample no.	FEU315	FEU321	FEU327	FEU342	FEU344	FEU347	FEU350	FEU359	FEU362	FEU394	FEU404	FEU408	FEU41	FEU412	FEU413	FEU415	FEU416	FEU431	FEU433
	Feature type	General deposit	General deposit	General deposit	House	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	Container fill	General deposit
Ratio 2	*Triticum monococcum* g/b	366	42	114	186	94	52	21,566	152	132	54	212	444	32	94	448	62	56	18	144
	Triticum monococcum	61	7	34	27	26	14	1,701	30	51	20	66	106	8	23	71	6	17	8	21
	GlumMono/GrainMono	**6.0**	**6.4**	**3.4**	**6.8**	**3.6**	**3.7**	**12.7**	**5.0**	**2.6**	**2.6**	**3.2**	**4.2**	**4.2**	**4.2**	**6.3**	**10.6**	**3.4**	**2.4**	**6.9**
	Interpretation	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
	T. monococcum 2 grain																			
	GlumMono2/GrainMono2																			
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b	12		12	4	1	4	2	78	4		6	4		2	6	2		2	4
	Triticum dicoccum	5		1	12	4		1	4	7	1	5	3		1	9		4		3
	GlumDicoc/GrainDicoc	-		-	-	-	-	-	**21**	-	-	-	-		-	-	-	-	-	-
	Interpretation	-	-	-	-	-	-	-	FS	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*Hordeum vulgare* rachis			1	2		1	431	1			5						1		
	Hordeum vulgare vulgare	19	4	9	9	15	1	271	33	34	9	30	31	6	1	31	7	24	5	7
	RachisHord/GrainHord	-	-	-	-	-	-	**2**	**0**	**0**	-	**0.2**	**0**	-	-	**0**	-	**0**	-	-
	Interpretation	-	-	-	-	-	-	W	P		-	SP	P	-	-	P	-	P	-	-
Ratio 2	*Triticum spelta* g/b								4										2	
	Triticum spelta																			
	GlumSpelt/GrainSpelt								-										-	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis																			
	T. aestivum/durum												5							
	RachisAest/GrainAest												-							
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	7		2		4	10	123	1	8	6	2	3			8	1	3		5
	Interpretation	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*			2				21	1			6	48				1			
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Ratio 4	Weeds	242	24	63	62	542	34	4,120	87	127	57	274	582	111	38	285	47	64	77	119
	Grains	92	11	48	48	49	25	2,117	69	100	37	109	197	14	25	118	15	47	12	36
	Weed/Grain	**3**	**2**	**1.3**	**1.3**	**11**	**1.4**	**2**	**1.3**	**1.3**	**2**	**3**	**3**	**8**	**2**	**2**	**3**	**1.4**	**6**	**3**
	Interpretation	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Ratio 5	1) SML A																			
	1) IBT A LRG + LRG A																			
	1) SML/LRG WEED A																			
	Interpretation A1																			
Ratio 5	2) IBT A SML + SML A																			
	2) LRG A																			
	2) SML/LRG WEED A																			
	Interpretation A2																			
Ratio 5	3) SML B	229	17	29	18	446	12	801	72	94	23	112	427	110	23	252	40	30	64	87
	3) IBT B LRG + LRG B	13	7	34	44	96	22	3,319	15	33	34	162	155	1	15	33	7	34	13	32
	3) SML/LRG WEED B	**18**	-	**0.9**	**0.4**	**5**	**0.5**	**0.2**	**5**	**3**	**0.7**	**0.7**	**3**	**110**	**2**	**8**	**6**	**0.9**	**5**	**3**
	Interpretation B3	FS	-	E	HP	FS	HP	HP	FS	FS	HP	HP	FS	FS	FS	FS	FS	E	FS	FS
Ratio 5	4) IBT B SML + SML B	229	18	29	19	448	13	829	73	95	23	113	448	110	23	252	40	30	65	88
	4) LRG B	13	6	34	43	94	21	3,291	14	32	34	161	134	1	15	33	7	34	12	31
	4) SML/LRG WEED B	**18**	-	**0.9**	**0.4**	**5**	**0.6**	**0.3**	**5**	**3**	**0.7**	**0.7**	**3**	**110**	**2**	**8**	**6**	**0.9**	**5**	**3**
	Interpretation B4	FS	-	E	HP	FS	HP	HP	FS	FS	HP	HP	FS	FS	FS	FS	FS	E	FS	FS
	Total id's	712	77	238	302	686	116	28,236	391	363	148	606	1,227	157	159	857	126	168	111	303
Ratio 6	Density	71	8	24	30	69	12	2,824	39	36	15	61	123	16	16	86	13	17	11	30
Interpretation code - Ratio results		**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**
Interpretation code - After CA		**UFS (E)**	**UFS (E)**	**SFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**
Weed categories (After Jones 1984)																				
SFL	Winnowing							25										1		
BHH	Coarse sieving by-product		1			6	1	113		2	1	28	21					4	1	3
SHH	Coarse sieving by-product		2		1	1		46	3	2		1	2			5				
SHL	Coarse sieving by-product	1						6					1							
SFH	Fine sieving by-product	228	15	29	18	447	13	752	70	93	23	112	428	110	23	247	40	31	65	88
BFH	Fine sieving by-product	13	5	34	43	82	20	2,806	14	30	32	90	118	1	15	21	7	28	11	24
IBT			1			6		372			1	43	12			12				4

	Unique sample no.	FEU434	FEU435	FEU441	FEU442	FEU444	FEU447	FEU457	FEU469	FEU477	FEU53	FEU62	FEU66	FEU73	FEU75	FEU80	FEU85	FEU88	FEU38	FEU77	FEU257
	Feature type	Yard	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	House	General deposit	Pit	General deposit	House	House	Hearth	Pit	House	Container fill	General deposit	House	General deposit
Ratio 2	*Triticum monococcum* g/b	74	348	812	228	242	98	46	58	322	34	74	24	62	248	48	36	46	2	1	14
	Triticum monococcum	2	93	135	36	57	38	19	11	125	13	27	8	18	27	4	8	14	24	31	6
	GlumMono/GrainMono	**37.0**	**3.7**	**6.0**	**6.3**	**4.2**	**2.6**	**2.4**	**5**	**2.6**	**2.6**	**2.8**	**3.0**	**3.4**	**9.1**	**12.0**	**4.3**	**3.4**	**0.1**	**0**	-
	Interpretation	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	P	P	-
	T. monococcum 2 grain																				
	GlumMono2/GrainMono2																				
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b		116	6	1	6	1		4	18	2				2	4			6	2	4
	Triticum dicoccum		14	13	9	2	2		2	3	3	2	1		4	2		2	2		1
	GlumDicoc/GrainDicoc		**8**	-	-	-	-		-	-	-	-	-		-	-		-	-	-	-
	Interpretation	-	FS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*Hordeum vulgare* rachis		2	11				1		3						1					
	Hordeum vulgare vulgare	1	43	52	17	23	8	11	2	59	6	2	8	3	12	3	3	2	7	1	8
	RachisHord/GrainHord	-	**0**	**0.2**	-	-	-	-	-	**0.1**	-	-	-	-	-	-	-	-	-	-	-
	Interpretation	-	P	SP	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum spelta* g/b										2			2							
	Triticum spelta																				
	GlumSpelt/GrainSpelt										-			-							
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis																				
	T. aestivum/durum		5												2						
	RachisAest/GrainAest		-												-						
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	2		24	8	9	3	10		202	2			9		1	3		1		4
	Interpretation	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*		1			1					1	1	1	1	5	1					1
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 4	Weeds	36	187	420	102	184	101	138	19	737	313	43	54	37	342	144	69	22	42	36	22
	Grains	5	156	224	71	92	52	40	15	390	25	31	18	31	51	11	14	18	34	32	21
	Weed/Grain	**7**	**1.2**	**2**	**1.4**	**2**	**2**	**3**	**1.3**	**2**	**13**	**1.4**	**3**	**1.2**	**7**	**13**	**5**	**1.2**	**1.2**	**1.1**	**1**
	Interpretation	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	E	E
Ratio 5	1) SML A																				
	1) IBT A LRG + LRG A																				
	1) SML/LRG WEED A																				
	Interpretation A1																				
Ratio 5	2) IBT A SML + SML A																				
	2) LRG A																				
	2) SML/LRG WEED A																				
	Interpretation A2																				
Ratio 5	3) SML B	19	99	54	23	39	87	13	7	331	308	37	40	24	324	134	56	17	35	33	14
	3) IBT B LRG + LRG B	17	88	366	79	145	14	125	12	406	5	6	14	13	18	10	13	5	7	3	8
	3) SML/LRG WEED B	**1.1**	**1.1**	**0.1**	**0.3**	**0.3**	**6**	**0.1**	-	**0.8**	**62**	**6**	**3**	**2**	**18**	**13**	**4**	-	5	11	-
	Interpretation B3	E	E	HP	HP	HP	FS	HP	-	E	FS	FS	FS	FS	FS	FS	FS	-	FS	FS	-
Ratio 5	4) IBT B SML + SML B	19	101	56	23	40	87	13	7	366	308	37	40	24	324	134	60	17	35	33	14
	4) LRG B	17	86	364	79	144	14	125	12	371	5	6	14	13	18	10	9	5	7	3	8
	4) SML/LRG WEED B	**1.1**	**1.2**	**0.2**	**0.3**	**0.3**	**6**	**0.1**	-	**1**	**62**	**6**	**3**	**2**	**18**	**13**	**7**	-	5	11	-
	Interpretation B4	E	E	HP	HP	HP	FS	HP	-	E	FS	FS	FS	FS	FS	FS	FS	-	FS	FS	-
	Total id's	115	809	1,473	402	524	252	225	96	1,470	376	148	96	132	643	208	119	86	84	71	61
Ratio 6	Density	12	81	147	40	52	25	23	10	147	38	15	10	13	64	21	12	9	8	7	6
Interpretation code - Ratio results		**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)?**
Interpretation code - After CA		**UFS (E)**	**SFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**	**UFS (E)**
Weed categories (After Jones 1984)																					
SFL	Winnowing			1	2								1								
BHH	Coarse sieving by-product		3	1	2	6		4	1	17											2
SHH	Coarse sieving by-product			1		1		1													
SHL	Coarse sieving by-product																				
SFH	Fine sieving by-product	19	101	55	21	39	87	12	7	367	308	37	39	24	328	134	60	17	35	33	14
BFH	Fine sieving by-product	17	83	361	75	133	13	119	11	352	5	5	14	12	10	10	9	5	7	3	6
IBT				1	2	5	1	2		1		1		1	4						

Table 6.5. Results of crop processing

	Unique sample no. / Feature type	FEU262 Miscellaneous	FEU37 General deposit	FEU11 Pit	FEU120 Pit	FEU137 Pit	FEU138 Pit	FEU15 House	FEU154 House	FEU155 House	FEU162 House	FEU163 House	FEU201 House	FEU352 Street	FEU373 General deposit	FEU391 General deposit	FEU410 General deposit	FEU420 General deposit	FEU427 General deposit	FEU436 General deposit	FEU440 General deposit	FEU492 Container fill	FEU514 General deposit	FEU185 House	FEU401 General deposit	FEU439 General deposit	FEU95 Miscellaneous	FEU10 Pit	FEU113 Pit	FEU12 General deposit	FEU134 House	FEU136 Hearth	FEU148 General deposit	FEU152 Miscellaneous	FEU164 House	FEU170 Pit	FEU171 Pit	FEU184 House	FEU202 House	FEU208 General deposit
Ratio 2	*Triticum monococcum* g/b	74	36	54	128	72	198	22	96	96	18	38	46	264	42	44	58	92	22	34	42	132	74	14	24	14	12	34	28	42	76	16	22	36	36	32	38	44	44	34
	Triticum monococcum	29	13	28	66	41	97	13	46	46	11	23	27	128	27	24	30	44	13	18	25	84	39	13	20	7	11	31	18	40	80	16	26	54	29	44	38	41	67	26
	GlumMono/GrainMono	**2.5**	**2.7**	**1.9**	**1.9**	**1.8**	**2.0**	**1.6**	**2.1**	**2.1**	**1.6**	**1.7**	**1.7**	**2.1**	**1.6**	**1.8**	**2.0**	**2.1**	**1.8**	**1.9**	**1.7**	**1.6**	**1.9**	**1.1**	**1.2**	-	-	**1.1**	**1.5**	**1.1**	**1.0**	**1.0**	**0.9**	**0.7**	**1.2**	**0.7**	**1.0**	**1.1**	**0.7**	**1.3**
	Interpretation	FS	FS	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP?	SP?	-	-	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?
	T. monococcum 2 grain																					1																		
	GlumMono2/GrainMono2																					-																		
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b	12	6	2	18	6	12		8	8	2	4	8	2	58			4	2	4		2	2	6			2		14		4	4		2	2	6			8	2
	Triticum dicoccum	4	6		3	4	9		3	3	2	2		4	7	1		10		2	5	3	2	4	1	4		1	3			4		3	1	1			4	
	GlumDicoc/GrainDicoc	-	-	-	-	-	-		-	-	-	-	-	-	**8**	-		-	-	-	-	-	-	-	-	-	-	-	-		-	-		-	-	-			-	-
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	FS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*Hordeum vulgare* rachis				2	2	2						1			1			1			1							1								1			
	Hordeum vulgare vulgare	4	13	10	2	15	22	38	3	3	1	5	27	18		4	1	7	8	8	7	17	11	1	5	11	7	25	6	1		4	5	9	13	9	1	5	12	8
	RachisHord/GrainHord	-	-	-	-	-	-	**0**	-	-	-	-	**0**	-		-	-	-	-	-	-	-	-	-	-	-	-	**0**	-	-		-	-	-	-	-	-	-	-	-
	Interpretation	-	-	-	-	-	-	P	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum spelta* g/b						8																						2											
	Triticum spelta																																							
	GlumSpelt/GrainSpelt						-																						-											
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis																																							
	T. aestivum/durum			1										1																										
	RachisAest/GrainAest			-										-																										
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	1			3	4	1		2	2	1		2	3	9	5		10			2	5	2	3			1	1	2		1	1		3	15			5	2	4
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Panicum miliaceum*	2					78	2	1	1	2										1							1	1				1		1	1		5		
	Interpretation	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 4	Weeds	43	30	42	107	269	615	89	61	61	33	129	49	271	49	91	69	177	44	86	119	94	55	29	38	19	18	64	59	138	694	200	113	88	77	60	58	240	88	397
	Grains	40	33	40	74	63	208	53	56	56	18	30	56	154	43	35	31	70	20	28	39	110	53	21	26	21	19	59	31	41	81	26	32	68	59	56	39	55	86	38
	Weed/Grain	**1.1**	**0.9**	**1.1**	**1.4**	**4**	**3**	**2**	**1.1**	**1.1**	**2**	**4**	**0.9**	**2**	**1.1**	**3**	**2**	**3**	**2**	**3**	**3**	**0.9**	**1**	**1.4**	**1.5**	**0.9**	**0.9**	**1.1**	**2**	**3**	**9**	**8**	**4**	**1.3**	**1.3**	**1.1**	**1.5**	**4**	**1**	**10**
	Interpretation	E	E	E	FS	FS	FS	FS	E	E	FS	FS	E	FS	E	FS	FS	FS	FS	FS	FS	E	E	FS	FS	E	E	E	FS	FS	FS	FS	FS	FS	FS	E	FS	FS	E	FS
Ratio 5	1) SML A																																							
	1) IBT A LRG + LRG A																																							
	1) SML/LRG WEED A																																							
	Interpretation A1																																							
Ratio 5	2) IBT A SML + SML A																																							
	2) LRG A																																							
	2) SML/LRG WEED A																																							
	Interpretation A2																																							
Ratio 5	3) SML B	32	25	24	77	249	202	81	23	23	24	122	25	178	14	50	48	145	35	61	104	54	16	27	19	16	16	53	54	127	661	183	105	31	39	37	26	129	72	367
	3) IBT B LRG + LRG B	11	5	18	30	20	413	8	38	38	9	7	24	93	35	41	21	32	9	25	15	40	39	2	19	3	2	11	5	11	33	17	8	57	38	23	32	111	16	30
	3) SML/LRG WEED B	**3**	**5**	**1.3**	**3**	**12**	**0.5**	**10**	**0.6**	**0.6**	3	**17**	**1**	**2**	**0.4**	**1.2**	**2**	**5**	4	**2**	**7**	**1.4**	**0.4**	14	1	-	-	**5**	**11**	**12**	**20**	**11**	**13**	**0.5**	**1**	**2**	**0.8**	**1.2**	**5**	**12**
	Interpretation B3	FS	FS	FS	FS	FS	HP	FS	HP	HP	FS	FS	E	FS	HP	E	FS	FS	FS	FS	FS	HP	HP	FS	E	-	-	FS	FS	FS	FS	FS	FS	HP	E	FS	E	FS	FS	FS
Ratio 5	4) IBT B SML + SML B	33	25	25	78	249	216	82	23	23	24	122	25	178	14	53	48	147	36	61	105	59	16	27	19	16	16	54	54	129	662	183	105	31	39	37	26	166	72	367
	4) LRG B	10	5	17	29	20	399	7	38	38	9	7	24	93	35	38	21	30	8	25	14	35	39	2	19	3	2	10	5	9	32	17	8	57	38	23	32	74	16	30
	4) SML/LRG WEED B	**3**	**5**	**1.5**	**3**	**12**	**0.5**	**12**	**0.6**	**0.6**	3	**17**	**1**	**2**	**0.4**	**1.4**	**2**	**5**	5	**2**	**8**	**2**	**0.4**	14	1	-	-	**5**	**11**	**14**	**21**	**11**	**13**	**0.5**	**1**	**2**	**0.8**	**2**	**5**	**12**
	Interpretation B4	FS	FS	FS	FS	FS	HP	FS	HP	HP	FS	FS	E	FS	HP	FS	FS	FS	FS	FS	FS	HP	HP	FS	E	-	-	FS	FS	FS	FS	FS	FS	HP	E	FS	E	FS	FS	FS
	Total id's	169	105	138	329	412	1,043	164	221	221	71	201	160	691	192	171	158	343	89	152	200	339	184	70	88	54	51	157	135	221	855	246	167	194	174	154	136	339	226	471
Ratio 6	Density	17	11	14	33	41	104	16	22	22	7	20	16	69	19	17	16	34	9	15	20	34	18	7	9	5	5	16	14	22	86	25	17	19	17	15	14	34	23	47
Interpretation code - Ratio results		**UFS (E)?**	**UFS (E)?**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**
Interpretation code - After CA		**UFS (E)**	**UFS (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**
Weed categories (After Jones 1984)																																								
SFL	Winnowing																																				1			
BHH	Coarse sieving by-product	1					13	1	5	5			1	1	3	1		5		4			4			1				2		1		7	1		4		1	
SHH	Coarse sieving by-product	1			1		6	1			1		1		1	1	3		2		1	1									4				1	1			1	
SHL	Coarse sieving by-product				1		1							1		1						1																		
SFH	Fine sieving by-product	32	25	25	76	249	197	81	23	23	23	122	24	179	13	51	45	146	34	61	104	57	16	27	19	16	16	54	54	129	658	183	105	31	38	37	25	166	71	367
BFH	Fine sieving by-product	9	4	14	28	19	191	6	32	32	9	7	21	89	31	36	11	24	8	21	13	31	34	2	18	2	2	9	5	7	30	16	7	50	34	19	15	72	14	28
IBT			1	3	1	1	207		1	1			2	1	1	1	10	2			1	4	1		1			1			2		1		3	3	13	2	1	2

Table 6.5. Results of crop processing

	Unique sample no.	FEU211	FEU216	FEU23	FEU233	FEU277	FEU320	FEU335	FEU393	FEU397	FEU409	FEU421	FEU464	FEU465	FEU468	FEU479	FEU501	FEU8
	Feature type	Pit	House	General deposit	Pit	Container fill	House	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	General deposit	House	General deposit	General deposit	Pit
Ratio 2	*Triticum monococcum* g/b	14	219	22	16	38	34	76	58	74	84	12	44	14	12	78	66	18
	Triticum monococcum	12	258	26	15	26	23	97	39	55	57	14	57	20	14	63	67	19
	GlumMono/GrainMono	**1.2**	**0.8**	**0.8**	**1.1**	**1.4**	**1.5**	**0.8**	**1.5**	**1.3**	**1.5**	**0.9**	**0.8**	**0.7**	**0.9**	**1.2**	**1.0**	**1.0**
	Interpretation	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?	SP?
	T. monococcum 2 grain																	
	GlumMono2/GrainMono2																	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 2	*Triticum dicoccum* g/b		2	1		2		6						2	3		2	
	Triticum dicoccum	2	2	2		4	8	2	5	2	1	3	1				2	
	GlumDicoc/GrainDicoc	**-**	**-**	**-**		**-**	**-**	**-**	**-**	**-**	**-**	-	**-**	**-**	**-**		**-**	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*Hordeum vulgare* rachis						1	7				1				1	1	
	Hordeum vulgare vulgare	7	22	17	8	11	8	14	11	12	13	4	12	12	5	12	58	20
	RachisHord/GrainHord	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	**-**	**-**	**-**	**-**	**0**	**-**
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-
Ratio 2	*Triticum spelta* g/b																	
	Triticum spelta																	
	GlumSpelt/GrainSpelt																	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	*T.aestivum/durum* rachis							1										
	T. aestivum/durum									1								
	RachisAest/GrainAest							**-**		**-**								
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratio 3	cf. *Secale cereale*	2	1	3	2	4	19	4	2	3	2			3		69	49	
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-
Ratio 2	*Panicum miliaceum*			1	4	1			7									17
	Interpretation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Ratio 4	Weeds	215	326	364	144	73	64	187	62	79	328	33	112	73	124	254	181	84
	Grains	22	283	49	29	45	57	118	64	73	73	21	70	35	19	144	176	56
	Weed/Grain	**10**	**1.2**	**7**	**5**	**2**	**1.1**	**2**	**1**	**1.1**	**4**	**2**	**2**	**2**	**7**	**2**	**1**	**2**
	Interpretation	FS	FS	FS	FS	FS	E	FS	E	E	FS	FS	FS	FS	FS	FS	E	FS
Ratio 5	1) SML A																	
	1) IBT A LRG + LRG A																	
	1) SML/LRG WEED A																	
	Interpretation A1																	
Ratio 5	2) IBT A SML + SML A																	
	2) LRG A																	
	2) SML/LRG WEED A																	
	Interpretation A2																	
Ratio 5	3) SML B	142	14	352	138	53	11	105	19	49	200	3	81	52	112	48	65	78
	3) IBT B LRG + LRG B	73	312	12	6	20	53	82	43	30	128	30	31	21	12	206	116	6
	3) SML/LRG WEED B	**2**	**0.04**	**29**	**23**	**3**	**0.2**	**1.3**	**0.4**	**2**	**2**	0.1	**3**	**2**	**9**	**0.2**	**0.6**	**13**
	Interpretation B3	FS	HP	FS	FS	FS	HP	FS	HP	FS	FS	HP	FS	FS	FS	HP	HP	FS
Ratio 5	4) IBT B SML + SML B	143	14	352	138	54	11	105	19	49	203	4	81	52	112	49	65	78
	4) LRG B	72	312	12	6	19	53	82	43	30	125	29	31	21	12	205	116	6
	4) SML/LRG WEED B	**2**	**0.04**	**29**	**23**	**3**	**0.2**	**1.3**	**0.4**	**2**	**2**	0.1	**3**	**2**	**9**	**0.2**	**0.6**	**13**
	Interpretation B4	FS	HP	FS	FS	FS	HP	FS	HP	FS	FS	HP	FS	FS	FS	HP	HP	FS
	Total id's	251	830	436	189	158	156	395	184	226	485	67	226	124	158	477	426	158
Ratio 6	Density	25	83	44	19	16	16	40	18	23	49	7	23	12	16	48	43	16
Interpretation code - Ratio results		**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**	**USP (E)?**
Interpretation code - After CA		**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**	**USP (E)**
Weed categories (After Jones 1984)																		
SFL	Winnowing	1				1		1								1	1	
BHH	Coarse sieving by-product	1	3					18	1	1		1	8			10	5	
SHH	Coarse sieving by-product	1						4		1	11		2			2		
SHL	Coarse sieving by-product							1	1								1	
SFH	Fine sieving by-product	141	14	352	138	53	11	99	18	48	195	4	79	52	112	46	63	78
BFH	Fine sieving by-product	70	306	8	4	19	52	63	40	29	73	27	23	20	12	191	101	2
IBT		1	3	4	2		1	1	2		49	1		1		4	10	4

Table 8.1a. Mid/Late Neolithic sites with archaeobotanical material from the Carpathian Basin

Phase code	Site name	Nearest town	Country	Culture	No. of samples	Bibliographic reference
Middle Neolithic						
ABON49-1	Abony 49.	Abony	Hungary	Szakálhát	2	Gyulai 2010
ABONY8-1	Abony 8.	Abony	Hungary	LBK	1	Gyulai 2010
BECBUK-1	Becsehely-Bükkalji dűlő	Becsehely	Hungary	Sopot	1	Gyulai 2010
BECUJM-1	Becsehely-Újmajori tábla	Becsehely	Hungary	Sopot		Gyulai 2010
CEGLE4-1	Cegléd 4.	Cegléd	Hungary	Szakálhát	3	Gyulai 2010
DEVREH-1	Dévaványa-Réhelyi gát	Dévaványa	Hungary	Szakálhát-Szilmeg	4	Gyulai 2010
FUZGUB-1	Füzesabony-Gubakút	Füzesabony	Hungary	LBK	38	Gyulai 2010
LUDVAR-1	Ludas, Varjú dűlő	Ludus	Hungary	LBK	71	Gyulai 2010
MARLOK-1	Marcali-Lókpuszta	Marcali	Hungary	LBK		Gyulai 2010
MOSPAL-1	Mosonszentmiklós-Pálmajor	Mosonszentmiklós	Hungary	LBK	6	Gyulai 2010
M334MN-1	M3 34	east of Budapest	Hungary		1	Gyulai 2010
PARALT-1	Pári-Altäcker dűlő	Pári	Hungary	LBK	1	Gyulai 2010
PETRIV-1	Petrivente	Petrivente	Hungary	LBK	4	Gyulai 2010
POLG31-1	Polgár 31	Polgár	Hungary	Szatmár II	1	Gyulai 2010
POLG31-2	Polgár 31	Polgár	Hungary	Alfold LBK	105	Gyulai 2010
POLG31-3	Polgár 31	Polgár	Hungary		61	Gyulai 2010
REGEC-1	Regéc	Regéc	Hungary	LBK	42	Gyulai 2010
SORMAN-1	Sormás-Mántai dűlő	Sormás	Hungary	Sopot	1	Gyulai 2010
SZEPIT-1	Szentgyörgyvölgy-Pityerdomb	Szentgyörgyvölgy	Hungary	LBK	3	Gyulai 2010
SZOARA-1	Szombathely - Aranypatak lakópark	Szombathely	Hungary	LBK	10	Gyulai 2010
TAPPLE-1	Tapolca-Plébániakert	Tapolca	Hungary	LBK		Gyulai 2010
TISDOM-3	Tiszaszőlős-Domaháza puszta	Tiszaszőlős	Hungary	LBK	104	Gyulai 2010
TORDUL-1	Törökbálint Dulácska (Outlet áruház)	Törökbálint	Hungary	LBK	16	Gyulai 2010
ZANVAS-1	Zánka-Vasúti bevágás	Zánka	Hungary	LBK		Gyulai 2010

Phase code	Site name	Nearest town	Country	Culture	No. of samples	Bibliographic reference
Late Neolithic						
ASZPAP-1	Aszód-Papi földek	Aszód	Hungary	Lengyel (phase 1)		Gyulai 2010
BATPAR-1	Battonya-Parázstanya	Battonya	Hungary	Tisza	51	Gyulai 2010
BATVER-1	Battonya-Vertán major	Battonya	Hungary			Gyulai 2010
BERHER-1	Berettyóújfalu-Herpály	Berettyóújfalu	Hungary	Tisza-Herpály-Berettyóvölgy	1	Gyulai 2010
BERSZI-1	Berettyóújfalu-Szilhalom	Berettyóújfalu	Hungary	Tisza-Herpály-Berettyóvölgy	6	Gyulai 2010
BORPAP-1	Börcs-Paphomlok	Börcs	Hungary	Lengyel	5	Gyulai 2010
BUTMIR-1	Butmir	Ilidža	Bosnia	Butmir	;7	Renfrew 1979; Kučan 2009
DIVOST-2	Divostin	Divostin	Serbia	Vinća		McPherron and Srejović 1988
DONMOS-1	Donje Moštre	Moštre	Bosnia	Butmir	47	Kroll in press
GOMOLA-1	Gomolava	Hrtkovci	Serbia	Vinća	39	Van Zeist 2003
GORTUZ-1	Gornja Tuzla	Gornja Tuzla	Serbia	Vinča		Hopf 1967
GRASPI-1	Grapčeva Špilja	Pokrivenik	Croatia	Hvar	11	Borojević *et al.* 2008
HODCUK-1	Hódmezővásárhely-Cukortanya	Hódmezővásárhely	Hungary			Gyulai 2010
HODGOR-1	Hódmezővásárhely-Gorzsa	Hódmezővásárhely	Hungary	Tisza	2	Medovic and Horvath 2011
HODKOT-1	Hódmezővásárhely-Kotacpart	Hódmezővásárhely	Hungary	Tisza		Gyulai 2010
KUNDRU-1	Kundruci	Travnik	Bosnia	Butmir	29	Kroll in press
LEBBIL-1	Lébény-Billedomb	Lébény	Hungary		2	Gyulai 2010
LENGYE-1	Lengyel	Lengyel	Hungary	Lengyel	14	Gyulai 2010
LISICI-1	Lisičići	Konjic	Bosnia			Hopf 1958; Hopf 1966/7
LUGLNB-1	Lug	Zupčići	Bosnia			Hopf 1958; Hopf 1966/7
MEDVED-1	Medvednjak	Medvednjak	Serbia	Vinća		Renfrew 1979
MOHHOM-1	Moha-Homokbánya	Moha	Hungary	Lengyel (v. Pécel)		Gyulai 2010
MOSPAL-2	Mosonszentmiklós-Pálmajor	Mosonszentmiklós	Hungary		4	Gyulai 2010
OBREII-1	Obre II	Mustajbasici	Bosnia	Butmir	4	Renfrew 1974
OKOLIS-1	Okolište	Kakanj	Bosnia	Butmir	511	Kučan 2009
OKOLIS-2	Okolište	Kakanj	Bosnia	Butmir	511	Kroll in press

Phase code	Site name	Nearest town	Country	Culture	No. of samples	Bibliographic reference
OPOVO-1	Opovo	Opovo	Serbia	Vinća	14	Borojević 2006
PARTA-1	Parța	Parța	Romania	Vinča		Cârciumaru 1996; Fiscer and Rosch 2004
POLG10-1	Polgár 10/11.	Polgár	Hungary		52	Gyulai 2010
POLGA6-1	Polgár 6.	Polgár	Hungary		31	Gyulai 2010
POLGA7-1	Polgár 7.	Polgár	Hungary		17	Gyulai 2010
SELEVA-1	Selevač	Selevac	Serbia	Vinća		McLaren and Hubbard 1990
SUMMOG-1	Sümeg-Mogyorósdomb	Sümeg	Hungary			Gyulai 2010
SZEKOV-1	Szeghalom-Kovácshalom	Szeghalom	Hungary	Tisza		Gyulai 2010
TISCSO-2	Tiszapolgár-Csőszhalom	Polgár	Hungary	Herpály	19	Gyulai 2010
TISCSO-1	Tiszapolgár-Csőszhalom	Polgár	Hungary		18	Gyulai 2010
UIVAR-1	Uivar	Uivar	Romania	Vinča	16	Schier and Draşovean 2004
VINCAD-1	Vinča D	Vinča	Serbia	Vinča		Renfrew 1979
ZAGREB-1	Zagrebnice	Nemila	Bosnia	Butmir	28	Kroll in press
Late Neolithic/ Early Copper Age						
CHEPES-1	Cheile Turzii-Pestera Ungureasca	Cheile Turzii	Romania			Ciuta 2009
Neolithic (exact date unknown)						
BIAHOS-1	Biatorbágy-Hosszúrét	Biatorbágy	Hungary		7	Gyulai 2010
BUDAMO-1	Budapest, M0 motorway	Budapest	Hungary		2	Gyulai 2010
CEGLE4-2	Cegléd 4/1	Cegléd	Hungary		5	Gyulai 2010
POLG31-4	Polgár 31	Polgár	Hungary		8	Gyulai 2010
RIPACB-1	Ripač	Bihać	Bosnia			Bauer 1894

Table 8.1b. Copper Age sites with archaeobotanical material from the Carpathian Basin

Phase code	Site name	Nearest town	Country	Culture	No. of samples	Bibliographic reference
Early Copper Age						
ABON49-2	Abony 49.	Abony	Hungary	Bodrogkeresztúr	6	Gyulai 2010
ALBERT-1	Albertfalva	Budapest	Hungary	-	1	Gyulai 2010
BECBUK-2	Becsehely-Bükkalji dűlő	Becsehely	Hungary	Balaton-Lasinja	1	Gyulai 2010
BUDAMO-2	Budapest, M0 motorway	Budapest	Hungary	-	3	Gyulai 2010
BUDKOT-1	Budapest XI. ker. Kőérberek-Tóváros (Kána falu)	Budapest	Hungary	Ludanice	4	Gyulai 2010
DEBKOL-1	Debrecen, volt Kölcsey Művelődési Központ I.	Debrecen	Hungary	Tiszapolgár	2	Gyulai 2010
ECSER-1	Ecser	Ecser	Hungary	-		Gyulai 2010
GRASPI-2	Grapčeva Špilja	Pokrivenik, Hvar	Croatia	Nakovana	6	Borojević et al. 2008
GYOSZA-1	Győr-Szabadrétdomb	Győr	Hungary	Ludanice-Balaton-Lasinja	4	Gyulai 2010
MOSPAL-3	Mosonszentmiklós-Pálmajor	Mosonszentmiklós	Hungary	Ludanice	9	Gyulai 2010
OCSKEN-1	Öcsöd-Kendereshalom	Öcsöd	Hungary	Bodrogkeresztúr	1	Gyulai 2010
RAKUJM-1	Rákoskeresztúr-Újmajor	Budapest	Hungary	Ludanice	3	Gyulai 2010
ZALSZO-1	Zalaszentbalázs-Szőlőhegyi mező	Zalaszentbalázs	Hungary	Lengyel-Balaton-Lasinja	1	Gyulai 2010
Late Copper Age						
ABON49-3	Abony 49.	Abony	Hungary	Protoboleráz	3	Gyulai 2010
BUDALK-1	Budapest, Albertfalva-Kitérő út	Budakalász	Hungary	Baden	16	Gyulai 2010
BUDB38-1	Budapest, Bécsi út 38-42.	Budapest	Hungary	Baden	4	Gyulai 2010
BUDB44-1	Budapest, Bécsi u. 44.	Budapest	Hungary	Baden	3	Gyulai 2010
BUDCSV-1	Budapest, Csepel-Vízmű	Budapest	Hungary	Baden	4	Gyulai 2010
BUDGYO-1	Budapest, Gyorskocsi u. 26.	Budapest	Hungary	Baden	4	Gyulai 2010
BUDVIT-1	Budapest, Vitéz u. 10., R30	Budapest	Hungary	Baden	5	Gyulai 2010
END161-1	Endrőd 161.	Gyomandrőd	Hungary	Baden	7	Gyulai 2010

Phase code	Site name	Nearest town	Country	Culture	No. of samples	Bibliographic reference
GYOSZA-2	Győr-Szabadrétdomb	Győr	Hungary	Boleráz	32	Gyulai 2010
KOMKIS-1	Kompolt-Kistéri tanya	Kompolt	Hungary	Protoboleráz		Gyulai 2010
PETUJK-1	Petrivente - Újkúti dűlő	Petrivente	Hungary	Protoboleráz	1	Gyulai 2010
SZOARA-2	Szombathely - Aranypatak lakópark	Szombathely	Hungary	Baden	6	Gyulai 2010
Late Copper Age/ Early Bronze Age						
CHEPES-2	Cheile Turzii-Pestera Ungureasca	Cheile Turzii	Romania	Coțofeni	20	Ciuta 2009
Copper Age (exact date unknown)						
BUCORS-1	Bucsu - Országhatár főút	Bucsu	Hungary		1	Gyulai 2010
BUKLAS-1	Buković-Lastvine	Buković	Croatia		24	Chapman *et al.* 1996
GOMOLA-2	Gomolava	Hrtkovci	Serbia	Kostolac	10	Van Zeist 2003
KESFEN-1	Keszthely-Fenékpuszta	Keszthely	Hungary			Gyulai 2010

Table 8.1c. Bronze Age sites with archaeobotanical material from the Carpathian Basin

Phase code	Site name	Nearest town	Country	Culture	No. of samples	Bibliographic reference
Early Bronze Age						
BIAHOS-2	Biatorbágy-Hosszúrét	Biatorbágy	Hungary	Makó	4	Gyulai 2010
BUDAHU-1	Budapest, Albertfalva - Hunyadi J. u.	Budapest	Hungary	Csepel (Bell beaker)	37	Gyulai 2010
BUDAKM-1	Budakalász M0 motorway, 12.	Budakalász	Hungary	Csepel (Bell beaker)	51	Gyulai 2010
BUDCOR-1	Budapest, Corvin tér	Budapest	Hungary		2	Gyulai 2010
BUDCSH-1	Budapest, Csepel-Hollandi u.	Budapest	Hungary	Csepel (Bell beaker)	6	Gyulai 2010
CETPIC-1	Cetea-Picuiata	Cetea	Romania	Coțofeni	2	Ciuta 2009
DUNSZE-1	Dunakeszi-Székesdűlő	Dunakeszi	Hungary	Csepel (Bell beaker)	16	Gyulai 2010
END161-2	Endrőd 161.	Gyomandrőd	Hungary	Makó	6	Gyulai 2010
FEUDVA-1	Feudvar	Mošorin	Serbia		11	Kroll 1991a; Borojević 1991
KISKUN-1	Kiskundorozsma (M5 45, 26/59)	Kiskundorozsma	Hungary		27	Gyulai 2010
KISNAG-1	Kiskundorozsma-Nagyszék (26/68, 33)	Kiskundorozsma	Hungary		3	Gyulai 2010
MOSPAL-4	Mosonszentmiklós-Pálmajor	Mosonszentmiklós	Hungary		6	Gyulai 2010
PECNAG-1	Pécs-Nagyárpád	Pécs	Hungary	Somogyvár-Vinkovci	9	Gyulai 2010
SEUGOR-1	Seusa-Gorgan	Seusa	Romania	Coțofeni	11	Ciuta 2009
SZIVIZ-1	Szigetszentmiklós-Vízmű	Szigetszentmiklós	Hungary	Csepel (Bell beaker)	10	Gyulai 2010
Middle Bronze Age						
ARODON-1	Ároktő-Dongóhalom	Ároktő	Hungary	Füzesabony	1	Gyulai 2010
BALSZA-1	Balatonboglár-Szárszó	Balatonboglár	Hungary			Gyulai 2010
BARBOT-1	Baracs-Bottyánsánc	Baracs	Hungary	Nagyrév and Vatya	1	Gyulai 2010
BEKVAR-1	Békés-Várdomb	Békés	Hungary			Gyulai 2010
BOLVOR-1	Bölcske-Vörösgyír	Bölcske	Hungary	Nagyrév and Vatya		Gyulai 2010
BUDBOF-1	Budapest, Bocskai-Fehérvári úti aluljáró	Budapest	Hungary	Vatya	6	Gyulai 2010
BUDCSS-1	Budapest, Csepel-Szennyvíztelep	Budapest	Hungary	Nagyrév	13	Gyulai 2010
CARBOB-1	Carei-Bobald	Carei	Romania	Koszider	1	Ciuta 2009

Phase code	Site name	Nearest town	Country	Culture	No. of samples	Bibliographic reference
CEGLE4-3	Cegléd 4/1	Cegléd	Hungary	Vatya	1	Gyulai 2010
DOMAPA-1	Dömsöd-Apaj	Dömsöd	Hungary	Vatya		Gyulai 2010
DUNKOS-1	Dunaújváros-Kosziderpadlás	Dunaújváros	Hungary	Nagyrév and Vatya	1	Gyulai 2010
FELVAR-1	Felsődobsza-Várdomb	Felsődobsza	Hungary	Tószeg		Gyulai 2010
JASKAP-1	Jászdózsa-Kápolnahalom	Jászdózsa	Hungary	Füzesabony		Gyulai 2010
MENLEA-1	Mende-Leányvár	Mende	Hungary	Vatya	4	Gyulai 2010
MENSZE-1	Ménfőcsanak-Szeles	Ménfőcsanak	Hungary	Lime deposit culture	32	Gyulai 2010
MONKOD-1	Monkodonja	Rovinj	Croatia			Becker 2001
NAGZSI-1	Nagyrév-Zsidóhalom (Áldozóhalom)	Nagyrév	Hungary	Nagyrév and Hatvan		Gyulai 2010
PAKVAR-1	Pákozd-Várhegy	Pákozd	Hungary	Vatya, Lime deposit culture		Gyulai 2010
SOLVAR-1	Solymár-Várhegy	Solymár	Hungary	Vatya	1	Gyulai 2010
SUTHOS-1	Süttő-Hosszúvölgy	Süttő	Hungary	Magyarád	1	Gyulai 2010
SZAFOL-1	Százhalombatta-Földvár	Százhalombatta	Hungary	Vatya	162	Gyulai 2010
SZATEG-1	Százhalombatta-Téglagyár	Százhalombatta	Hungary		6	Gyulai 2010
SZIFOL-1	Szihalom-Földvár	Szihalom	Hungary		1	Gyulai 2010
TISASO-1	Tiszafüred-Ásotthalom	Tiszafüred	Hungary	Füzesabony-Hatvan-Pécel		Gyulai 2010
TISVAR-1	Tiszaalpár-Várdomb	Tiszaalpár	Hungary		43	Gyulai 2010
TOSLAP-1	Tószeg-Laposhalom	Tószeg	Hungary	Nagyrév and Hatvan		Gyulai 2010
TURTER-1	Túrkeve-Terehalom	Túrkeve	Hungary	Ottományi	4	Gyulai 2010
Late Bronze Age						
BALHID-1	Balatonmagyaród-Hídvégpuszta	Balatonmagyaród	Hungary	Tumulus	1	Gyulai 2010
BORPAP-2	Börcs-Paphomlok	Börcs	Hungary		10	Gyulai 2010
BUCORS-2	Bucsu - Országhatár főút	Bucsu	Hungary	Urnfield	3	Gyulai 2010
BUDALK-2	Budapest, Albertfalva-Kitérő út	Budapest	Hungary	Urnfield	4	Gyulai 2010
DUNSZE-2	Dunakeszi-Székesdűlő	Dunakeszi	Hungary		35	Gyulai 2010
GORKAP-1	Gór-Kápolnadomb	Gór	Hungary	Urnfield	16	Gyulai 2010

Phase code	Site name	Nearest town	Country	Culture	No. of samples	Bibliographic reference
GYOSZA-3	Győr-Szabadrétdomb	Győr	Hungary		4	Gyulai 2010
LEBBIL-2	Lébény-Billedomb	Lébény	Hungary		2	Gyulai 2010
LUDVAR-2	Ludas, Varjú dűlő	Ludus	Hungary	Kyjatice	231	Gyulai 2010
MOSNEM-1	Mosonmagyaróvár-Németdűlő	Mosonmagyaróvár	Hungary		1	Gyulai 2010
POLG31-5	Polgár 31. (Szatmár II.)	Polgár	Hungary	Tumulus	6	Gyulai 2010
PORAPO-1	Poroszló-Aponhát	Poroszló	Hungary	Gáva	2	Gyulai 2010
SOPKRA-1	Sopron-Krautacker 1	Sopron	Hungary	Urnfield	1	Gyulai 2010
Bronze Age (exact date unknown)						
BUDCOR-2	Budapest, Corvin tér	Budapest	Hungary		1	Gyulai 2010
CAREIO-1	Carei	Carei	Romania			Cârciumaru 1996
CAUSEV-1	Čauševica	Raštević	Croatia		2	Chapman *et al.* 1996
END161-3	Gyomaendrőd (Endrőd 161)	Gyomandrőd	Hungary		17	Gyulai 2010
KLAFAL-1	Klara Falva	Klárafalva	Hungary		16	Fischer and Rösch 2004
KOLCSO-1	Kölesd-Csonthegy	Kölesd	Hungary	Lime deposit culture		Gyulai 2010
MEDAUR-1	Medieşil Aurit	Medieşil Aurit	Romania			Cârciumaru 1996
NOVCUP-1	Novacka Ćuprija	Ćuprija	Serbia		38	Bankoff and Winter 1990
OARDSU-1	Oarţa de Sus	Oarţa de Jos	Romania			Cârciumaru 1996
OTOMAN-1	Otomani	Sálacea	Romania	Otomani		Cârciumaru 1996
POLG31-6	Polgár 31	Polgár	Hungary		2	Gyulai 2010
SANMIC-1	Santul Mic	Pecica	Romania		25	Oas 2010
TISBAS-1	Tiszaeszlár-Bashalom	Tiszaeszlár	Hungary		2	Gyulai 2010
ZIDOVA-1	Židovar	Vršac	Serbia	Vatin	10	Medović 2002

Table 8.1d. Mid/Late Neolithic archaeobotanical remains from the Carpathian Basin

Taxon	Middle Neolithic	ABON49-1	ABONY8-1	BECBUK-1	BECUJM-1	CEGLE4-1	DEVREH-1	FUZGUB-1	LUDVAR-1	MARLOK-1	MOSPAL-1	M334MN-1	PARALT-1	PETRIV-1	POLG31-1	POLG31-2	POLG31-3	REGEC-1	SARMON-1	SZEPIT-1	SZOARA-1	TAPPLE-1	TORDUL-1	TISDOM-3	ZANVAS-1
Abies alba																									
Abutilon theophrasti																									
Aethusa cynapium L.																									
cf. Agrimonia spp.																									
Agrostemma githago L.																									2
cf. Agrostemma githago L.																1	1								
Agrostis spp.																									
Ajuga chamaepitys L.																									
Alchemilla vulgaris L.																									
Amaranthus lividus L.																									
Amaranthus spp.																									
Amygdalus communis																									
cf. Anagallis arvensis L.		1																							
cf. Anemona nemorosa L.																					1				
Anthemis cotula																									
Anthyllis vulneraria L.																									
Aphanes arvensis L.																									
cf. Asteraceae																									
Astragalus glycyphyllus L.																									
Atriplex patula L.																5	1								
Atriplex spp.																									
Atropa belladonna																									
Avena cf. fatua L.																1									
Avena fatua L.								1								23	3						1		
cf. Avena sativa																									
Avena spp.																									
cf. Avena spp.																6									
Berberis vulgaris L.																									
Brassica campestris L.																1									
Brassica/Sinapis sp.																									
cf. Brassica nigra																									
cf. Brassicaceae																									
Bromus arvensis L.																3	4								
Bromus cf. arvensis L.																									
Bromus cf. secalinus L.																									
Bromus inermis L.																									
Bromus mollis L.																									
Bromus secalinus L.																4									
Bromus spp.													1			4									
Bromus sterilis L.																									1
Camelina sativa (L.)																									
Camelina spp.																									
Carex distans																									
Carex flacca																									
Carex hirta L.																									
Carex muricata																									
Carex spp.																									
Carex vulpina L.																									
Carex vulpina L./muricata L.																	1								
Caryophyllaceae																									
Cerealia		2				3		49			10					4032	335	15		8	227				
Cerealia - culm																8	2								
Cerealia - g/b																									
Chenopodiaceae																									
Chenopodium album agg.							1									2973	79						1		
Chenopodium hybridum L.																120									
Chenopodium polyspermum L.																									
Chenopodium spp.																				2					
Cichorium intybus L.																1									
Claviceps purpurea																								1	
Conium maculatum L.																									
Convolvulus arvensis L.																									
Cornus mas L.									1																
Coronilla varia L.																2									
Corylus avellana L.																									
Corylus spp.																									
Crataegus monogyna																									
cf. Cupressus spp.																									
Cuscuta europaea L.																									
Cuscuta spp.																									
Cyperaceae																									
Dianthus spp.																									
Digitaria ischaemum (L.)																1									
Digitaria sanguinalis (L.)																									
Echinochloa crus-galli (L.)																1							1		
Eleocharis palustris agg.																6									
Euphorbia cyparissias L.																1									
Euphorbia helioscopia																									
Fabaceae																									
Festuca cf. pratensis																2									
Festuca pratensis																									
Fragaria cf. vesca																									
Fragaria spp.																									
Fragaria vesca L.																2								2	
Fumaria cf. schleicherii																									
Galium aparine L.																									
Galium aparine/tricornutum																									
Galium mollugo L.																									
Galium spp.													1												
Galium spurium L.											1					5		1						2	
Galium verum agg.																									
Glaucium corniculatum (L.)																1	1								
Glyceria maxima																									
Gramineae		1							3							18	3							3	
Gramineae - culm																1									
Heliotropium europaeum L.																1									
Hordeum murinum L.																									
Hordeum vulgare L.																365	14				1				
Hordeum vulgare L. - hulled		2	2				245	16	27	1	1			9	1	830	73	9	X	3	25		18	21	3
Hordeum vulgare var. nudum																60	7							6	
Hordeum vulgare L. - rachis								2								16	12								
cf. Hordeum vulgare L. - culm																									
Hordeum spp.																									
Hordeum spp. - rachis																									
cf. Hordeum spp.																									
Hordeum/Triticum spp.									413					58		362	25				5		57	181	

Taxon	Late Neolithic	ASZPAP-1	BATPAR-1	BATVER-1	BERHER-1	BERSZI-1	BORPAP-1	BUTMIR-1	DIVOST-2	DONMOS-1	GOMOLA-1	GORTUZ-1	GRASPI-1	HODCUK-1	HODGOR-1	HODKOT-1	KUNDRU-1	LEBBIL-1	LENGYE-1	LISICI-1	LUGLNB-1	MEDVED-1	MOHHOM-1	MOSPAL-2
Abies alba																								
Abutilon theophrasti															934									
Aethusa cynapium L.																								
cf. Agrimonia spp.																								
Agrostemma githago L.			1								2								X					
cf. Agrostemma githago L.																								
Agrostis spp.																								
Ajuga chamaepitys L.											2													
Alchemilla vulgaris L.																								
Amaranthus lividus L.																								
Amaranthus spp.				1				1																
Amygdalus communis													17											
cf. Anagallis arvensis L.																								
cf. Anemona nemorosa L.																								
Anthemis cotula										X														
Anthyllis vulneraria L.																								
Aphanes arvensis L.																								
cf. Asteraceae																								
Astragalus glycyphyllus L.																			X					
Atriplex patula L.																								
Atriplex spp.																								
Atropa belladonna											1													
Avena cf. fatua L.											3													
Avena fatua L.																			X					
cf. Avena sativa																								
Avena spp.										X														
cf. Avena spp.																								
Berberis vulgaris L.																			X					
Brassica campestris L.																								
Brassica/Sinapis sp.																								
cf. Brassica nigra																								
cf. Brassicaceae																								
Bromus arvensis L.										X	13								X					
Bromus cf. arvensis L.																								
Bromus cf. secalinus L.								X																
Bromus inermis L.							1																	
Bromus mollis L.																								
Bromus secalinus L.										X									X					
Bromus spp.										X														
Bromus sterilis L.																								
Camelina sativa (L.)																								
Camelina spp.																								
Carex distans																								
Carex flacca																								
Carex hirta L.																								
Carex muricata																								
Carex spp.											1								X					
Carex vulpina L.																								
Carex vulpina L./muricata L.																								
Caryophyllaceae													1											
Cerealia			X				15			X			14	X	1		X	15						21
Cerealia - culm																								
Cerealia - g/b																								
Chenopodiaceae										X							X							
Chenopodium album agg.			4					6			167													
Chenopodium hybridum L.										X	1													
Chenopodium polyspermum L.											1				11									
Chenopodium spp.				3							2													
Cichorium intybus L.																								
Claviceps purpurea																								
Conium maculatum L.																								
Convolvulus arvensis L.																								
Cornus mas L.			1	2						X	9						X		X					
Coronilla varia L.																								
Corylus avellana L.								2		X							X							
Corylus spp.																								
Crataegus monogyna																								
cf. Cupressus spp.													16											
Cuscuta europaea L.																								
Cuscuta spp.																			X					
Cyperaceae																								
Dianthus spp.																			X					
Digitaria ischaemum (L.)																								
Digitaria sanguinalis (L.)																								
Echinochloa crus-galli (L.)										X					3				X					
Eleocharis palustris agg.																								
Euphorbia cyparissias L.																								
Euphorbia helioscopia											1													
Fabaceae													1											
Festuca cf. pratensis																								
Festuca pratensis																								
Fragaria cf. vesca																								
Fragaria spp.																								
Fragaria vesca L.											3				1									
Fumaria cf. schleicherii																								
Galium aparine L.																								
Galium aparine/tricornutum																								
Galium mollugo L.																								
Galium spp.																								
Galium spurium L.											1													
Galium verum agg.																								
Glaucium corniculatum (L.)																								
Glyceria maxima																								
Gramineae										X	4		1				X							
Gramineae - culm																								
Heliotropium europaeum L.																								
Hordeum murinum L.																								
Hordeum vulgare L.											76										X			
Hordeum vulgare L. - hulled							13	X		X								3	X	X	X			
Hordeum vulgare var. nudum			2792			550				X							X							
Hordeum vulgare L. - rachis		1									5													
cf. Hordeum vulgare L. - culm																								
Hordeum spp.										X							X							
Hordeum spp. - rachis										X														
cf. Hordeum spp.													2											
Hordeum/Triticum spp.																								

Taxon	OBREII-1	OKOLIS-1	OKOLIS-2	OPOVO-1	PARTA-1	POLG10-1	POLGA6-1	POLGA7-1	SELEVA-1	SUMMOG-1	SZEKOV-1	TISCSO-1	TISCSO-2	UIVAR-1	VINCAD-1	ZAGREB-1	Late Neoliuthic/ Early Copper Age	CHEPES-1	Neolithic (exact date unknown)	BIAHOS-1	BUDAMO-1	CEGLE4-2	POLG31-4	RIPACB-1
Abies alba		1																						
Abutilon theophrasti																								
Aethusa cynapium L.							1																	
cf. Agrimonia spp.														1										
Agrostemma githago L.							2							5										
cf. Agrostemma githago L.																								
Agrostis spp.														2										
Ajuga chamaepitys L.			X																					
Alchemilla vulgaris L.												3												
Amaranthus lividus L.												1												
Amaranthus spp.																								
Amygdalus communis																								
cf. Anagallis arvensis L.																								
cf. Anemona nemorosa L.																								
Anthemis cotula																								
Anthyllis vulneraria L.																							10	
Aphanes arvensis L.							3																	
cf. Asteraceae														57										
Astragalus glycyphyllus L.																								
Atriplex patula L.												7												
Atriplex spp.														2										
Atropa belladonna																								
Avena cf. fatua L.																								
Avena fatua L.							6	1				37												
cf. Avena sativa															X									
Avena spp.									X					2										
cf. Avena spp.																								
Berberis vulgaris L.																								
Brassica campestris L.																								
Brassica/Sinapis sp.														9										
cf. Brassica nigra														2										
cf. Brassicaceae														26										
Bromus arvensis L.		278										47				X								
Bromus cf. arvensis L.														2										
Bromus cf. secalinus L.																								
Bromus inermis L.																								
Bromus mollis L.	X											1												
Bromus secalinus L.		1						3				11								1				
Bromus spp.		54		19					X					49										
Bromus sterilis L.																								
Camelina sativa (L.)												1												
Camelina spp.														1										
Carex distans														2										
Carex flacca														1										
Carex hirta L.								1				1												
Carex muricata														1										
Carex spp.														22										
Carex vulpina L.												1												
Carex vulpina L./muricata L.																								
Caryophyllaceae																								
Cerealia		569	X			12	24	1947			X	9381		376		X					1		29	
Cerealia - culm														13						3			1	
Cerealia - g/b														5						2				
Chenopodiaceae		3	X													X								
Chenopodium album agg.		67					50	13	X			184		99						5			3	
Chenopodium hybridum L.		1	X				1	1				1		3		X								
Chenopodium polyspermum L.														1										
Chenopodium spp.				20					X			1		154										
Cichorium intybus L.								1																
Claviceps purpurea																								
Conium maculatum L.														5										
Convolvulus arvensis L.							1					4												
Cornus mas L.		22	X	34			5	1	X			7	17	421	X	X		19		5				
Coronilla varia L.																								
Corylus avellana L.			X						X					132		X								
Corylus spp.		29																						
Crataegus monogyna							1																	
cf. Cupressus spp.																								
Cuscuta europaea L.												1												
Cuscuta spp.																								
Cyperaceae		1																						
Dianthus spp.																								
Digitaria ischaemum (L.)												57								1				
Digitaria sanguinalis (L.)							1					21												
Echinochloa crus-galli (L.)		19	X					3				16		2		X				2				
Eleocharis palustris agg.							7					108												
Euphorbia cyparissias L.																								
Euphorbia helioscopia																								
Fabaceae				23										43										
Festuca cf. pratensis																								
Festuca pratensis							1																	
Fragaria cf. vesca				70																				
Fragaria spp.														21										
Fragaria vesca L.																								
Fumaria cf. schleicherii														18										
Galium aparine L.	X	1		5																			1	
Galium aparine/tricornutum														7										
Galium mollugo L.						1						1												
Galium spp.														76										
Galium spurium L.		4						6				3		46										
Galium verum agg.												3												
Glaucium corniculatum (L.)																								
Glyceria maxima												1												
Gramineae		58		8			8					41		57						1				
Gramineae - culm												1												
Heliotropium europaeum L.																								
Hordeum murinum L.												3												
Hordeum vulgare L.	X			26			285		X					78										X
Hordeum vulgare L. - hulled		4				2	42	269				994	12			X				7		1	11	
Hordeum vulgare var. nudum		20			11		73					7				X							4	
Hordeum vulgare L. - rachis												1		15						1				
cf. Hordeum vulgare L. - culm																						25		
Hordeum spp.		13	X													X								
Hordeum spp. - rachis		8																						
cf. Hordeum spp.																								
Hordeum/Triticum spp.							838													306			14	

Table 8.1d. Mid/Late Neolithic archaeobotanical remains from the Carpathian Basin

	Middle Neolithic	ABON49-1	ABONY8-1	BECBUK-1	BECUJM-1	CEGLE4-1	DEVREH-1	FUZGUB-1	LUDVAR-1	MARLOK-1	MOSPAL-1	M334MN-1	PARALT-1	PETRIV-1	POLG31-1	POLG31-2	POLG31-3	REGEC-1	SARMON-1	SZEPIT-1	SZOARA-1	TAPPLE-1	TORDUL-1	TISDOM-3	ZANVAS-1
Hyoscyamus niger L.																1								1	
Hyoscyamus spp.																									
Indet.		3							6		2	1			1	419	93						7	15	
Juniperus phoenicea - cone																									
Juniperus spp. - cone																									
Lamium amplexicaule L.																									
Lapsana communis																									
Lathyrus nissolia																									
Lathyrus sativus L.																	1								
Leguminosae																									
Lens culinaris Medic.				1			5									37	10				2		2	1	
Lens esculenta																									
Lens spp.																									
Linum spp.																									
Linum usitatissimum L.																292									
Lithospermum officinale L.																									
Lolium cf. remotum																1									
Lolium perenne L.																									
Lolium remotum																2									
Lolium spp.																									
Lolium temulentum L.																									
Lotus corniculatus L.																4									
Lychnis flos-cuculi L.																									
Malus spp.																									
Malus sylvestris agg.																									
Malva neglecta																									
Malva pusilla																1									
Malva spp.																									
Malva sylvestris L.																									
Matricaria inodora L.																									
Medicago cf. falcata L.																1									
Medicago lupulina L.																5	2								
Medicago minima L.																1								1	
Melampyrum arvense L.																									
Melilotus albus																2									
Melilotus cf. albus																1									
Mentha spp.																									
Molinia coerulea L.																									
Muscari comosum L.																1	1								
Oxalis cf. corniculata L.																1									
Panicum cf. miliaceum L.																									
Panicum miliaceum L.																25	1	3							5
Papaver spp.																									
Papilionaceae non cultiv.																6									
Persicaria maculosa																									
Phleum pratense L.																									
Phragmites australis																									
Physalis alkekengi																									
Pimpinella saxifraga L.																									
Pinus silvestris L.																									
Pinus spp.																									
Pinus spp. - cone																									
Pisum sativum L.											1					2	2			1					
Pisum spp.																1									
Plantago lanceolata L.																3									
Poa annua L.																2									
Poa cf. annua L.																1									
Poa cf. pratensis agg.																1									
Poa pratensis agg.																									
Poa spp.									1							2									
Polygonaceae																1									
Polygonum aviculare agg.																31									
Polygonum aviculare/convolvulus																									
Polygonum convolvulus L.							20		3				3			56					5		1	1	
Polygonum dumetorum L.																2									
Polygonum lapathifolium L.																2									
Polygonum minus																5									
Polygonum mite																									
Polygonum persicaria L.																									
Polygonum spp.																4				1					
Portulaca oleracea L.																									
Potentilla cf. reptans L.																									
Potentilla reptans L.																	3								
Potentilla spp.																									
Prunella vulgaris L.																									
Prunus avium L.																									
Prunus cerasifera																									
Prunus cf. institia																			X						
Prunus cf. spinosa agg.																									
Prunus domestica L.																									
Prunus institia																									
Prunus spinosa agg.																					2				
Prunus spp.																1									
Pucinella spp.																									
Pyrus communis																									
Pyrus spp.																									
Quercus spp.									8																
Quercus cf. pubescens																									
Ranunculus arvensis																									
Ranunculus cf. repens L.																									
Ranunculus repens L.																3									
Rubus caesius L.																									
Rubus fruticosus																									
Rubus idaeus																									
Rubus spp.																									
Rumex acetosa L.																2	1								
Rumex acetosella L.																1									
Rumex cf. obtusifolius L.																									
Rumex crispus L.																									
Rumex hydrolapathum																									
Rumex obtusifolius L.																3									
Rumex sanguineus L.																									
Rumex spp.																									
Sambucus ebulus L.														5							3			16	
Sambucus nigra L.																									
Sambucus racemosa																									

	Late Neolithic	ASZPAP-1	BATPAR-1	BATVER-1	BERHER-1	BERSZI-1	BORPAP-1	BUTMIR-1	DIVOST-2	DONMOS-1	GOMOLA-1	GORTUZ-1	GRASPI-1	HODCUK-1	HODGOR-1	HODKOT-1	KUNDRU-1	LEBBIL-1	LENGYE-1	LISICI-1	LUGLNB-1	MEDVED-1	MOHHOM-1	MOSPAL-2	OBREII-1	OKOLIS-1	OKOLIS-2	OPOVO-1	PARTA-1	POLG10-1	POLGA6-1	POLGA7-1	SELEVA-1	SUMMOG-1	SZEKOV-1	TISCSO-1	TISCSO-2	UIVAR-1	VINCAD-1	ZAGREB-1
Hyoscyamus niger L.										X																														X
Hyoscyamus spp.																										23														
Indet.			X			102					38		30			X		2						1				221			53	7				282				
Juniperus phoenicea - cone													6																											
Juniperus spp. - cone													3																											
Lamium amplexicaule L.																																						41		
Lapsana communis										X																13														
Lathyrus nissolia																										1														
Lathyrus sativus L.			557						X								X		X												1									
Leguminosae										X							X									3	X													X
Lens culinaris Medic.			2179					X		X	95		1														X	26			2					32	1	86		
Lens esculenta																									X															
Lens spp.																										446							X							
Linum spp.																			X																					
Linum usitatissimum L.			245							X	12															10												109		X
Lithospermum officinale L.																												5												
Lolium cf. remotum																																								
Lolium perenne L.																																	X							
Lolium remotum																																								
Lolium spp.																										1		2												
Lolium temulentum L.																										1														
Lotus corniculatus L.																																								
Lychnis flos-cuculi L.																																				26				
Malus spp.								X																		1														
Malus sylvestris agg.						3					3																									6				
Malva neglecta																															3									
Malva pusilla																																								
Malva spp.																															1							23		
Malva sylvestris L.																																				2		2		
Matricaria inodora L.																																								
Medicago cf. falcata L.																																								
Medicago lupulina L.																																				1		10		
Medicago minima L.																																				1				
Melampyrum arvense L.																																				8				
Melilotus albus																																						7		
Melilotus cf. albus																																								
Mentha spp.																																						9		
Molinia coerulea L.																																				1				
Muscari comosum L.																																								
Oxalis cf. corniculata L.																																								
Panicum cf. miliaceum L.																																								
Panicum miliaceum L.										X	265																				20	4				91		17		X
Papaver spp.																																						10		
Papilionaceae non cultiv.																															5					2				
Persicaria maculosa																										4														
Phleum pratense L.																																				2				
Phragmites australis																																				1				
Physalis alkekengi											235															1							X					18		X
Pimpinella saxifraga L.																																				11				
Pinus silvestris L.																			X																					
Pinus spp.																					X																			
Pinus spp. - cone													1																											
Pisum sativum L.			21		155	1619	3			X	7								X							13	X				5	2				96	2	56		
Pisum spp.																																	X							
Plantago lanceolata L.											1								X												3					3		3		X
Poa annua L.																																								
Poa cf. annua L.																																								
Poa cf. pratensis agg.																																								
Poa pratensis agg.																															1					1				
Poa spp.																																								
Polygonaceae																										4										2		11		
Polygonum aviculare agg.								1							1																6					18		6		
Polygonum aviculare/convolvulus																																	X					14		
Polygonum convolvulus L.			8							X	36													1		51	X			1	1	9				6		73		X
Polygonum dumetorum L.																																								
Polygonum lapathifolium L.								1																														2		
Polygonum minus																															1					2		4		
Polygonum mite																																				3				
Polygonum persicaria L.										X					6																									X
Polygonum spp.				1																								64								4				
Portulaca oleracea L.															1																									
Potentilla cf. reptans L.																																						2		
Potentilla reptans L.																																								
Potentilla spp.																																						27		
Prunella vulgaris L.																															15									
Prunus avium L.																																		2						
Prunus cerasifera																																				1	22			
Prunus cf. institia																																								
Prunus cf. spinosa agg.																																								
Prunus domestica L.																																					1			
Prunus institia																																						10		
Prunus spinosa agg.								1																			X					2					133	48		
Prunus spp.			2																X												1					1		30		
Pucinella spp.																																						1		
Pyrus communis																																	X							
Pyrus spp.								X																																
Quercus spp.													20																							3				
Quercus cf. pubescens																							X																	
Ranunculus arvensis																																								X
Ranunculus cf. repens L.																																						1		
Ranunculus repens L.																															1					1				
Rubus caesius L.																																	X					1		
Rubus fruticosus											9						X									2														X
Rubus idaeus																										3												1		
Rubus spp.																	X											17												
Rumex acetosa L.																																						6		
Rumex acetosella L.																															3									
Rumex cf. obtusifolius L.																																						4		
Rumex crispus L.																															1									
Rumex hydrolapathum																																1								
Rumex obtusifolius L.																															9									
Rumex sanguineus L.																																				16		6		
Rumex spp.										X	3															8														
Sambucus ebulus L.				1							44															5		5					X			1		9		
Sambucus nigra L.											2																						X					2		
Sambucus racemosa										X																1														

	Late Neolithic/ Early Copper Age	CHEPES-1	Neolithic (exact date unknown)	BIAHOS-1	BUDAMO-1	CEGLE4-2	POLG31-4	RIPACB-1
Hyoscyamus niger L.								
Hyoscyamus spp.								
Indet.				22			12	
Juniperus phoenicea - cone								
Juniperus spp. - cone								
Lamium amplexicaule L.								
Lapsana communis								
Lathyrus nissolia								
Lathyrus sativus L.								
Leguminosae								
Lens culinaris Medic.				5				X
Lens esculenta								
Lens spp.								
Linum spp.								
Linum usitatissimum L.							6	
Lithospermum officinale L.								
Lolium cf. remotum								
Lolium perenne L.								
Lolium remotum								
Lolium spp.								
Lolium temulentum L.								
Lotus corniculatus L.								
Lychnis flos-cuculi L.								
Malus spp.								
Malus sylvestris agg.								
Malva neglecta								
Malva pusilla								
Malva spp.								
Malva sylvestris L.								
Matricaria inodora L.				2				
Medicago cf. falcata L.								
Medicago lupulina L.				1				
Medicago minima L.								
Melampyrum arvense L.								
Melilotus albus								
Melilotus cf. albus								
Mentha spp.								
Molinia coerulea L.								
Muscari comosum L.								
Oxalis cf. corniculata L.								
Panicum cf. miliaceum L.		1						
Panicum miliaceum L.				5				X
Papaver spp.								
Papilionaceae non cultiv.								
Persicaria maculosa								
Phleum pratense L.								
Phragmites australis								
Physalis alkekengi								
Pimpinella saxifraga L.								
Pinus silvestris L.								
Pinus spp.								
Pinus spp. - cone								
Pisum sativum L.								
Pisum spp.				1				
Plantago lanceolata L.								
Poa annua L.							1	
Poa cf. annua L.							1	
Poa cf. pratensis agg.								
Poa pratensis agg.								
Poa spp.								
Polygonaceae								
Polygonum aviculare agg.								
Polygonum aviculare/convolvulus								
Polygonum convolvulus L.				12				
Polygonum dumetorum L.								
Polygonum lapathifolium L.								
Polygonum minus								
Polygonum mite								
Polygonum persicaria L.								
Polygonum spp.								
Portulaca oleracea L.								
Potentilla cf. reptans L.								
Potentilla reptans L.								
Potentilla spp.								
Prunella vulgaris L.								
Prunus avium L.		1						
Prunus cerasifera								
Prunus cf. institia								
Prunus cf. spinosa agg.						1		
Prunus domestica L.								
Prunus institia								
Prunus spinosa agg.								
Prunus spp.		2						
Pucinella spp.								
Pyrus communis								
Pyrus spp.								
Quercus spp.								
Quercus cf. pubescens								
Ranunculus arvensis								
Ranunculus cf. repens L.								
Ranunculus repens L.								
Rubus caesius L.								
Rubus fruticosus								
Rubus idaeus								
Rubus spp.								
Rumex acetosa L.								
Rumex acetosella L.								
Rumex cf. obtusifolius L.								
Rumex crispus L.								
Rumex hydrolapathum								
Rumex obtusifolius L.							1	
Rumex sanguineus L.								
Rumex spp.								
Sambucus ebulus L.								
Sambucus nigra L.								
Sambucus racemosa								

Table 8.1d. Mid/Late Neolithic archaeobotanical remains from the Carpathian Basin

	Middle Neolithic	ABON49-1	ABONY8-1	BECBUK-1	BECUJM-1	CEGLE4-1	DEVREH-1	FUZGUB-1	LUDVAR-1	MARLOK-1	MOSPAL-1	M334MN-1	PARALT-1	PETRIV-1	POLG31-1	POLG31-2	POLG31-3	REGEC-1	SARMON-1	SZEPIT-1	SZOARA-1	TAPPLE-1	TORDUL-1	TISDOM-3	ZANVAS-1
Sambucus spp.														2											
Sanguisorba officinalis L.																43	2								
Saponaria officinalis L.														1											
Schoenoplectus lacustris (L.)																3									
Schoenoplectus lacustris (L.)/Scirpus maritimus (L.)																									
Schoenoplectus maritimus (L.)																									
Schoenoplectus mucronatus (L.)																1	1								
Scleranthus annuus L.																2									
Scleranthus spp.																									
Secale cereale - rachis																									
Secale cereale L.																74									
Secale spp.																									
Setaria italica (L.)																									
Setaria lutescens																2									
Setaria pumila																									
Setaria verticilata/viridis																									
Setaria verticillata (L.)																								1	
Setaria viridis (L.)																30					2				
Sherardia arvensis L.																									
Silene alba																1									
Silene spp.																									
Sinapis arvensis L.																									
Solanaceae																									
Solanum dulcamara L.																1									
Solanum nigrum L.																4									
Sparganium erectum L.																									
Sparganium spp.																									
Stachys annua L.																									
cf. Stachys annua																									
Stellaria media agg.																2								1	
Teucrium chamaedrys/scordium																									
Teucrium spp.																1									
Thalictrum flavum L.																1									
Thlaspi arvense L.																									
Trapa natans L.																									
Trapa natans L. - spines																									
cf. Trapa natans																12								37	
Trifolium arvense L.																2									
Trifolium campestre																									
Trifolium cf. arvense L.																1									
Trifolium pratense (L.)																									
Trifolium repens (L.)																									
Trifolium spp.																									
Triticum cf. spelta (L.)																1								3	
Triticum aestivum L.					4											3				1				1	1
Triticum aestivum/durum																								2	
Triticum aestivum/durum - rachis																									
Triticum cf. aestivum L.																									
Triticum cf. aestivum/durum																5									
Triticum cf. boeoticum					2																				
Triticum compactum					1																				23
Triticum cf. compactum																									
Triticum dicoccum L.					130		X	14	16	5			X	5		560	17	3		52	2		6	20	11
Triticum dicoccum L. - g/b																									
Triticum cf. dicoccum L.																1	1								
Triticum cf. dicoccum L. - g/b																10									
cf. Triticum dicoccum																									
Triticum dicoccum/cf. timopheevii																									
Triticum dicoccum/cf. timopheevii - g/b																									
Triticum dicoccum/monococcum/cf. timopheevii - g/b																									
Triticum dicoccum/spelta - g/b																1				1					
Triticum durum - g/b																									
Triticum monococcum L.					15		100		3				0			23	2			12	1		2	3	9
Triticum cf. monococcum L.																				3					
Triticum monococcum L. - 2 grained																				1					
Triticum monococcum L. - g/b																									
Triticum monococcum/dicoccum									1					3		121	8			8			1		
Triticum monococcum/dicoccum - g/b																									
Triticum spelta L.					14											7	3								
Triticum spelta L. - g/b																1									
Triticum cf. timopheevii																									
Triticum cf. timopheevii - g/b																									
Triticum tetraploid (cf. Triticum parvicoccum Kislev)																1									
Triticum spp.									1							22	1			5		1	3		12
Triticum spp. - g/b																									
Triticum spp. - rachis																				1					
cf. Triticum spp.					2																				
Urtica dioica L.																									
Urtica urens L.																									
Vaccaria pyramidata																									
Verbena officinalis L.																									
Veronica hederifolia agg.																									
Veronica persica																									
Veronica spp.																									
Vicia angustifolia L.																									
Vicia angustifolia L./tetrasperma (L.)																1									
Vicia cracca L.																									
Vicia ervilia (L.)																									
Vicia faba L.																									
Vicia sativa L.																									
Vicia spp.					1																				
Vicia tetrasperma (L.)																	1								
Viola arvensis agg.																1									
Viola tricolor																									
Vitis vinifera L.																									
Vitis vinifera L. subsp. silvestris																									
Xanthium strumarium L.																									

	Late Neolithic	ASZPAP-1	BATPAR-1	BATVER-1	BERHER-1	BERSZI-1	BORPAP-1	BUTMIR-1	DIVOST-2	DONMOS-1	GOMOLA-1	GORTUZ-1	GRASPI-1	HODCUK-1	HODGOR-1	HODKOT-1	KUNDRU-1	LEBBIL-1	LENGYE-1	LISICI-1	LUGLNB-1	MEDVED-1	MOHHOM-1	MOSPAL-2	OBREII-1	OKOUS-1	OKOUS-2	OPOVO-1	PARTA-1	POLG10-1	POLG6-1	POLG7-1	SELEVA-1	SUMMOG-1	SZEKOV-1	TISCSO-1	TISCSO-2	UIVAR-1	VINCAD-1	ZAGREB-1	Late Neolithic/ Early Copper Age	CHEPES-1	Neolithic (exact date unknown)	BIAHOS-1	BUDAMO-1	CEGLE4-2	POLG31-4	RIPACB-1
Sambucus spp.																																						10										
Sanguisorba officinalis L.																																				2												
Saponaria officinalis L.																			X																													
Schoenoplectus lacustris (L.)																															15	1				3		5										
Schoenoplectus lacustris (L.)/Scirpus maritimus (L.)																															1																	
Schoenoplectus maritimus (L.)																																				1												
Schoenoplectus mucronatus (L.)																																																
Scleranthus annuus L.																																				6												
Scleranthus spp.																																						8										
Secale cereale - rachis																																						1										
Secale cereale L.																															27							11										
Secale spp.											3																																					
Setaria italica (L.)																			X																													
Setaria lutescens																																																
Setaria pumila										X																																						
Setaria verticilata/viridis																																						4										
Setaria verticillata (L.)																																	X															
Setaria viridis (L.)																															3		X			75												
Sherardia arvensis L.																															1																	
Silene alba																																				2												
Silene spp.										X	1																																					
Sinapis arvensis L.																															1																	
Solanaceae																												224										53										
Solanum dulcamara L.																																	X															
Solanum nigrum L.											2															6					3					2		46		X								
Sparganium erectum L.																																				16												
Sparganium spp.																																						3										
Stachys annua L.																															1	1				1												
cf. Stachys annua																																						14										
Stellaria media agg.																															1																1	
Teucrium chamaedrys/scordium											1																																					
Teucrium spp.																										1												19										
Thalictrum flavum L.																															1																	
Thlaspi arvense L.								1																																								
Trapa natans L.																												375										8										
Trapa natans L. - spines											12																																					
cf. Trapa natans																																																
Trifolium arvense L.																															10					154												
Trifolium campestre																																						31										
Trifolium cf. arvense L.																																																
Trifolium pratense (L.)																																				6												
Trifolium repens (L.)																																				8		89										
Trifolium spp.																										58										10												
Triticum cf. spelta (L.)																																						1										
Triticum aestivum L.						13			X		150								X													209					3					1						
Triticum aestivum/durum										X												X										2				617		99										
Triticum aestivum/durum - rachis																																						94										
Triticum cf. aestivum L.													2																													1						
Triticum cf. aestivum/durum																																						17										
Triticum cf. boeoticum																																																
Triticum compactum								X																	X					2	1					2											1	
Triticum cf. compactum																																										1						
Triticum dicoccum L.			2817	0		325		2		X	1829	X	3		1		X			X	X	X			X	286	X	636	104	2	160	6	X			4645	11624			X		36		63	1	7		X
Triticum dicoccum L. - g/b								20		X					3		X			X	X					2333	X	46										21420		X								
Triticum cf. dicoccum L.																																																
Triticum cf. dicoccum L. - g/b																																																
cf. Triticum dicoccum																																							X									
Triticum dicoccum/cf. timopheevii																																						545										
Triticum dicoccum/cf. timopheevii - g/b																																						140562										
Triticum dicoccum/monococcum/cf. timopheevii - g/b																																						194265										
Triticum dicoccum/spelta - g/b																																																
Triticum durum - g/b																										1																						
Triticum monococcum L.			1242	X		266				X	7763	X	1		1		X		X	X	X	X			X	621	0	127	352		7		X			152		479		X		9		15				
Triticum cf. monococcum L.																																																
Triticum monococcum L. - 2 grained																									X																							
Triticum monococcum L. - g/b								3		X					6		X			X	X					8908	0	1894										231716		X								
Triticum monococcum/dicoccum			238																											1	14																	
Triticum monococcum/dicoccum - g/b											8393																																					
Triticum spelta L.																															98					17	14	9						2				
Triticum spelta L. - g/b																																								X								
Triticum cf. timopheevii															9																							160										
Triticum cf. timopheevii - g/b																																						68496										
Triticum tetraploid (cf. Triticum parvicoccum Kislev)																X			X																													
Triticum spp.			X					82					14																								3					3		27				
Triticum spp. - g/b															4																																	
Triticum spp. - rachis																																																
cf. Triticum spp.																																																
Urtica dioica L.																										1																						
Urtica urens L.																															14																	
Vaccaria pyramidata																										1																						
Verbena officinalis L.																											X																					
Veronica hederifolia agg.																																						3										
Veronica persica																																															1	
Veronica spp.																										1												13										
Vicia angustifolia L.																																3				5												
Vicia angustifolia L./tetrasperma (L.)																																																
Vicia cracca L.																			X																													
Vicia ervilia (L.)					2																																	1										
Vicia faba L.																			X																			1										X
Vicia sativa L.																																				1												
Vicia spp.										X	10								X							65	X									1		21										
Vicia tetrasperma (L.)																																																
Viola arvensis agg.																																1																
Viola tricolor																																						5										
Vitis vinifera L.											1																													X								X
Vitis vinifera L. subsp. silvestris																												6								1												
Xanthium strumarium L.										X																										2												

Table 8.1e. Copper Age archaeobotanical remains from the Carpathian Basin

	Early Copper Age	ABON49-2	ALBERT-1	BECBUK-2	BUDAMO-2	BUDKOT-1	DEBKOL-1	ECSER-1	GRASPI-2	GYOSZA-1	MOSPAL-3	OCSKEN-1	RAKUJM-1	ZALSZO-1	Late Copper Age	ABON49-3	BUDALK-1	BUDB38-1	BUDB44-1	BUDCSV-1	BUDGYO-1	BUDVIT-1	END161-1	GYOSZA-2	KOMKIS-1	PETUJK-1	SZOARA-2	Late Copper Age/ Early Bronze Age	CHEPES-2	Copper Age (exact date unkown)	BUCORS-1	BUKLAS-1	GOMOLA-2	KESFEN-1
Aegilops spp.																					X													
Agrostemma githago L.																	18																23	133
Agrostemma githago L. - capsule																																		1
Atriplex patula/hastata																																1		
Avena cf. fatua L.																																	5	
Avena fatua L.		1									1						9				6													
Avena spp. - culm																																2		
Avena spp. - floret base																																2		
Ballota nigra																																	1	
Bromus arvensis L.											1						2			1														
Bromus mollis L.																	2																	
Bromus secalinus L.																	13			1				2										32
Bromus spp.																																	4	21
Bromus sterilis L.																																		1
Carex spp.																																	2	
Cerealia		30			2	55				2	49		36			63	4	3	9	14	13	7	6	152			440		208		1	21		
Chenopodiaceae																																3		
Chenopodium album agg.		6									1			1				3		1				6	1							2	8	15
Chenopodium hybridum L.																					1												1	
Convolvulus arvensis L.												1																						
Cornus mas L.						1											5												52					
Coronilla spp.																																	1	
Corylus avellana L.																									125				1					
Crataegus monogyna																				2														
cf. Cupressus spp.									2																									
Cyperaceae																																	1	
Digitaria cf. sanguinalis (L.)																																	1	
Digitaria ischaemum (L.)																	1																	
cf. Echinochloa crus-galli (L.)																																	2	
Echinochloa spp.																																1		
Eleocharis spp.																																	1	
Fagus silvatica L.																				2														
Galium aparine L.																																	2	
Galium spp.																																	8	
Galium spurium L.						1											1																	
Gramineae		1							1								8										1					28	4	
Gramineae - culm																	1																	
Hordeum vulgare L.																	76					4					4		1				1301	
Hordeum vulgare L. - hulled		8		2		4				2	12		30			21	45	2	5	3	13	3	6	108	3		19							
Hordeum vulgare var. nudum																	12							3			1						507	1
Hordeum vulgare L. - rachis																	1							2										
Hordeum spp. - rachis																																	1	
cf. Hordeum spp.																																1		
Hordeum/Triticum spp.				7		4											705									1	39							
Hyoscyamus cf. niger																																	1	
Indet.		6	1				1		6	1							99	2			2												31	
Lamiaceae																																1		
Lathyrus cicera L.																								1										
Leguminosae																																1		
Lens culinaris Medic.										4																							6	
Linum cf. tenuifolium L.																					1													
Linum usitatissimum L.										4																							1	
Malva spp.																																	1	
Malva sylvestris L.																	1				1													
Malvaceae																																	1	
Nepeta spp.																																	1	
Panicum miliaceum L.										5														12					1				406	
cf. Panicum miliaceum L.		1																																
Papaver dubium L.																																		1
Papilionaceae non cultiv.																	1																	
Physalis alkekengi																																	5	
Pisum sativum L.																											1							
Poa spp.																							1											
Polygonum aviculare agg.																					1												2	
Polygonum convolvulus L.												5					20				2												5	
Portulaca oleracea L.																																1		
Quercus spp.									22																									
Quercus robur L./petraea																				34														
Rumex acetosa L.																																1		
Rumex conglomeratus													2																					
Rumex pulcher																																	1	
Rumex spp.																																	1	
Sambucus ebulus L.						1											1								18		2						11	
Sambucus nigra L.																													108					
Schoenoplectus lacustris (L.)													1																					
Schoenoplectus maritimus (L.)																																	1	
Scirpus spp.																																	7	
Secale cereale L.																													1					2
Setaria spp.																								2										
Setaria viridis (L.)																	2																	
cf. Setaria spp.																																2		
Sinapis arvensis L.												X																						
Solanum dulcamara L.																									4									
Solanum nigrum L.																																	5	
Stipa spp.								X																										
Teucrium chamaedrys L.																					55													
Teucrium chamaedrys/scordium																																	21	
Thalictrum flavum L.													1																					
Triticum aestivum L.																					1								3				96	
Triticum compactum																	1			1				1										
Triticum dicoccum L.		2				6					1		1				118		1	11	12	1		14		2	7		103				308	102
Triticum monococcum L.		2				12											449			55	3			3					55				1474	508
Triticum monococcum/dicoccum						51																												
Triticum monococcum/dicoccum - g/b																																	104	
Triticum spelta L.																	4																	2
Triticum spp.									1							2	1																	
Triticum spp. - g/b																																37		
cf. Triticum spp.																																3		
Vicia cf. angustifolia L.																	1																	
Vicia ervilia (L.)																																	1	
Vicia spp.																													4				8	
Vitis vinifera L. subsp. silvestris																									18									

Table 8.1f. Bronze Age archaeobotanical remains from the Carpathian Basin

	Early Bronze Age	BIAHOS-2	BUDAHU-1	BUDAKM-1	BUDCOR-1	BUDCSH-1	CETPIC-1	DUNSZE-1	END161-2	FEUDVA-1	KISKUN-1	KISNAG-1	MOSPAL-4	PECNAG-1	SEUGOR-1	SZIVIZ-1
Aegilops cf. cylindrica			1												
Aethusa cynapium L.															
Agrimonia eupatoria L.													X		
Agrimonia spp.									43					
Agropyron repens L.			3										X		
Agrostemma githago L.			2										21		
Ajuga chamaepitys L.															
Ajuga reptans L.															
Ajuga spp.															
Amaranthus lividus L.															
Anagallis arvensis L.				1								1			
Anethum graveolens L.															
cf. Apium graveolens L.															
Apiaceae															
Arenaria serpyllifolia L.															
Asteraceae															
Atriplex patula L.															
cf. Atriplex patula															
Avena fatua L.		1		2		23									
Avena fatua L./sterilis L.															
Avena spp.								1		1					
Beupleurum rotundifolium															
Blysmus compressus L.						1									
Brassica campestris L.																1
Brassica nigra (L.)															
Brassica rapa															
Brassica spp. - capsule															
Brassicaceae															
Bromus arvensis L.			9			1		1		21					
Bromus arvensis/secalinus															
Bromus cf. commutatus															
Bromus erectus L.															
Bromus inermis L.															
Bromus mollis L.			2												
Bromus secalinus L.			16										8		
Bromus spp.															
Bromus sterilis L.										3				1		
Bromus tectorum L.													X		
Bupleurum rotundifolium L.															
Calamintha acinos (L.)			1												
Calystegia spp.															
Camelina sativa (L.)										3				X		
Camelina sativa (L.) - capsule													1		
Capsella bursa-pastoris (L.) Medic.															
Carduus acanthoides L.															
Carex bicarpellat															
Carex hirta L.															
Carex hordeistichos															
Carex spp.															
Carex subgen. Eucarex															
Carpinus cf. orientalis Mill.															
Carthamus tinctorius L.															
Caryophyllaceae															
Centaurea jacea L.			1												
Centaurea spp.													X		
Cerealia			679	205	112	174						7	74			206
Cerealia - culm															
Cerinthe minor L.															
Chenopodium album agg.			5		1	3		2				1		2		6
Chenopodium cf. album										100					
Chenopodium ficifolium Sm.															
Chenopodium hybridum L.				1									1		
Chenopodium polyspermum L.			7												
Chenopodium spp.															
Cicer arietinum L.															
Cichorium intybus L.															
Cirsium arvense L.						1									
Cirsium spp.															
Cladium mariscus															
Claviceps purpurea															
Clinopodium vulgare L.			1												
Conium maculatum L.															
Conringia orientalis (L.)															
Convolvulus arvensis L.													X		
Cornus mas L.										1					
Cornus sanginea															
cf. Cucumis sativus L.															
Cucumis spp.															
Cyperaceae															
Datura stramonium L.													X		
Daucus carota L.															
Daucus spp.															
Digitaria ischaemum (L.)			3			1									
Digitaria sanguinalis (L.)															
Echinochloa crus-galli (L.)			1												
Eleocharis palustris agg.															
Equisetum arvense L.			1												
Euphorbia cyparissias L.															
Fabaceae										2					
Festuca cf. pratensis															
Fragaria vesca L.										1					
Fumaria schleicheri				2											
Galium aparine L.			1												
Galium cf. spurium L.															
Galium mollugo L.															
Galium spp.															

	Middle Bronze Age	ARODON-1	BALSZA-1	BARBOT-1	BEKVAR-1	BOLVOR-1	BUDBOF-1	BUDCSS-1	CARBOB-1	CEGLE4-3	DOMAPA-1	DUNKOS-1	FELVAR-1	JASKAP-1	MENLEA-1	MENSZE-1	MONKOD-1	NAGZSI-1	PAKVAR-1	SOLVAR-1	SUTHOS-1	SZAFOL-1	SZATEG-1	SZIFOL-1	TISASO-1	TISVAR-1	TOSLAP-1	TURTER-1
Aegilops cf. cylindrica																											
Aethusa cynapium L.																											
Agrimonia eupatoria L.																											
Agrimonia spp.																											
Agropyron repens L.		7																									
Agrostemma githago L.		128	8	5	X		1					2			4				2			13	132			11		
Ajuga chamaepitys L.																						1					
Ajuga reptans L.																						1					
Ajuga spp.																						1					
Amaranthus lividus L.																						2					
Anagallis arvensis L.							1																				
Anethum graveolens L.																											
cf. Apium graveolens L.																											
Apiaceae																											
Arenaria serpyllifolia L.																						3					
Asteraceae																											
Atriplex patula L.																											X	2
cf. Atriplex patula								1																			
Avena fatua L.						35	6	48														55					1	8
Avena fatua L./sterilis L.																											
Avena spp.																	X					1					
Beupleurum rotundifolium																											
Blysmus compressus L.																											
Brassica campestris L.																												1
Brassica nigra (L.)																										5		
Brassica rapa																											
Brassica spp. - capsule																											
Brassicaceae												1										1					
Bromus arvensis L.			18					2								4						10				22		
Bromus arvensis/secalinus																											
Bromus cf. commutatus				4																							
Bromus erectus L.																						1					
Bromus inermis L.																											
Bromus mollis L.						3																5					
Bromus secalinus L.						622	1					3				3						26				14		1
Bromus spp.											X								1			2	103				1	2
Bromus sterilis L.				3																							
Bromus tectorum L.						1																					
Bupleurum rotundifolium L.																											
Calamintha acinos (L.)																											
Calystegia spp.					X																						
Camelina sativa (L.)																											
Camelina sativa (L.) - capsule																											
Capsella bursa-pastoris (L.) Medic.												1															
Carduus acanthoides L.																						1					
Carex bicarpellat																											
Carex hirta L.																						1					
Carex hordeistichos																										5		
Carex spp.																											
Carex subgen. Eucarex																											
Carpinus cf. orientalis Mill.							1																				
Carthamus tinctorius L.																												1246
Caryophyllaceae																						5					
Centaurea jacea L.																											
Centaurea spp.																											1	
Cerealia						129		99				3				82						1230						101
Cerealia - culm																											
Cerinthe minor L.																											
Chenopodium album agg.						3	10					5			15							72				16		36609
Chenopodium cf. album																											
Chenopodium ficifolium Sm.																											
Chenopodium hybridum L.																								2				
Chenopodium polyspermum L.																											
Chenopodium spp.														2														
Cicer arietinum L.																											X	
Cichorium intybus L.																											
Cirsium arvense L.		5																									
Cirsium spp.												1															
Cladium mariscus																											
Claviceps purpurea																											
Clinopodium vulgare L.																											
Conium maculatum L.																											
Conringia orientalis (L.)				1																							
Convolvulus arvensis L.		4																							4	1	
Cornus mas L.						2								12														
Cornus sanginea																											
cf. Cucumis sativus L.																											
Cucumis spp.																								X				
Cyperaceae																											
Datura stramonium L.																											
Daucus carota L.																						1					
Daucus spp.												1															
Digitaria ischaemum (L.)																						1					
Digitaria sanguinalis (L.)																											
Echinochloa crus-galli (L.)																											
Eleocharis palustris agg.																											
Equisetum arvense L.																											X	
Euphorbia cyparissias L.								1																			
Fabaceae																											
Festuca cf. pratensis																						2					
Fragaria vesca L.																											
Fumaria schleicheri																											
Galium aparine L.																						1						1
Galium cf. spurium L.																											
Galium mollugo L.																											
Galium spp.								2																			

	Late Bronze Age	BALHID-1	BORPAP-2	BUCORS-2	BUDALK-2	DUNSZE-2	GORKAP-1	GYOSZA-3	LEBBIL-2	LUDVAR-2	MOSNEM-1	POLG31-5	PORAPO-1	SOPKRA-1
Aegilops cf. cylindrica													
Aethusa cynapium L.										2				
Agrimonia eupatoria L.													
Agrimonia spp.													
Agropyron repens L.													
Agrostemma githago L.							35			5			51	
Ajuga chamaepitys L.					1									
Ajuga reptans L.									1					
Ajuga spp.													
Amaranthus lividus L.													
Anagallis arvensis L.													
Anethum graveolens L.										3				
cf. Apium graveolens L.										1				
Apiaceae										3				
Arenaria serpyllifolia L.													
Asteraceae													
Atriplex patula L.						13				1				
cf. Atriplex patula													
Avena fatua L.		1								12		1		
Avena fatua L./sterilis L.										2				
Avena spp.													
Beupleurum rotundifolium													
Blysmus compressus L.													
Brassica campestris L.									5	1				
Brassica nigra (L.)													
Brassica rapa													
Brassica spp. - capsule												1		
Brassicaceae													
Bromus arvensis L.					2	2	59		3	5			57	
Bromus arvensis/secalinus													
Bromus cf. commutatus													
Bromus erectus L.							1							
Bromus inermis L.							19						4	
Bromus mollis L.					1		3							
Bromus secalinus L.			1			2	261			36		1	84	
Bromus spp.							353		2					
Bromus sterilis L.													
Bromus tectorum L.													
Bupleurum rotundifolium L.										1				
Calamintha acinos (L.)										1				
Calystegia spp.													
Camelina sativa (L.)							359							
Camelina sativa (L.) - capsule													
Capsella bursa-pastoris (L.) Medic.													
Carduus acanthoides L.													
Carex bicarpellat									1					
Carex hirta L.													
Carex hordeistichos													
Carex spp.													
Carex subgen. Eucarex													
Carpinus cf. orientalis Mill.													
Carthamus tinctorius L.													
Caryophyllaceae													
Centaurea jacea L.													
Centaurea spp.													
Cerealia			219	4	131	36		9	184	352	13	132		
Cerealia - culm												16		
Cerinthe minor L.									1					
Chenopodium album agg.					333	15	96	1	17	130		46		11
Chenopodium cf. album													
Chenopodium ficifolium Sm.										2				
Chenopodium hybridum L.					39		184		4	7				
Chenopodium polyspermum L.													
Chenopodium spp.							10							
Cicer arietinum L.													
Cichorium intybus L.										2				
Cirsium arvense L.													
Cirsium spp.													
Cladium mariscus													
Claviceps purpurea										6				
Clinopodium vulgare L.													
Conium maculatum L.					1					3				
Conringia orientalis (L.)													
Convolvulus arvensis L.													8	
Cornus mas L.						1								
Cornus sanginea													
cf. Cucumis sativus L.					3									
Cucumis spp.													
Cyperaceae													
Datura stramonium L.													
Daucus carota L.										3				
Daucus spp.													
Digitaria ischaemum (L.)			2			1			22	2				
Digitaria sanguinalis (L.)					1				2	24				
Echinochloa crus-galli (L.)					2					26		1		
Eleocharis palustris agg.							1							
Equisetum arvense L.													
Euphorbia cyparissias L.			1											
Fabaceae													
Festuca cf. pratensis						1				1				
Fragaria vesca L.													
Fumaria schleicheri											4			
Galium aparine L.										3				
Galium cf. spurium L.													
Galium mollugo L.			1											
Galium spp.													

	Bronze Age (exact date unkown)	BUDCOR-2	CAREIO-1	CAUSEV-1	END161-3	KLAFAL-1	KOLCSO-1	MEDAUR-1	NOVCUP-1	OARDSU-1	OTOMAN-1	POLG31-6	SANMIC-1	TISBAS-1	ZIDOVA-1
Aegilops cf. cylindrica														
Aethusa cynapium L.														
Agrimonia eupatoria L.														1
Agrimonia spp.														
Agropyron repens L.														
Agrostemma githago L.														18
Ajuga chamaepitys L.														
Ajuga reptans L.														
Ajuga spp.														
Amaranthus lividus L.														
Anagallis arvensis L.														
Anethum graveolens L.														
cf. Apium graveolens L.														
Apiaceae														
Arenaria serpyllifolia L.														
Asteraceae														1
Atriplex patula L.														
cf. Atriplex patula														
Avena fatua L.													20	
Avena fatua L./sterilis L.														
Avena spp.												10		
Beupleurum rotundifolium														1
Blysmus compressus L.														
Brassica campestris L.														
Brassica nigra (L.)														
Brassica rapa												13		
Brassica spp. - capsule														
Brassicaceae												33		
Bromus arvensis L.														27
Bromus arvensis/secalinus														7
Bromus cf. commutatus														
Bromus erectus L.														
Bromus inermis L.														
Bromus mollis L.		1													
Bromus secalinus L.														10
Bromus spp.			X							X			28		4
Bromus sterilis L.														
Bromus tectorum L.														
Bupleurum rotundifolium L.														
Calamintha acinos (L.)														
Calystegia spp.														
Camelina sativa (L.)														1091
Camelina sativa (L.) - capsule														
Capsella bursa-pastoris (L.) Medic.														
Carduus acanthoides L.														
Carex bicarpellat														
Carex hirta L.														
Carex hordeistichos														
Carex spp.												18		
Carex subgen. Eucarex														1
Carpinus cf. orientalis Mill.														
Carthamus tinctorius L.														
Caryophyllaceae														
Centaurea jacea L.														
Centaurea spp.														
Cerealia		3055			7										53
Cerealia - culm														
Cerinthe minor L.														
Chenopodium album agg.		2			617								248		
Chenopodium cf. album														
Chenopodium ficifolium Sm.														
Chenopodium hybridum L.		1			1										3
Chenopodium polyspermum L.														5940
Chenopodium spp.									69					
Cicer arietinum L.														
Cichorium intybus L.														
Cirsium arvense L.														
Cirsium spp.														
Cladium mariscus														1
Claviceps purpurea														
Clinopodium vulgare L.														
Conium maculatum L.														
Conringia orientalis (L.)														
Convolvulus arvensis L.														
Cornus mas L.		1							9						1
Cornus sanginea								1						
cf. Cucumis sativus L.														
Cucumis spp.														
Cyperaceae														11
Datura stramonium L.														
Daucus carota L.														
Daucus spp.														
Digitaria ischaemum (L.)		2													
Digitaria sanguinalis (L.)														
Echinochloa crus-galli (L.)														2
Eleocharis palustris agg.														
Equisetum arvense L.														
Euphorbia cyparissias L.														
Fabaceae												28		2
Festuca cf. pratensis														
Fragaria vesca L.														3
Fumaria schleicheri														
Galium aparine L.														
Galium cf. spurium L.									1					
Galium mollugo L.														
Galium spp.														

Table 8.1f. Bronze Age archaeobotanical remains from the Carpathian Basin

	Early Bronze Age	BIAHOS-2	BUDAHU-1	BUDAKM-1	BUDCOR-1	BUDCSH-1	CETPIC-1	DUNSZE-1	END161-2	FEUDVA-1	KISKUN-1	KISNAG-1	MOSPAL-4	PECNAG-1	SEUGOR-1	SZIVIZ-1
Galium spurium L.			5						1							
Galium verum agg.																
Glaucium corniculatum (L.)			4													
Glechoma hederacum L.																
Gramineae			22					1			1					
Gramineae - culm																
Gramineae - g/b																
Heliotropium europaeum L.			2													
Hibiscus trionum L.																
Hordeum murinum L.			1													
Hordeum vulgare L.			1035			2			56	3661						
Hordeum vulgare L. - hulled			52	48	44	36		31			1		11	X		52
Hordeum vulgare var. nudum			9	4		1		3								
Hordeum vulgare L. - rachis			10													
cf. Hordeum vulgare L. - culm																
Hordeum spp.																
Hordeum/Triticum spp.		20	1					268								
Hordeum/Triticum spp. - rachis																
Hyoscyamus niger L.			1													
Indet.		59	313	1		5		5			11			X		
Iris pseudacorus L.																
Juniper spp.																
Lamiaceae																
Lamium amplexicaule L.																
Lathyrus sativus L.																
Leersia oryzoides																
Lens culinaris Medic.				1						4				X		
Linum perenne L./austriacum L.																
Linum spp.													1			
Linum usitatissimum L.										1						
Linum usitatissimum L. - capsule																
Lithospermum arvense L.																
Lithospermum officinale L.																
Lolium multiflorum																
Lolium perenne L.																
Lolium spp.			1							38				X		
Lolium temulentum L.																
Lotus corniculatus L.																
Lychnis flos-cuculi L.																
Lycopus europaeus L.																
Malus spp.																
Malus sylvestris agg.																
Malva neglecta			2													
Malva spp.														X		
Malva sylvestris L.			5													1
Marrubium vulgare L.																
Matricaria inodora L.																
Matricaria spp.																
Medicago lupulina L.																
Medicago minima L.			1													
Medicago spp.					1											
Melampyrum arvense L.			1					1								
Melampyrum spp.																
Melilotus albus			1													
Melilotus dentatus																
Melilotus officinalis L.			1													
Melilotus spp.																
Melilotus/Trifolium spp.																
Mentha spp.																
Muscari comosum L.																
Nepeta cataria L.			1													
Neslia paniculata L.			1													
Olea spp.																
Ornithogalum pyramidale L.			8													
Panicum miliaceum L.				1					1	4						8
Papaver somniferum L.																
Papaver spp.																
Papilionaceae cultiv.																
Phragmites australis																
cf. Phragmites australis																
Pimpinella saxifraga L.																
Pisum elatius																
Pisum sativum L.			1							1			3	X		
Pisum spp.																
Plantago lanceolata L.										34						
Plantago media L.																
Poa cf. annua L.			1													
Poa cf. pratensis agg.																
Poa spp.																
Poa/Alopecurus spp.														1		
Polygonaceae																
Polygonum aviculare agg.			1						1							
Polygonum convolvulus L.			3							88				1		1
Polygonum dumetorum L.																
Polygonum hydropiper L.						1										
Polygonum lapathifolium L.																
Polygonum minus																
Polygonum mite			2													
Polygonum persicaria L.																
Portulaca oleracea L.																
Potentilla cf. supina L.																
Potentilla reptans L.																
Potentilla spp.																
Prunella vulgaris L.																
Prunus cerasifera																
Prunus non spinosa																

	Middle Bronze Age	ARODON-1	BALSZA-1	BARBOT-1	BEKVAR-1	BOLVOR-1	BUDBOF-1	BUDCSS-1	CARBOB-1	CEGLE4-3	DOMAPA-1	DUNKOS-1	FELVAR-1	JASKAP-1	MENLEA-1	MENSZE-1	MONKOD-1	NAGZSI-1	PAKVAR-1	SOLVAR-1	SUTHOS-1	SZAFOL-1	SZATEG-1	SZIFOL-1	TISASO-1	TISVAR-1	TOSLAP-1	TURTER-1
Galium spurium L.				1				2							1													
Galium verum agg.																												
Glaucium corniculatum (L.)				4																								
Glechoma hederacum L.																												
Gramineae						24	2	37				5										53						1
Gramineae - culm						5																8						
Gramineae - g/b						7																1						
Heliotropium europaeum L.																												
Hibiscus trionum L.																												
Hordeum murinum L.																1						5						
Hordeum vulgare L.							46					141					X									3		
Hordeum vulgare L. - hulled				##	X	9320	34	3			X	231	46	5	X	74			2	X		3603	1			4559	X	4
Hordeum vulgare var. nudum						9	1						X			1						21	3			5		
Hordeum vulgare L. - rachis												2										123						
cf. Hordeum vulgare L. - culm										1																		
Hordeum spp.																												
Hordeum/Triticum spp.							259	8																				
Hordeum/Triticum spp. - rachis																												15
Hyoscyamus niger L.																												
Indet.							43	28				X										24				X	X	18
Iris pseudacorus L.																												
Juniper spp.																												
Lamiaceae																												
Lamium amplexicaule L.																												
Lathyrus sativus L.																	X									744	X	
Leersia oryzoides																												
Lens culinaris Medic.				13		4688	3	1					X		1							114				3253	X	53
Linum perenne L./austriacum L.																												
Linum spp.																												
Linum usitatissimum L.																										11		
Linum usitatissimum L. - capsule																										1		
Lithospermum arvense L.																						6						
Lithospermum officinale L.																										7		
Lolium multiflorum																												
Lolium perenne L.																												
Lolium spp.																												
Lolium temulentum L.																												
Lotus corniculatus L.																						1						
Lychnis flos-cuculi L.																												1
Lycopus europaeus L.																												1
Malus spp.																			1									
Malus sylvestris agg.																								5				
Malva neglecta																												
Malva spp.																												
Malva sylvestris L.																								1				
Marrubium vulgare L.																												
Matricaria inodora L.																												
Matricaria spp.																												
Medicago lupulina L.						1	1															1						
Medicago minima L.																								2				
Medicago spp.																								1				
Melampyrum arvense L.																1								1				
Melampyrum spp.					X																							
Melilotus albus																												
Melilotus dentatus							1																					
Melilotus officinalis L.																												
Melilotus spp.																												
Melilotus/Trifolium spp.																												
Mentha spp.																												
Muscari comosum L.		8																										
Nepeta cataria L.																												
Neslia paniculata L.																												
Olea spp.																												
Ornithogalum pyramidale L.																						9						
Panicum miliaceum L.						6										2	X					2			X		2	
Papaver somniferum L.																												
Papaver spp.																												
Papilionaceae cultiv.						1																20						
Phragmites australis																												
cf. Phragmites australis																												
Pimpinella saxifraga L.															1													
Pisum elatius																										4		
Pisum sativum L.						11	2										X		X			18		X		383	X	103
Pisum spp.							1																			5		
Plantago lanceolata L.																												
Plantago media L.																												1
Poa cf. annua L.																												
Poa cf. pratensis agg.							2																					
Poa spp.																												
Poa/Alopecurus spp.																												
Polygonaceae																						1						
Polygonum aviculare agg.																			45			2				8		9
Polygonum convolvulus L.				1		2	1								28	1						19				3	9	27
Polygonum dumetorum L.		5																										
Polygonum hydropiper L.																												
Polygonum lapathifolium L.																												
Polygonum minus																												
Polygonum mite																												
Polygonum persicaria L.																												
Portulaca oleracea L.							1																					
Potentilla cf. supina L.																												
Potentilla reptans L.																												
Potentilla spp.																						3						
Prunella vulgaris L.																												
Prunus cerasifera																												
Prunus non spinosa																												

	Late Bronze Age	BALHID-1	BORPAP-2	BUCORS-2	BUDALK-2	DUNSZE-2	GORKAP-1	GYOSZA-3	LEBBIL-2	LUDVAR-2	MOSNEM-1	POLG31-5	PORAPO-1	SOPKRA-1	Bronze Age (exact date unkown)	BUDCOR-2	CAREIO-1	CAUSEV-1	END161-3	KLAFAL-1	KOLCSO-1	MEDAUR-1	NOVCUP-1	OARDSU-1	OTOMAN-1	POLG31-6	SANMIC-1	TISBAS-1	ZIDOVA-1
Galium spurium L.							23			18																			16
Galium verum agg.							1			1																			
Glaucium corniculatum (L.)																													
Glechoma hederacum L.										1																			
Gramineae							241		3	17								2	1								498		23
Gramineae - culm					1	8				2																			
Gramineae - g/b																													
Heliotropium europaeum L.									1	2																			
Hibiscus trionum L.										1																			
Hordeum murinum L.										1																			
Hordeum vulgare L.					16					13		5					X					X			X		11		
Hordeum vulgare L. - hulled		1	76		30	31	673	7	205	48	6	17	265	2		6			9					248		10			118
Hordeum vulgare var. nudum			1					1	1	16		1												1					
Hordeum vulgare L. - rachis											1																		
cf. Hordeum vulgare L. - culm																													
Hordeum spp.																							30				41		
Hordeum/Triticum spp.			6009			22				6009		3														10			
Hordeum/Triticum spp. - rachis																													
Hyoscyamus niger L.									1																				1
Indet.			1		20	34	15		3	850		5				23			1							6			
Iris pseudacorus L.						1																							
Juniper spp.																		20											
Lamiaceae										1																			12
Lamium amplexicaule L.										1																			
Lathyrus sativus L.		37																											
Leersia oryzoides																											20		
Lens culinaris Medic.		4	1		2		56			32		4	40	2									95				3		56
Linum perenne L./austriacum L.					1																								
Linum spp.																													
Linum usitatissimum L.																													
Linum usitatissimum L. - capsule																													
Lithospermum arvense L.										1																			
Lithospermum officinale L.																													
Lolium multiflorum																											2		
Lolium perenne L.										1																			
Lolium spp.																													9
Lolium temulentum L.							400																		X				
Lotus corniculatus L.										2																			
Lychnis flos-cuculi L.																													
Lycopus europaeus L.																													
Malus spp.																													
Malus sylvestris agg.								1		12		1				1													
Malva neglecta																													
Malva spp.																													1
Malva sylvestris L.					1					7						1													
Marrubium vulgare L.										1																			
Matricaria inodora L.										1																			
Matricaria spp.																													1
Medicago lupulina L.					1					7																			
Medicago minima L.					1					1																			
Medicago spp.										1																			
Melampyrum arvense L.																													
Melampyrum spp.																													
Melilotus albus									2	5																			
Melilotus dentatus																													
Melilotus officinalis L.										1																			
Melilotus spp.																											3		
Melilotus/Trifolium spp.										1																			
Mentha spp.																													2
Muscari comosum L.																													
Nepeta cataria L.																													
Neslia paniculata L.																													
Olea spp.																		12											
Ornithogalum pyramidale L.										1																			
Panicum miliaceum L.		660	113		107	30	14	1	783	775	1	7	X										5				9		
Papaver somniferum L.										7																			
Papaver spp.										1																			
Papilionaceae cultiv.		2614								4																			
Phragmites australis										1																			
cf. Phragmites australis										1																			
Pimpinella saxifraga L.																													
Pisum elatius																													
Pisum sativum L.		678			1		8			134													12				3		18
Pisum spp.																													
Plantago lanceolata L.			1													1													
Plantago media L.																													
Poa cf. annua L.										1																			
Poa cf. pratensis agg.																													
Poa spp.																								3			17		
Poa/Alopecurus spp.																													
Polygonaceae																													7
Polygonum aviculare agg.							5			10			45			X			X										10
Polygonum convolvulus L.					3		47		1	59		2				1													22
Polygonum dumetorum L.																													
Polygonum hydropiper L.																													
Polygonum lapathifolium L.							1																						
Polygonum minus										1																			
Polygonum mite										5																			
Polygonum persicaria L.			1																										
Portulaca oleracea L.										1																			1
Potentilla cf. supina L.										1																			
Potentilla reptans L.										1																			
Potentilla spp.																													
Prunella vulgaris L.																													1
Prunus cerasifera																							3						
Prunus non spinosa																													1

Table 8.1f. Bronze Age archaeobotanical remains from the Carpathian Basin

	Early Bronze Age	BIAHOS-2	BUDAHU-1	BUDAKM-1	BUDCOR-1	BUDCSH-1	CETPIC-1	DUNSZE-1	END161-2	FEUDVA-1	KISKUN-1	KISNAG-1	MOSPAL-4	PECNAG-1	SEUGOR-1	SZIVIZ-1
Prunus spinosa agg.																
Prunus spp.																
Pyrus spp.																
Quercus spp.																
Quercus robur																
Quercus robur L./petraea																
Ranunculus bulbosus L.																
Ranunculus cf. acris L.																
Ranunculus repens L.																
Ranunculus spp.																
Reseda lutea L.			1			1										
Reseda luteola L.			1													
Rhamnus catharticus L.																
Rosa spp.																
Rosaceae																
Rubus caesius L.																
Rubus fruticosus																
Rubus spp.																
Rumex acetosa L.																
Rumex acetosella L.														X		
Rumex cf. acetosa L.																
Rumex crispus L.														X		
Rumex obtusifolius L.						1										
Rumex spp.														X		
Salvia pratensis L.																
Sambucus cf. ebulus																
Sambucus ebulus L.				1												
Sambucus nigra L.																
Schoenoplectus lacustris (L.)						44		11								
Schoenus nigricans L.						1										
Scleranthus annuus L.			12													
Secale cereale L.								1								
Secale cf. cereale L.																
Setaria lutescens																
Setaria viridis (L.)										4718						
cf. Setaria spp.																
Sherardia arvensis L.			1													
Silene alba																
Silene spp.																
Sinapis arvensis L.			1													
Solanum nigrum L.			2													
Spergularia media																
Stachys annua L.																
Stachys annua L./arvensis L.																
Stachys arvensis L.			1			3										
Stellaria graminea L.																
Stellaria media agg.			1			2										
Teucrium chamaedrys L.			10							334						
Teucrium scordium agg.																
Thalictrum flavum L.			1													
Thlaspi arvense L.																
Trapa natans L.										1						
Trifolium arvense L.			19													3
Trifolium campestre																
Trifolium pratense (L.)																
Trifolium spp.			4													
Triticum cf. spelta (L.)									1							
Triticum aestivum L.			2		10			1	3	15			2			
Triticum aestivum L. - rachis					1											
Triticum aestivum/durum																
Triticum cf. boeoticum			1													
Triticum compactum				1										X		
Triticum cf. dicoccoides																
Triticum dicoccum L.		4	76	2	10	4	500	14		24907				82	X	5
Triticum dicoccum L. - g/b		5	99	2		21		4		14996			1			
Triticum cf. dicoccum L.																
Triticum cf. dicoccum L. - g/b																
Triticum cf. durum																
Triticum monococcum L.			64	3				17		485				238	X	
Triticum monococcum L. - g/b			584	2				7		226				X		
Triticum cf. monococcum L.																
Triticum monococcum/dicoccum			13			6										
Triticum spelta L.			1													
Triticum spelta L. - g/b																
Triticum tetraploid (cf. Triticum parvicoccum Kislev)																
Triticum spp.		4	1													
Triticum spp. - g/b																
Valerianella dentata																
Verbascum spp.														X		
Verbena officinalis L.										2						
Veronica hederifolia agg.			1													
Vicia angustifolia L.			3													
Vicia ervilia (L.)										3						
Vicia faba L.			1													
Vicia faba L. var. minor																
Vicia hirsuta (L.)																
Vicia sativa L.																
Vicia spp.																
Vicia tetrasperma (L.)																
Viola arvensis agg.																
Viola spp.																
Vitis vinifera L.																
Vitis vinifera L. subsp. silvestris																

	Middle Bronze Age	ARODON-1	BALSZA-1	BARBOT-1	BEKVAR-1	BOLVOR-1	BUDBOF-1	BUDCSS-1	CARBOB-1	CEGLE4-3	DOMAPA-1	DUNKOS-1	FELVAR-1	JASKAP-1	MENLEA-1	MENSZE-1	MONKOD-1	NAGZSI-1	PAKVAR-1	SOLVAR-1	SUTHOS-1	SZAFOL-1	SZATEG-1	SZIFOL-1	TISASO-1	TISVAR-1	TOSLAP-1	TURTER-1
Prunus spinosa agg.			1			5										1												
Prunus spp.																												
Pyrus spp.																											X	
Quercus spp.					X	1										62												
Quercus robur									300																			
Quercus robur L./petraea																												
Ranunculus bulbosus L.																						2						
Ranunculus cf. acris L.																												
Ranunculus repens L.																						1						
Ranunculus spp.																						1						
Reseda lutea L.																												
Reseda luteola L.																												
Rhamnus catharticus L.																												
Rosa spp.																												
Rosaceae																												
Rubus caesius L.																						1						
Rubus fruticosus																												
Rubus spp.																	X									16		
Rumex acetosa L.																						4						2
Rumex acetosella L.																						1						
Rumex cf. acetosa L.																												
Rumex crispus L.																						1						1
Rumex obtusifolius L.																												
Rumex spp.																												
Salvia pratensis L.																						1						
Sambucus cf. ebulus																												
Sambucus ebulus L.		1					1																					
Sambucus nigra L.							1																					
Schoenoplectus lacustris (L.)																	X											
Schoenus nigricans L.																												
Scleranthus annuus L.																						3						
Secale cereale L.		X														2						3						
Secale cf. cereale L.																												
Setaria lutescens																												
Setaria viridis (L.)						1																3						
cf. Setaria spp.																												
Sherardia arvensis L.																												
Silene alba																						1						
Silene spp.																												
Sinapis arvensis L.																											6	1
Solanum nigrum L.																												
Spergularia media																												
Stachys annua L.																						4						
Stachys annua L./arvensis L.																												
Stachys arvensis L.																												
Stellaria graminea L.																												1
Stellaria media agg.																						1						1
Teucrium chamaedrys L.																						14						
Teucrium scordium agg.																												
Thalictrum flavum L.																												
Thlaspi arvense L.																												
Trapa natans L.																												
Trifolium arvense L.																						2						
Trifolium campestre																												
Trifolium pratense (L.)																												
Trifolium spp.				1																								
Triticum cf. spelta (L.)																												
Triticum aestivum L.		X				5							9			3										179	X	49
Triticum aestivum L. - rachis																												
Triticum aestivum/durum																						7						
Triticum cf. boeoticum																												
Triticum compactum																					15					35		
Triticum cf. dicoccoides																												
Triticum dicoccum L.			X	4		1158	11	2				9	12	X	X	47	X		10			716	32			1375	243	87
Triticum dicoccum L. - g/b						43	1				X			X	X							82				1		40
Triticum cf. dicoccum L.																												
Triticum cf. dicoccum L. - g/b																												
Triticum cf. durum																												
Triticum monococcum L.			X	X	X	20823	17						4	20	X	55	X		104		141	137	592			4504	X	191
Triticum monococcum L. - g/b						22	2				X	80			X							810	X			1	1	20
Triticum cf. monococcum L.																												
Triticum monococcum/dicoccum																												
Triticum spelta L.						33										7						7						
Triticum spelta L. - g/b																						4						
Triticum tetraploid (cf. Triticum parvicoccum Kislev)													X															
Triticum spp.					X	415							X			1		X				104			X	1988	X	6
Triticum spp. - g/b																						7						
Valerianella dentata																												
Verbascum spp.																												
Verbena officinalis L.																												
Veronica hederifolia agg.																												
Vicia angustifolia L.																1						2					X	1
Vicia ervilia (L.)						325											X		1			10	1				212	220
Vicia faba L.																	X											
Vicia faba L. var. minor						19													1			2						
Vicia hirsuta (L.)																												1
Vicia sativa L.				4																								
Vicia spp.		2				1	1															1						
Vicia tetrasperma (L.)		2																										
Viola arvensis agg.								1																				1
Viola spp.																												
Vitis vinifera L.																	X											
Vitis vinifera L. subsp. silvestris																												

	Late Bronze Age	BALHID-1	BORPAP-2	BUCORS-2	BUDALK-2	DUNSZE-2	GORKAP-1	GYOSZA-3	LEBBIL-2	LUDVAR-2	MOSNEM-1	POLG31-5	PORAPO-1	SOPKRA-1
Prunus spinosa agg.														
Prunus spp.														
Pyrus spp.														
Quercus spp.														
Quercus robur														
Quercus robur L./petraea										91				
Ranunculus bulbosus L.														
Ranunculus cf. acris L.									1					
Ranunculus repens L.					1					4				
Ranunculus spp.														
Reseda lutea L.														
Reseda luteola L.														
Rhamnus catharticus L.										1				
Rosa spp.														
Rosaceae														
Rubus caesius L.														
Rubus fruticosus														
Rubus spp.														
Rumex acetosa L.										17				
Rumex acetosella L.						1								
Rumex cf. acetosa L.														
Rumex crispus L.										1				
Rumex obtusifolius L.														
Rumex spp.														
Salvia pratensis L.														
Sambucus cf. ebulus														
Sambucus ebulus L.										264	1			
Sambucus nigra L.										2				
Schoenoplectus lacustris (L.)									1					
Schoenus nigricans L.														
Scleranthus annuus L.														
Secale cereale L.					3	1	2			20				
Secale cf. cereale L.														
Setaria lutescens							41			2				
Setaria viridis (L.)					2	2				26			2	
cf. Setaria spp.														
Sherardia arvensis L.														
Silene alba							60			1				
Silene spp.										2				
Sinapis arvensis L.					2					2				
Solanum nigrum L.					2		61						2	
Spergularia media														
Stachys annua L.							13			1				
Stachys annua L./arvensis L.						1								
Stachys arvensis L.					23				4					
Stellaria graminea L.														
Stellaria media agg.							18		1	1				
Teucrium chamaedrys L.					1		1							
Teucrium scordium agg.						9								
Thalictrum flavum L.														
Thlaspi arvense L.							1							
Trapa natans L.														
Trifolium arvense L.						1				12				
Trifolium campestre										6				
Trifolium pratense (L.)										1				
Trifolium spp.							4			1				
Triticum cf. spelta (L.)														
Triticum aestivum L.			2		1		15		14	19	1			
Triticum aestivum L. - rachis										1				
Triticum aestivum/durum			4											
Triticum cf. boeoticum														
Triticum compactum					1		3			8				
Triticum cf. dicoccoides														
Triticum dicoccum L.			3		17	2	7160		6	35813	3	1	25	7
Triticum dicoccum L. - g/b			1		37	7	963	1	4	320	5		X	
Triticum cf. dicoccum L.														
Triticum cf. dicoccum L. - g/b												1		
Triticum cf. durum														
Triticum monococcum L.			1		4		4254			282		1	69	
Triticum monococcum L. - g/b					28	1	7			11		1	X	
Triticum cf. monococcum L.														
Triticum monococcum/dicoccum										25				
Triticum spelta L.					5		1607		6	162		1	X	
Triticum spelta L. - g/b					2		1106		2	14			X	
Triticum tetraploid (cf. Triticum parvicoccum Kislev)														
Triticum spp.					1		2601		4	8				
Triticum spp. - g/b														
Valerianella dentata					1									
Verbascum spp.														
Verbena officinalis L.							1			1				
Veronica hederifolia agg.										1				
Vicia angustifolia L.		1	1							3				
Vicia ervilia (L.)		261								990				
Vicia faba L.										2				
Vicia faba L. var. minor														
Vicia hirsuta (L.)		1												
Vicia sativa L.														
Vicia spp.										2				
Vicia tetrasperma (L.)														
Viola arvensis agg.														
Viola spp.							1							
Vitis vinifera L.														
Vitis vinifera L. subsp. silvestris										2				

	Bronze Age (exact date unkown)	BUDCOR-2	CAREIO-1	CAUSEV-1	END161-3	KLAFAL-1	KOLCSO-1	MEDAUR-1	NOVCUP-1	OARDSU-1	OTOMAN-1	POLG31-6	SANMIC-1	TISBAS-1	ZIDOVA-1
Prunus spinosa agg.															9
Prunus spp.															1
Pyrus spp.															12
Quercus spp.															21
Quercus robur															
Quercus robur L./petraea															
Ranunculus bulbosus L.															
Ranunculus cf. acris L.															
Ranunculus repens L.															
Ranunculus spp.															
Reseda lutea L.															
Reseda luteola L.															
Rhamnus catharticus L.															
Rosa spp.															1
Rosaceae															2
Rubus caesius L.															
Rubus fruticosus									4						
Rubus spp.															
Rumex acetosa L.			X												
Rumex acetosella L.															
Rumex cf. acetosa L.										2					
Rumex crispus L.															
Rumex obtusifolius L.															
Rumex spp.													8		1
Salvia pratensis L.															
Sambucus cf. ebulus													11		
Sambucus ebulus L.		1													81
Sambucus nigra L.															
Schoenoplectus lacustris (L.)															
Schoenus nigricans L.															
Scleranthus annuus L.															
Secale cereale L.															
Secale cf. cereale L.										1					
Setaria lutescens															
Setaria viridis (L.)															12
cf. Setaria spp.				4											
Sherardia arvensis L.															1
Silene alba															
Silene spp.													46		2
Sinapis arvensis L.															
Solanum nigrum L.															17
Spergularia media													76		
Stachys annua L.															
Stachys annua L./arvensis L.															
Stachys arvensis L.															
Stellaria graminea L.															
Stellaria media agg.															
Teucrium chamaedrys L.															12
Teucrium scordium agg.															
Thalictrum flavum L.															
Thlaspi arvense L.															
Trapa natans L.															
Trifolium arvense L.		1													
Trifolium campestre															
Trifolium pratense (L.)		3													
Trifolium spp.													4		39
Triticum cf. spelta (L.)											X				
Triticum aestivum L.			X		1				7	42	X	1			1419
Triticum aestivum L. - rachis															1
Triticum aestivum/durum															
Triticum cf. boeoticum															
Triticum compactum															
Triticum cf. dicoccoides			X												
Triticum dicoccum L.		501	X						86	129	X			54	50
Triticum dicoccum L. - g/b		4													141
Triticum cf. dicoccum L.											X				
Triticum cf. dicoccum L. - g/b															
Triticum cf. durum										6					
Triticum monococcum L.		2	X						172	5	X		3278		308
Triticum monococcum L. - g/b		2											377		1556
Triticum cf. monococcum L.													124		
Triticum monococcum/dicoccum															
Triticum spelta L.		89									X				7
Triticum spelta L. - g/b		2													
Triticum tetraploid (cf. Triticum parvicoccum Kislev)															
Triticum spp.													980		
Triticum spp. - g/b		13					X						141		
Valerianella dentata															
Verbascum spp.															
Verbena officinalis L.															22
Veronica hederifolia agg.															
Vicia angustifolia L.															
Vicia ervilia (L.)									11				6		3
Vicia faba L.													3		
Vicia faba L. var. minor															
Vicia hirsuta (L.)															
Vicia sativa L.															
Vicia spp.											X		3		
Vicia tetrasperma (L.)															
Viola arvensis agg.															
Viola spp.															
Vitis vinifera L.															
Vitis vinifera L. subsp. silvestris															8