# A Man and a Plant: Archaeobotany

**Maria Lityńska-Zając**

## 1 Introduction

A man is surrounded by plants, no matter in which part of the globe and under which changeable climatic conditions he lives. Basically, plants are not encountered individually; instead they form communities of different types, some of which are primeval and natural, while others are of anthropogenic nature, i.e. transformed by a man. Plants play an enormous ecological role as providers of oxygen and primary producers of organic matter. Their economic significance cannot be overestimated either.

"Plants have been used by humans for various purposes. Multiple applications of plants are possible thanks to their specific properties. Some species, such as grasses commonly encountered in our surroundings, produce caryopses that contain a considerable amount of starch, as well as carbohydrates, proteins and fats, due to which they are cultivated as cereal crops all over the world, and constitute the major source of food for humans. An enormous alimentation role is played by other crop species, such as peas, beans, lentils or faba beans that contain a significant amount of proteins, fat, starch, fibre and mineral salts. There are commonly known numerous species of fruit and vegetable crops, mainly rich in vitamins and mineral salts. Other plants containing chemically active substances, such as alkaloids, tannins, glycosides, glucosinolates, mucilage, organic acids or vitamins, are used in cooking as spices (black pepper, mustard), production of medicines (fennel, camomile) and cosmetics as beauty and therapeutic products (nettle). There are also plants that can serve for production of textiles (flax, hemp, cotton) or natural dyes (elder and oak bark). Finally, people use woody plants for making furniture and small everyday objects" (Lityńska-Zając and Nalepka 2008).

M. Lityńska-Zając (✉)
The Institute of Archaeology and Ethnology, Polish Academy of Sciences, Kraków, Poland
e-mail: marialitynska@gazeta.pl

 
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In a word, “plants are essential to human existence” (Hastorf 1999, 56).

The history of plants is within the scope of interests of palaeobotany, a part of which is archaeobotany. Distinctiveness of this scientific discipline results from the nature of sources it examines. Assemblages subject to archaeobotanical studies emerged as a direct outcome of human activity and are preserved in archaeological layers or features created partially or mostly by men, whereas Quaternary palaeobotany investigates associations that formed naturally, at most more or less influenced by humans and preserved in geological deposits shaped by natural processes (i.a. lacustrine sediments and peat soils). The general difference between these two scientific disciplines mentioned above is based on the type of remains they study, which with regard to archaeobotany are not entirely fossilised (Fuller 2002, 248; Lityńska-Zając and Wasylikowa 2005, 24).

## 2 Archaeobotany: Definition and Brief History

According to the Polish handbook, “archaeobotany aims to recognise the mutual relationship between a man and a plant in the past, based on an analysis of all plant remains that could be recovered from archaeological sites. The scope of archaeobotany encloses, on one hand investigations of various applications of plants in human activities, changes in flora and vegetation caused by this activity, and evolution of cultivated species, on the other hand a recognition of the impact of natural environment and available plant resources on the development of human civilisations” (Lityńska-Zając and Wasylikowa 2005, 23).

In the existing literature, very similar definitions of the discipline in question can be found (e.g. Greig 1989; Jacomet and Kreuz 1999; Fuller 2002, 247; Denham et al. 2009; Mariotti Lippi 2012; Pearsall 2015). In some related publications, the term palaeoethnobotany is used, derived mostly from American tradition (Hastorf 1999, 55). There are authors who consider these two terms to be synonymous; others give them different meanings (Lityńska-Zając and Wasylikowa 2005, 23). In the latter case, palaeoethnobotany is defined as a scientific discipline dealing with plants that were utilised by men for various purposes (Dimbleby 1967; Popper and Hastorf 1988, 2; Hastorf 1999, 56; Fuller 2002, 248; Pearsall 2015, 1–2). The terms archaeobotany and palaeoethnobotany were introduced by a Danish scholar, H. Helbæk (Helbæk 1959).

The first interests in fossil materials and the beginnings of widely understood palaeontology as an individual discipline of science reach back to the first half of the nineteenth century (Raup and Stanley 1984). Archaeobotany is also a discipline of relatively young tradition, the beginning of which is dated to 1865 when a dissertation by a Swiss botanist O. Heer was published, dedicated to plants from Swiss pile dwellings of the Neolithic and the Bronze Age (Heer 1865). The greatest achievements in archaeobotanical studies have been presented in numerous handbooks (e.g. Renfrew 1973; Greig 1989; Jacomet and Kreuz 1999; Lityńska-Zając and Wasylikowa 2005; Pearsall 2015); therefore, they will not be quoted here. Amongst the latest accomplishments, one should name a collection of articles referring to the history of development and expansion of agriculture and cultivation of plants in many regions of the Old World (Colledge and Conolly 2007) and an overview based on detailed case studies, giving the grounds for new research concepts (Conolly et al. 2008). Recently, the significance of studies on stable isotopes has grown, which are successfully used for reconstruction of paleo diet and allowed the investigators to prove that fertilisation of farmlands is a practice employed by humans since the beginning of the Neolithic period (Bogaard et al. 2013, 2016; Styring et al. 2014a, 2014b).

Archaeobotanical studies in Poland (in Polish tradition often referred to as Quaternary palaeobotany) were initialised by investigations carried out by A. Kozłowska (1921), although they were preceded by occasional identifications of diaspores obtained from Peruvian mummies (Lityńska-Zając and Wasylikowa 2005, 32). The interwar period delivered a relatively small number of elaborated sites (Jaroń 1936, 1938, 1939). However, there were botanists who undertook many interesting studies useful in identifying the remains. Matlakówna (1925) subjected grains of modern cereal plants to burning process in order to recognise deformations that must have affected the forms of plant remains obtained from archaeological sites. Swederski (1925) performed microscopic observations of the structure of "siliceous skeletons" (phytoliths) within fruits of various plants (acc. to Lityńska-Zając and Wasylikowa 2005, 31–34).

The period following the Second World War stimulated a significant flourishing of archaeobotanical studies, which have induced, especially recently, a growing interest of scholars and have been gaining more and more significant position as a part of regular archaeological research. This resulted in an emergence of many detailed papers referring to finds obtained from particular archaeological sites. Investigations conducted in that time delivered a great number of detailed studies referring to finds encountered at particular archaeological sites, including an elaboration of abundant materials coming from medieval cities, such as Gdańsk (Lechnicki et al. 1961; Badura 2011), Poznań (Moldenhawer 1939; Klichowska 1969; Koszałka 2008), Przemyśl (Wieserowa 1967), Wrocław (Klichowska 1961), Kraków (Wasylikowa 1978; Wieserowa 1979; Mueller-Bieniek 2012a), Wolin (Latałowa 1999a, 1999b), Elbląg (Latałowa et al. 1998) and Kołobrzeg (Latałowa and Badura 1996; Badura 1998, 1999), as well as development of methods employed for their examination (Wasylikowa et al. 2009; Zemanek and Wasylikowa 1996). Noteworthy were also case studies dedicated to individual sites, yet referring to exceptional finds (Table 1).

Recognition of cultivated plant species encountered at various archaeological sites has led to numerous attempts at reconstruction of the crop structure within the present territories of Poland (Klichowska 1972a, 1976, 1984; Wasylikowa 1984; Wasylikowa et al. 1991). The most recent overviews are rather of regional nature (Mueller-Bieniek 2002, 2007; Lityńska-Zając 1997a, 2007) or refer to a single chronological unit, namely, the Roman Period (Lityńska-Zając 1997b). Research topics associated with the reconstruction of crop structure were widely addressed in the European related literature (e.g. Hajnalová 1993; Maier 1999; Bogaard 2004;

**Table 1** Selected examples of exceptionally interesting archaeobotanical finds from Poland.

| Site | Chronology | Plant remains | Description | Related literature |
|---|---|---|---|---|
| Gwoździec, com. Zakliczyn, site 2 | Neolithic (Linear Pottery culture) | *Malus sylvestris* | Pit | Bieniek and Lityńska-Zając (2001) |
| Szarbia, com. Koniusza, site 14 | Bronze Age (Mierzanowice culture) | *Lithospermum officinale* | Grave, plaster (cataplasm) made of tar with the fruit | Baczyńska, Lityńska-Zając (2005a); Lityńska-Zając (2005b) |
| Lutomiersk–Koziówki, near Łódź | Late Bronze Age (Lusatian culture) | *Xanthium strumarium* | Pit | Mueller-Bieniek et al. (2015) |
| Wrześnica, com. Sławno, site 7 | Tenth century | *Linum usitatissimum* | Bunch of compressed stems of flax with weeds | Latałowa (1998); Latałowa and Rączkowski (1999) |
| Kraków | Medieval period | *Daucus carota* | Cultural layer | Mueller-Bieniek (2010) |

Kreuz et al. 2005; Hajnalovà 2007, 2012; Kreuz 2007; Conolly et al. 2008; Dreslerová and Kočár 2013; Stika and Heiss 2013).

Moreover, studies carried out by palaeobotanists addressed numerous detailed issues. A significance of weeds in archaeological finds was discussed for the first time by W. Giżbert (1971). K. Wasylikowa (1983) presented theoretical possibilities of economic and ecological interpretations based on examinations of remains of wild herbaceous plants encountered in vegetal deposits or scattered within archaeological layers and features. The latter author (Wasylikowa 1978, 1981) was the first botanist who introduced a phytosociological and autecological method into Polish science based on ecological indicator values developed by Ellenberg (1950, 1974) and then by Zarzycki (Zarzycki et al. 2002), used for interpretations of subfossil material. Those methods were employed in many other papers dedicated to, e.g. materials of the Lengyel culture from site 62 in Mogiła (Gluza 1983/1984) or the Roman Period in Otalążka (Madeyska 1984) and Wąsosz Górny (Bieniek 1999a). Investigations carried out at numerous European sites were also based on this methodology (e.g. Körber-Grohne 1967; van Zeist 1974, 1996/1997; Knörzer 1975; Behre 1976, 1993). However, it should be stressed that engaging the above-mentioned phytosociological method in examinations of subfossil materials has been subject to criticism on many occasions (e.g. van der Veen 1992; Cappers 1994). Analyses of wild plants gathered during archaeological excavations allowed the researchers to reveal the origins and trace transformations of synanthropic flora and vegetation in prehistoric and early historical times (Lityńska-Zając 2005). Other studies focused on comparison of transformations recorded in the current synanthropic flora in a given region with archaeological data, for instance, in medieval Kraków (Trzcińska-Tacik and Wieserowa 1976; Trzcińska-Tacik and Wasylikowa 1982) and the Roman site in Jakuszowice, com. Kazimierza Wielka (Trzcińska-Tacik and Lityńska-Zając 1999).

Simultaneously with the studies on fruits and seeds, remains of wood (xylology) and charcoal (anthracology) found within archaeological materials were subject to examinations (e.g. Smart and Hoffman 1988; Kadrow and Lityńska-Zając 1994).

In the second half of the twentieth century, archaeobotanical interests expanded, including studies on tubers and other plant tissues encountered at archaeological sites (Hillman et al. 1989; Hather 1991, 1993, 2000; Kubiak-Martens 2005, 300–320), as well as phytoliths (Piperno 1988, 2006; Polcyn et al. 2005, 372–385). Moreover, a pollen analysis was introduced (e.g. Makohonienko 1998; Makohonienko et al. 1998a) to investigate "cultural layers on settlements and fillings of archaeological features [*on-site analysis*], and obtain information that has not been recorded in natural biogenic deposits [*off-site analysis*]" (Wasylikowa et al. 2005, 37; comp. also Wasylikowa 2005, 347; Rösch et al. 2014).

Nowadays, environmental and archaeological investigations often take a form of close interdisciplinary cooperation, starting from the moment of assuming a certain research strategy suitable for a given site and ending with a collective, archaeological and environmental interpretation of sources, which is becoming a more and more popular practice (e.g. Wacnik et al. 2014; Kittel et al. 2014; Mueller-Bieniek et al. 2015, 2016). There is another example provided by the material from Stradów that served for reconstruction of the picture of an early medieval settlement complex based on archaeological, biological (botanical and zoological) and written sources (Lityńska-Zając et al. 2010). Thanks to employing written sources and archaeobotanical data obtained in Gdańsk and dated to the fourteenth to fifteenth century, a more comprehensive list of species utilised by human communities of those times was elaborated (Badura et al. 2015). Similar analyses covering both of the above-mentioned types of sources were performed for Krakow in the Renaissance period (sixteenth to early seventeenth centuries) (Wasylikowa and Zemanek 1995; Zemanek and Wasylikowa 1996; Zemanek 2012).

## 3 Plant Remains

The source materials collected for archaeobotanical studies are plant remains referred to as subfossil plant remains. By tradition, they are divided into two groups, macro- and microremains. The former group encloses i.a. fruits, seeds and vegetative parts of plants, including wood and charcoal. The latter embraces, e.g. sporomorphs (pollen grains of flowering plants and spores of cryptogams), diatoms, phytoliths and starch grains (e.g. Jacomet and Kreuz 1999; Lityńska-Zając and Wasylikowa 2005; Pearsall 2015).

The quantity and quality of plant materials that can be recovered from an individual archaeological site are a resultant of a number of depositional and post-depositional factors affecting plants and their conservation, determining whether they are preserved until present or not. In a word, only a small part of truly abundant ancient flora and vegetation has been preserved in archaeological features and cultural layers till nowadays. This is due to many factors, amongst which, in very simple terms, the most important are the following:

1. Natural properties resulting from the anatomy of entire or parts of plant organs, supporting their preservation within a given sediment
2. A manner in which the plant naturally existed in the environment
3. Selective activity of men due to particular roles played by given plants in human economy
4. A number of the so-called post-depositional processes activated after the plant had been covered with a sediment (Lityńska-Zając and Wasylikowa 2005; Wasylikowa et al. 2009; Pearsall 2015, 35)

Macroscopic plant remains can be encountered in different forms, such as charred, uncharred (waterlogged), mineralised, frozen or dried specimens. Under climatic conditions of Central Europe, charred and uncharred remains are most frequently recovered. A state of preservation of plant "deposits" depends on numerous factors, including conditions of conservation occurring at particular archaeological sites. Studies on conservation processes (fossilisation) of organic matter (plants) that become active at the moment of covering the material with sediments are within the scope of interests of taphonomy (e.g. Lityńska-Zając and Wasylikowa 2005, 37–46, and literature quoted there; Antolin and Buxó 2011). Terms referring to taphonomy were introduced into archaeobotany by U. Willerding (1979, 1990/1991). When making an attempt to interpret plant material, one must realise that taphonomic processes were responsible for depositing and preserving a given plant material within a particular archaeological site, feature or cultural layer. For instance, charred specimens could have gotten into the sediment from fireplaces and windspread conflagration or as a result of burning down of an archaeological feature in situ, e.g. storage pits containing crop reserves (Lityńska-Zając 1994). An occurrence of charred grains of cereals and fruits, or seeds of other cultivated species or weeds e.g. recovered nearby fireplaces might have been due to preparation of food from crops that incidentally contained undesirable plants (e.g. Wasylikowa 1997; Wilkinson and Stevens 2008). Uncharred remains (waterlogged) may be either of autochthonous, as "remnants of plants having grown in the certain time and space" (Mueller-Bieniek 2012a, 31), or allochthonous origin, as "plants having been intentionally or accidentally brought to a given region" (Mueller-Bieniek 2012a, 31). Such remains can be recovered from cultural layers of medieval cities (e.g. Latałowa et al. 2003; Badura 2011; Mueller-Bieniek 2012a) or archaeological sites situated in wetlands, such as peat bogs or lacustrine deposits (Jaroń 1938; Kalis et al. 2015). Uncharred plant material can also be found in deep features reaching down to the groundwaters, such as wells (Greig 1988; Tyniec et al. 2015) or latrines (Greig 1994; Tomczyńska and Wasylikowa 1999). Determining the age of uncharred remains obtained from sites situated in the so-called drylands occurring, e.g. on loess soils, thus in regions being constantly above the groundwater table, is always controversial, and in most cases, such remains are considered to be contaminations of younger or even modern chronology (Lityńska-Zając and Wasylikowa 2005, 41–42). Noteworthy is also the fact that the composition of recovered plant remains is affected by the manner of exploring archaeological features, taking samples and preparing collected materials for laboratory examinations.

The type of an archaeological site, feature or cultural layer determines the possibility of recovering plant remains that may be deposited within it (Lityńska-Zając and Wasylikowa 2005, 47). For instance, storage pits usually contain remains of cultivated plants, possibly accompanied with field weeds, though their number is frequently scarce, which supports a utilitarian function of these features. Although collective finds of remains of cereals or other crop species are also encountered, they are rather sporadic (e.g. Gluza 1983/1984; Kohler-Schneider 2001; Palmer 2004; Lityńska-Zając 2005; Sady 2015; Mueller-Bieniek et al. 2016). When charcoals are found in features at dwelling sites, particularly in hearths or fireplaces, they provide the investigators with information about the type of wood used as fuel (e.g. Chabal et al. 1999; Asouti and Austin 2005; Moskal-del Hoyo 2013). Charcoals also occur at cremation cemeteries, in urns, recesses or grave pits, being remnants of funeral pyres (e.g. Deforce and Haneka 2012; Stępnik 2001; Moskal-del Hoyo 2012; Lityńska-Zając 2015). Grave pits may contain remains of plants that had been placed there as grave goods (e.g. Klichowska 1972b; Latałowa 1994; Moskal-del Hoyo and Badal 2009). Certain plant remains are sometimes found in amazing contexts. Finds of cereals in burial-related features are most likely due to their ritual function, not corresponding with their economic role (Viklund 1998, 175). Perhaps a similar significance is that of finds of tubers of *Arrhenatherum elatius* subsp. *bulbosum* (Mueller-Bieniek 2012b). In some cases, it can be assumed that fruits and seeds or charcoals got into sediments altogether with the dirt swept from the closest surroundings to cover grave pits (Lityńska-Zając et al. 2014).

Apart from plant remains, numerous sites delivered interesting finds in a form of impressions or tiny fragments of charred or dried tissues, mainly caryopses and parts of cereal husks, preserved within burnt clay and on pottery surface (e.g. Jacomet and Kreuz 1999 and literature quoted there; Burchard and Lityńska-Zając 2002; Lityńska-Zając 2002; Lityńska-Zając and Wasylikowa 2005). These are usually traces of by-products produced in the course of cleaning grains, which were intentionally added to clay mass as the so-called temper (e.g. Lityńska-Zając and Wasylikowa 2005; Fuller 2013). Recently conducted studies (micromorphological and anatomical analyses) indicated an intentional application of thoroughly selected, fine-grained, plant additive in production of pottery (Moskal-del Hoyo et al. 2017).

Archaeobotanical examinations, regardless of the type of plant remains (fruit, seeds, wood fragments, phytoliths or sporomorphs), cover three major stages of field and laboratory research, which are as follows: (1) recovering samples from archaeological sites, (2) extracting plant remains from the samples and sorting the material obtained and (3) identifying plant material. Different plant materials require suitable procedures to be employed in the field and during laboratory examinations (e.g. Lityńska-Zając and Wasylikowa 2005, 182–193; Pearsall 2015, 35), developed by those "subdisciplines" separately, according to their specific research goals. The entire above-mentioned process should be preceded by assuming an appropriate strategy of sampling, matching the characteristics of a given archaeological site (Kadrow 2005).

Identifying macroscopic and microscopic plant remains is based on a confrontation of fossil materials with comparative collections of modern specimens, supported by the respective literature (Hillman 1984; Miksicek 1987; Jacomet and Kreuz 1999; Lityńska-Zając and Wasylikowa 2005; Nesbitt 2006). From the European viewpoint, there are very useful tools to perform such analyses, e.g. plant identification keys and atlases designated for identification of fruits and seeds (Kulpa 1974; Körber-Grohne 1991; Jacomet 2006; Cappers et al. 2006; Cappers et al. 2009; Neef et al. 2011) and vegetative parts of plants, including wood and charcoals (Esau 1973; Schweingruber 1978, 1982, 1990; Hejnowicz 2002; Grosser 2003), tubers and other storage organs (Hather 1993, 2000), pollen grains (Fægri and Iversen 1978; Fægri et al. 1989; Dybova-Jachowicz and Sadowska 2003; Wasylikowa 2005) and finally phytoliths (Piperno 1988, 2006; Twiss 1992; Meunier and Colin 2001).

A separate branch of studies helpful in identification of fossil materials are examinations of morphology of fruits and seeds. As mentioned above, fossil material is usually identified with the use of existing plant identification keys based on morphological properties of modern diaspores. For obvious reasons, most of these keys neglect changes caused by fossilisation. Therefore, many publications referring to plant remains contain morphological descriptions regarding those deformations (e.g. Wasylikowa 1978, millet grasses; Wieserowa 1979, genus *Galeopsis*; Bieniek 1999b, *Stipa*; Latałowa 1998, *Spergula*). A monograph describing morphological properties and measurements of charred caryopses of brome *Bromus* was written by I. Gluza (1977), while the variability in achenes of the genus *Ranunculus* was presented by Trząski (1994). In order to conform current material to fossil remains, modern diaspores were subject to artificial fossilisation: maceration (e.g. seeds of *Juncus*, Körber-Grohne 1964; caryopses of grasses Poaceae, Körber-Grohne 1991) or burning (Hopf 1975; Hillman et al. 1983; Wilson 1984; Kislev and Rosenzweig 1991). Other examples were described in handbooks of archaeobotany (Hather 1993; Lityńska-Zając and Wasylikowa 2005, 204–212).

A crucial matter for reasoning in archaeobotanical studies is a correct identification and description of plant remains. As a result of identifying all types of plant remains preserved at archaeological sites, a list of taxa can be obtained. This term was used purposefully since plant material is identified to various taxonomic levels (the level of species, genus, family or morphological type. The latter category was distinguished, e.g. at the site in Nabta Playa, in Egypt; see Wasylikowa 1997). The level of possible identification of plant remains is mostly due to a morphological or anatomical diversity of specimens under analysis and their more or less legible distinctive traits, the state of their preservation and possibilities provided by laboratory examinations engaged by a given discipline (Lityńska-Zając and Nalepka 2008, 2012). Employing new techniques and instruments (scanning electron microscope) has considerably expanded those possibilities (Conolly 1976; Karcz 2008). However, one should keep in mind that the list of taxa determined for a certain archaeological site will never correspond with all the plants that grew in surroundings of human settlements and were utilised by men. Nevertheless, this list delivers a lot of useful information enabling an interpretation of the sources with regard to reconstruction of the ancient environment (palaeoenvironment), exploitation of natural plant resources and development of agriculture. The most favourable approach, in respect of further interpretations, is to identify plant remains to the level of species (Lityńska-Zając and Wasylikowa 2005; Lityńska-Zając and Nalepka 2012) because higher taxonomic units (e.g. genus) usually enclose species existing in varied environments.

Apart from the quality composition, a properly performed archaeobotanical analysis should also provide quantitative data. One of these parameters is the abundance, i.e. an absolute number of specimens belonging to a given taxon identified within a sample. This data allows the investigator to assess, within certain limits, the role of particular plants. Another parameter quoted in presentations of plant remains is the frequency or ubiquity, referring to the number of samples containing remains of a particular taxon, determined for the entire site (Lityńska-Zając and Wasylikowa 2005, 201). With regard to the quantitative type of analyses, it is essential to realise that there is no simple, direct relation between the quantitative share of a given taxon within the entire archaeobotanical material and the role it played in both ancient vegetation and human economy in the past. This relation is disturbed by natural factors on one hand and on the other hand by anthropogenic factors resulting from purposeful or unintentional activities of men. Nevertheless, the quantitative share of particular taxa within different samples obtained from one or a few other sites may contain important information about their emergence and significance in the past, providing that it was properly interpreted. Therefore, it can be assumed, with certain limitations, that plant remains abundantly and frequently represented in archaeological materials are those having commonly occurred in ancient flora. Moreover, the species that are often encountered at sites within one chronological horizon indicate that they were utilised by communities of a given cultural unit. However, this has not been proved for all case studies (comp. discussion Mueller-Bieniek 2012a).

## 4 Interpretation of Plant Remains

Assemblages of archaeobotanical data obtained in the course of excavations provide the grounds for interpretation of sources. This interpretation may enclose individual archaeological sites or a complex of sites ascribed to a particular cultural unit or sites situated within a given geographical region. Well-dated materials allow the investigators to trace changes in a taxonomic composition of vegetation throughout the time. Reconstruction of elements of human economy or the ancient environment of man's life is based on many theoretical assumptions that were briefly discussed below in the context of particular issues addressed in this chapter (Lityńska-Zając and Wasylikowa 2005).

As mentioned above, one of the major factors responsible for the fact that a given plant got into archaeological layers was the economic activity of men. For obvious reasons, this activity was strictly determined by the natural environment. Men could only use what was available in their surroundings. Having introduced the agriculture over a given area, humans became the major factor in shaping the environment, to a smaller of greater extent.

The major research trends in archaeobotany are developing in two separate directions. Some of them address strictly biological issues. For instance, a comparative analysis of DNA and proteins provided scholars with reliable explanations to major affinities between taxa of various ranks and revealed the mechanisms of their evolution that lead to an emergence of new taxa, e.g. crop plant species (Zohary et al. 2012). An archaeological context of fruits and seeds deposited at excavated sites delivers information referring to dispersion of crop plants within both their origin centres and beyond. Moreover, it evidences an acquaintance of agriculture in a given time and space, which is strictly determined by the cultural development of human communities.

Other research tasks of archaeobotany are associated with reconstruction of particular elements of natural environment, as well as development and directions of evolution of synanthropic flora (e.g. Willerding 1986; Lityńska-Zając 2005). Due to their specific cultural nature, an assemblage of plant remains recovered from an archaeological site enables an identification of alternative paths of how agriculture emerged and expanded and reconstruction of certain aspects of human economy in the past, including plant cultivation. This issue is also closely connected with reconstruction of many conditions and techniques applied in ancient agriculture.

Archaeobotany can also provide basic information about an occurrence of wild species used by people for consumption, or playing certain roles in their economy, healing treatments, magic and religious practices, and art. Moreover, this discipline may be helpful in reconstruction of the impact of humans on the natural environment.

The major problem, in the light of the above-mentioned matters, is the state of the art of archaeobotanical studies, which is due to cognitive values of unit data. There are finds that enable very precise and detailed interpretation of sources preserved in a given archaeological context. Others are extremely difficult to be assessed explicitly. Nevertheless, systematic gathering of data may lead to a better recognition of subfossil floras. An important research postulate, raised by many scholars in the related literature, is an encouragement to take a large number of samples, even if they are very small, from features of varied nature, providing the investigators with more representative research material. This will make the assessment of the archaeological context more accurate and ensure the most comprehensive spectrum of plant remains as possible (Jones 1991; Lityńska-Zając and Wasylikowa 2005).

## 5 Cultivated Plants

Qualitative and quantitative data of cultivated plant remains preserved at archaeological sites provided the grounds for developing models of structure of ancient crops (Lityńska-Zając and Wasylikowa 2005, 489–491). According to theoretical

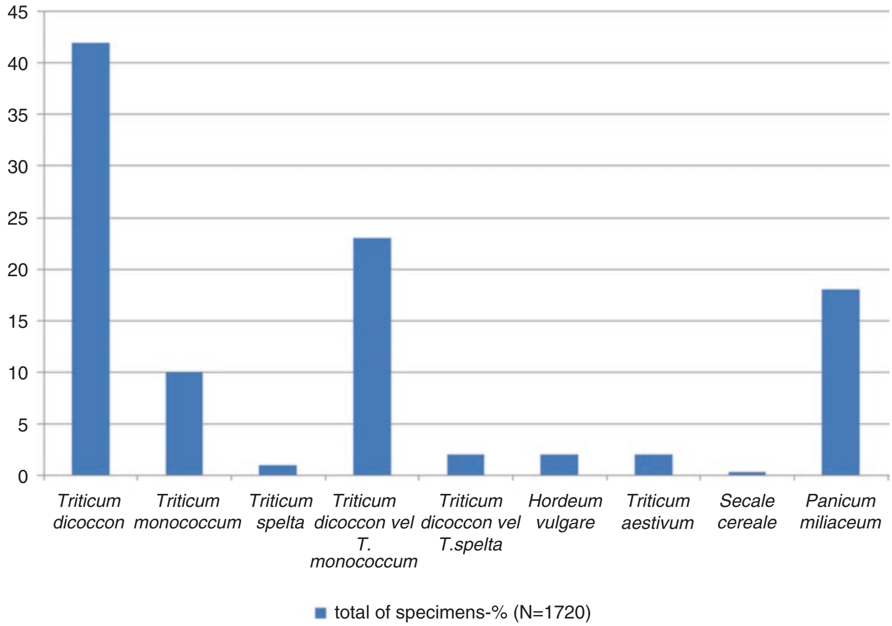


**Fig. 1** The percentage of the total of cereal remains from the sites of the Linear Pottery culture (SE Poland)

assumptions, they revealed simple relations between the shares of particular species within a given assemblage. For addressing the issues raised in this paper, the author compiled data obtained from 23 archaeological sites of the Linear Pottery culture located in south-western Poland (Lityńska-Zając et al. 2017). With regard to the region in question, recovered plant remains enclosed charred caryopses and fragments of cereal husks and impressions in burnt clay of several cereal species, such as *Triticum dicoccon*, *T. monococcum*, *T. spelta*, *T. aestivum*, *Hordeum vulgare*, *Panicum miliaceum* and *Secale cereale.*

Based on the fossil material, it is possible to obtain relatively reliable information about plant species that were cultivated in the past, and the occurrence of their remains proves a local cultivation of certain plants by communities having lived in the settlement (region or culture) under investigation. Far more difficult is to recreate quantitative relations between particular plants and determine their share within the ancient crops. Therefore, for interpretation of the above-mentioned data, two comparative methods were engaged: (1) the share of particular species per total number of plant remains classified into the respective category of sources (Fig. 1) and (2) the frequency of occurrence of particular plant species at given archaeological sites (Fig. 2). On this basis, a prevalence of remains of dehusked wheat was recorded, represented mostly by emmer and less numerous einkorn. The former species is also the most frequently encountered at the sites under scrutiny. Both wheats were surely the most common crop species of those times in various regions

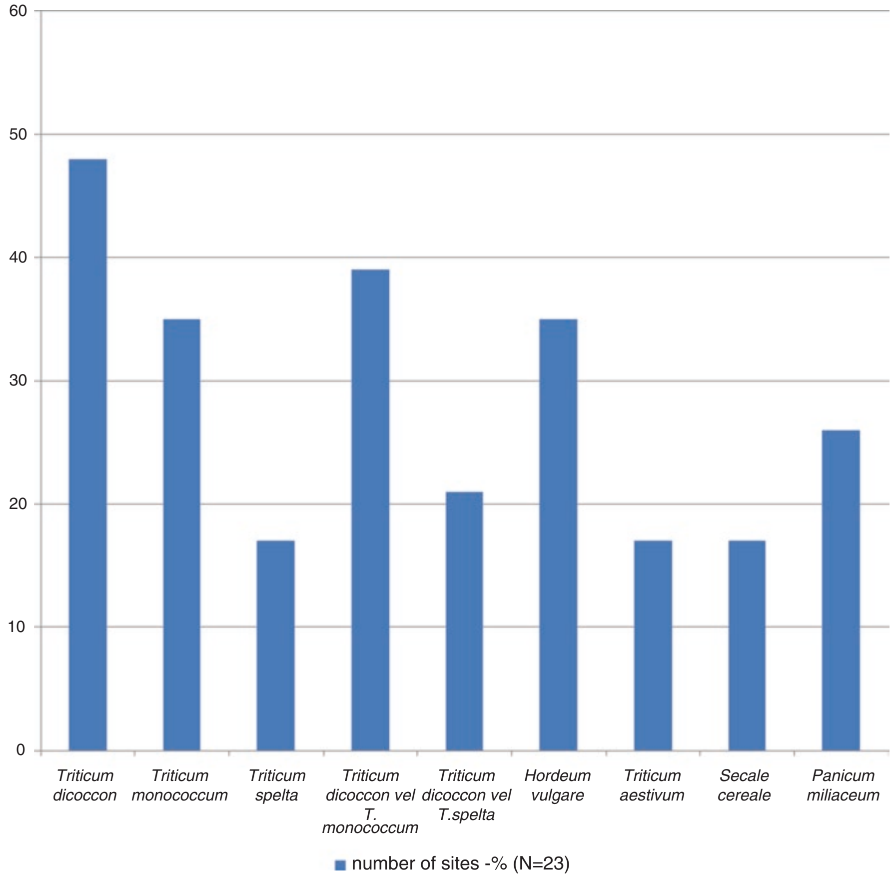


**Fig. 2** The frequency of cereals in the Linear Pottery culture sites. The percentage of the total number of sites with macroscopic plant remains ($N = 23$)

of Poland (Bieniek 2007; Lityńska-Zając 2007) and neighbouring countries as well (e.g. Hajnalovà 2007; Dreslerová and Kočár 2013). Slightly different observations were made while investigating the Early Neolithic sites in Bulgaria and to the north of the Alps (Kreuz et al. 2005; Kreuz 2007), where a predominance of einkorn over emmer was recorded, which was explained by different climatic conditions. Spelt *T. spelta* occurred at four sites and was poorly represented. Relatively frequently encountered plant species (eight sites), though represented by a small number of remains, was *Hordeum vulgare*. Its representation in assemblages of macroscopic remains dated to the Early Neolithic recovered in other regions of Europe is also rather poor (e.g. Conolly et al. 2008; Zohary et al. 2012). The role of this species within a structure of crops cultivated by communities of the Linear Pottery culture is not entirely explicit. It might have been cultivated on a small scale and was of little, if any, economic significance of that time. It could have co-occurred with wheat on crop fields, being just a weed (e.g. Bogaard 2004, 14; Kreuz et al. 2005). With regard to the number of identified plant remains, a considerable position was taken by *Panicum miliaceum.* Remains of millet were recorded at European archaeological sites relatively early, though the latest research indicated that it was no sooner than in the fourth or third millennium cal. B.C., when this species expanded in crop fields (Moreno-Larrazabal et al. 2015 and literature quoted there). Remains of *Secale cereale* were encountered at four archaeological sites in a form of few charred caryopses and an impression of a spike with solid rachis internodes (Giżbert 1961). Archaeobotanical sources documented the late introduction of rye into cultivation (Wasylikowa 1983; Behre 1992; Lityńska-Zając and Wasylikowa 2005, 99), which is also confirmed by palynological sources (Okuniewska-Nowaczyk et al. 2004, 349).

Amongst other cultivated plants found in cultural layers ascribed to the Linear Pottery culture in south-western Poland, seeds of *Linum usitatissimum* and *Pisum sativum* were recorded. Determining an economic significance of crop plants, in particular papilionaceous plants, is definitely more difficult due to the fact that they are poorly represented in fossil materials (Lityńska-Zając 2013). Therefore, it is uncertain whether their small share results from their truly marginal role within the structure of crops of that time or there are different reasons connected to an exceptional fragility of charred seeds of papilionaceous plants, being susceptible to fragmentation (Tanno and Willcox 2006). However, one should keep in mind that at many archaeological sites, including those in Poland, there were recorded numerous remains of *Pisum sativum* (e.g. within a feature of the Trzciniec culture in Słonowice, Calderoni et al. 1998–2000) and *Lens culinaris* (e.g. in features of the Lusatian culture in Sobiejuchy, Palmer 2004). These species arrived in Europe altogether with primeval variants of wheat and barley (Zohary et al. 2012). They occurred rather sporadically and in small numbers at the Neolithic sites in Poland (Lityńska-Zając 2013) and north-western Europe (McClatchie et al. 2014). Probably, they became more common in crop structure of the Late Bronze Age, simultaneously with the spread of millet cultivation (Kohler-Schneider 2001).

Stating that inhabitants of the Linear Pottery settlements were farmers is a kind of truism. Based on the material gathered, we can conclude that the major components of their plant-based diet were agricultural products, mainly cereals (Nowak 2009, 62 and literature quoted there). Unfortunately, we cannot explicitly estimate what was the share or other cultivated plants in this diet, including papilionaceous plants.

## 6 Wild Plants

One of the major issues referring to studies on elements of everyday life of prehistoric human communities is determining the strategies employed by those communities to satisfy their basic needs connected with acquiring food (e.g. Helbæk 1960; van der Veen 2007; Behre 2008; López-Dóriga 2011). Gathering various parts of plants collected from natural and anthropogenic habitats, supported by hunting and fishing, was a major food supply for humans in the Palaeolithic and Mesolithic, which was proved by finds obtained from sites dated to those periods. Based on archaeobotanical studies, it was established that gathering could have been continued also in the following periods, after the introduction of agriculture in a given region (Pirożnikow and Szymański 2005), and most probably was of selective nature manifested by choosing only certain species (Dembińska 1976). Famine periods stimulated a rapid increase in demand for gathered food. "Gathering in the time of famine strives to exploit the maximum of opportunities offered by the environment; everything is collected then, everything what can be eaten, using the knowledge gathered by former generations, which is always alive due to high frequency of occurrence of famine periods" (Twarowska 1983, 231; Lityńska-Zając 2012). The volume of gathered products reached the levels of crop yields (Helbæk 1960), and food made from them played an essential role in men's diet (Ayerdi et al. 2016). A part of those plants could have been gathered easily, in the closest surroundings of men's dwelling sites due to highly effective production of seeds of particular species (Behre 2008), which consequently were able to provide large volume of crops. Gathering plants was seasonal and dependent upon the rhythms of nature.

Determining the type of a diet of prehistoric communities based on plant remains in a form of fruits, seeds and vegetative parts of plants that have been preserved at archaeological sites is a complex and difficult issue. In fossil materials obtained from sites of various cultures or located in certain geographical regions, remains of spontaneous herbaceous plants or relics of fruits of trees and shrubs usually did not occur collectively, in large numbers that would directly indicate their intentional utilisation. Taking into account various limitations (Lityńska-Zając 2008) hindering the assessment of fossil materials, it was assumed that its major criterion is the manner of utilisation of plants as described in ethnological sources, i.e. "a criterion of potential usefulness" (e.g. Zegarski 1985; Tylkowa 1989), and the knowledge of chemical, physical and biological properties of particular species (Kuźniewski and Augustyn-Puziewicz 1986; Ożarowski and Jaroniewski 1989). This hypothesis is based on an assumption that these properties have been known to humans for ages. However, it must be stressed that amongst plants growing in men's surroundings, and commonly occurring in flora, most of them have an economic application, and many of them can be used for consumption (comp., e.g. Maurizio 1926; Twarowska 1983; Łuczaj 2004).

When making an attempt to reconstruct plant-based diet of prehistoric societies, one cannot neglect the fact of possible utilisation of vegetative parts of plants, which due to their perishable nature are very rarely encountered at archaeological sites (Skrzyński 2012, msc.). Furthermore, there are very rare finds of underground organs of plants, such as roots, rhizomes or bulbs, and inflorescences, which have also been used by men (Kubiak-Martens 2005; Szymański 2008; Colledge and Conolly 2014). This is particularly readable at sites located in drylands, where charred remains of herbaceous plants have usually preserved in a form of diaspores. A more complete picture of humans' diet can be obtained from investigating sites situated in moisture areas, where "green" parts of plants may be encountered (e.g.

Kubiak-Martens 2005; Wilkinson and Stevens 2008). Nevertheless, a prevalence of plant remains at archaeological sites supports an assumption that they constituted an important element of everyday food. This is supported by analyses of the teeth and hair of the Iceman discovered in 1991 in the Alps (Oeggl 2000; Heiss and Oeggl 2009) or examinations of the stomach content of human corpse excavated from turf sediments in northern Europe (Harild et al. 2007) and finally investigations of latrines and coproliths (Reinhard and Bryant 1992; Tomczyńska and Wasylikowa 1999; Badura 2003; Shillito et al. 2011).

Based on botanical research conducted at prehistoric and medieval archaeological sites in Poland, 968 taxa of various ranks have been distinguished until present. Amongst them there are many species of wild plants of significant utility qualities (e.g. Maurizio 1926; Twarowska 1983; Łuczaj 2004, 2013). Due to obvious reasons, only a small part of them is presented below.

An important alimentation role was played by plants producing soft fruits ready to eat just after picking, such as raspberries and blackberries of the genus *Rubus* and various species of blueberries *Vaccinium*. They contain a lot of vitamins and microelements, including magnesium, calcium and ferrum. Those fruits cannot be stored for a long time without heat treatment. Remains of these plant species were recorded at many archaeological sites in the territory of Poland.

There is another group of plants that can be consumed directly after picking or stored for a long time. This group encloses, e.g. hazelnut *Corylus avellana*. An abundant find of hazelnut shells, containing 11,045 specimens identified in 61 samples, was recovered at site 7 in Krzyż Wielkopolski and dated to the Mesolithic period (Kabaciński and Lityńska-Zając in print). The remains of hazelnuts discovered at this site represented two different states of preservation, i.e. charred and uncharred specimens. This manner of conservation may indicate varied forms of their utilisation and consumption, as fresh and dried or roasted fruits. The process of drying and roasting aimed to increase the durability of nuts that could be stored for a longer period of time. A side effect of this process was changing the flavour of nuts and making it spicier. Diaspores of this species were also encountered at archaeological sites dated to younger chronological periods. Seeds of hazel have a high calorific value and contain fats, proteins, sugars and vegetable oil rich in unsaturated fats (Byszewski 1972, 337; Podbielkowski 1985, 192–193; Tomanek 1987, 256), as well as many microelements, such as calcium, magnesium, ferrum, phosphorus, potassium and B-group vitamins. Hazelnuts are tasty and can be eaten directly after picking. They can also be stored but only in a dried form (Maurizio 1926, 67; Łuczaj 2004, 118). Common hazel is one of the species, the fruits of which could have played the major alimentation role in human's diet in the Mesolithic period (Kertész 2002). They could be eaten fresh and did not require any special treatments and processing before consumption (Kubiak-Martens 2002).

Another species, the remains of which are discovered at archaeological sites in Poland, is wild apple *Malus sylvestris*, though its finds are not very frequent and abundant. The oldest remains of this species, seeds and fragments of fruits, were recorded at a site of the Linear Pottery culture in Gwoździec, com. Zakliczyn (Bieniek and Lityńska-Zając 2001 and literature quoted there). Others come from the Mesolithic site in Dąbki in Pomerania (Kubiak-Martens 1998). There is no doubt that fruits of common pear *Pyrus communis* and plum *Prunus* were also gathered. Apples, pears and plums contain a lot of vitamin C and other groups of vitamins, microelements and fibre. They could be eaten fresh or stored in a dried form. Possibly other plants, such as fruits of hawthorn *Crataegus*, dogwood *Cornus* and oak nuts (acorns) *Quercus*, were also gathered. In prehistoric archaeobotanical materials, finds of fruits of the latter are not frequently encountered, and their assemblages, if found, usually do not contain many specimens.

Vegetative parts of herbaceous plants, such as sorrel, goosefoot and nettle, were also gathered and used for making salads and pottages. For instance, young individuals of *Chenopodium album* could be eaten fresh or cooked (Łuczaj 2004, 101). White goosefoot was also used to feed domesticated animals (Szot-Radziszewska 2007). Its seeds could have been utilised to produce flour and groats and as an additive to flour for baking bread. However, it must be stressed that an excessive content of white goosefoot seeds in bread may cause various pathological symptoms experienced by individuals who ate these products (Bagiński and Mowszowicz 1963, 39). In the opinion of some scholars, in particular regions of the globe species in the family of Chenopodiaceae were used for consumption as early as in the last glacial period (McConnell 1998). White goosefoot, being a species of crop fields and ruderal habitats, grew nearby human dwelling sites and produced ca. 100,000 seeds per 1 individual (Tymrakiewicz 1962, 31–32; Behre 2008), which made it a highly available food source in the surroundings of ancient settlements. Remains of white goosefoot have been commonly encountered in archaeological materials of various chronologies collected in the territory of Poland (Lityńska-Zając 2005, 87).

## 7 Farming

Since the beginning of the Neolithic period, humans have been engaged in cultivation of plants. It is possible to determine the nature of crops based on, amongst others, weeds co-occurring within a single feature with grains of cereals (Lityńska-Zając 2005). An alternative interpretation of the characteristics of cultivations is based on edaphic requirements and biological properties of cultivated species (Lityńska-Zając and Wasylikowa 2005).

The oldest variants of hulled wheat, such as emmer and einkorn, were most likely sown together as a mix, which is supported by the fact that they often occur within one archaeological feature identified as a storage pit. This is very legible in materials of the Funnel Beaker culture (Kruk et al. 2016), though in Ćmielów (Podkowińska 1961) pure deposits of *Triticum dicoccon* were encountered as well. There is no doubt that a certain part of crop species was cultivated in monocultures. This mainly concerns millet *Panicum miliaceum* requiring special agricultural treatments based on maintaining appropriate interrows and a manner of harvesting crops suitable for this particular species (Strzelczyk 2003; Lityńska-Zając 2005). Another species that could have been cultivated in monoculture was *Hordeum vulgare*.

However, at site G in Słonowice, within a feature of the Trzciniec culture, caryopses of barley co-occurred with seeds of common pea (Calderoni et al. 1998–2000; Lityńska-Zając 2005, 155–157). The fact that remains of these two species lay within a single pit may indicate either an intentional sowing of mixed seeds of barley and pea or a secondary mixing of the material primarily stored in two separate, probably wooden containers. The latter may be supported by fragments of wood preserved in the pit in question. This interpretation of the material seems to be the most probable; however, one cannot reject a hypothesis that this particular species composition proves crop rotation, i.e. a practice of growing a series of different types of crops in the same area in sequenced seasons. It can be assumed that mixed seeds of barley and pea were sown together in the same area. Perhaps common pea was grown in vegetable gardens as well (Kruk 1980; Kruk and Milisauskas 1999; Bogaard 2004; Nowak 2009; Kruk et al. 2016).

Remains of wild herbaceous plants co-occurring with remains of cereals within a single storage pit can provide the grounds for economic interpretations leading to a reconstruction of major agricultural activities. This chapter presents the data published in a monograph entitled *Weeds* (*Chwasty*) (Lityńska-Zając 2005). One of the elements of such analysis is an assessment of the degree of weed infestation of growing crops. This can be described through the ratio of a total number of weed diaspores to the number of cereal caryopses. The following stage of the analysis may cover an assessment of habitats where crop fields were established, which is based on habitat requirements referring to a particular crop plant and co-occurring species of weeds. In order to draw such characteristics, the so-called ecological indicator values were used (Zarzycki et al. 2002) for three parameters that describe the following properties of soil: W, moisture; Tr, trophism; and R, soil acidity. Then the type of crop should be determined, which means answering the question whether the cereals were sown in autumn (winter crops) or in spring (spring crops). To solve this issue, properties of both the cereals and the accompanying weeds should be taken into account; the latter can be divided, depending on their life cycles, into short-lived and perennial weeds, while the former enclose spring plants, overwintering plants, winter plants and biennials. Having performed the analysis of composition of weed species, an attempt to determine the manner of crop harvesting can be made. Such considerations are based on the knowledge of the height of weeds which constitute four layers within a single crop field.

The analysis presented here was based on observations of the contemporary relationships between the weeds having grown within the crops and the nature of these crops. When performing such an analysis, one should keep in mind that the significance of weeds can sometimes be ambiguous for several reasons. Some of them result from the properties of plants that can have a wide range of ecological tolerance and, in certain cases, cannot be considered precise markers of given economic treatments. This method can be engaged in analysing plant materials found within a single archaeological feature, where except for remains of a crop plant, diaspores of field weeds were also encountered. However, it must be assumed that the co-occurring specimens had grown together on a single field. With regard to the present conditions, employing the method of bioindication can be successful and

**Table 2** Weeds in the sample of rye from the Early Medieval feature (no. 18/87) at Parchatka, site 12 (After Lityńska-Zając 2005).

| Species name | Number of remains | Ecological indicators | | | | | | Height | Life forms | Flowering time |
|---|---|---|---|---|---|---|---|---|---|---|
| | | W min | W max | Tr min | Tr max | R min | R max | | | |
| *Agrostemma githago* | 11 | 3 | 3 | 3 | 4 | 4 | 5 | 90 | RO/J | VI–VII |
| *Artemisia* cf. *vulgaris* | 43 | 3 | 3 | 4 | 4 | 4 | 5 | 50–150 | W | VII–IX |
| *Echinochloa crus-galli* | 16 | 3 | 4 | 4 | 5 | 3 | 4 | 30–70 | RJ | VII |
| *Fallopia convolvulus* | 3 | 3 | 3 | 3 | 4 | 3 | 4 | 100 | RJ | VII–IX |
| *Lychnis flos-cuculi* | 6 | 4 | 4 | 4 | 4 | 4 | 5 | 35–80 | W | VII–IX |
| *Melandrium album* | 12 | 3 | 3 | 4 | 4 | 4 | 4 | 30–100 | R/D/W | V–IX |
| *Plantago lanceolata* | 1 | 2 | 4 | 3 | 4 | 4 | 4 | 5–60 | W | V–IX |
| *Polygonum persicaria* | 3 | 3 | 3 | 4 | 3 | 4 | 4 | 100 | RJ | VII–X |
| *Rumex crispus* | 10 | 3 | 4 | 4 | 4 | 4 | 4 | 40–100 | W | VI–VIII |
| *Setaria pumila* | 73 | 2 | 3 | 3 | 3 | 3 | 4 | 10–40 | RJ | VII–IX |
| *Spergula arvensis* | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 10–60 (100) | RJ | VII–IX |
| *Urtica dioica* | 2 | 3 | 4 | 4 | 5 | 4 | 4 | 100 | W | VI–X |
| Mean index value | | 2.9 | 3.4 | 3.5 | 3.9 | 3.6 | 4.2 | | | |

Explanations: ecological indicators, W soil moisture value, Tr trophism value, R soil acidity value, ecological numbers according to Zarzycki et al. (2002); life forms, R annuals, J summer annuals, O winter annuals, D biannuals, W perennials; height in cm; height; life forms; flowering time after Tymrakiewicz (1962) and Szafer et al. (1986).

provide reliable results providing that a minimum number of ten species was proved to coexist on a single filed (Borowiec 1972).

The above-mentioned issues were presented based on materials dated to the Early Middle Ages, recovered from site 12 in Parchatka (eastern Poland), from the feature 18/87, where more than 2400 specimens caryopses and 81 fragments of spike rachis internodes of *Secale cereale* were found. Within these features, fruits and seeds of apple *Malus sylvestris* were also recorded. This feature served as a pit for storing food reserves. Most likely a part where the crops were kept was separated from the other part where gathered plants were stored. These could have been organic containers or a kind of a wooden structure, the traces of which have been preserved in a form of charcoals.

In the storage pit in question, remains of crop plants were accompanied with 12 species of weeds (Table 2). The degree of weed infestation of grains amounted to 0.175. A mean moisture value ranged between 2.9 and 3.4. A distribution of this parameter indicates that these species grew in similar habitats and could have grown on fresh soils, though some of them had a wider range of moisture tolerance (W 3–4). Others could develop only on moist (*Lychnis flos-cuculi*) or dryer soils (*Setaria pumila* and *Plantago lanceolata*). A mean value of trophism index ranged from 3.5 to 3.92. Most of the species revealed similar requirements with regard to this parameter, and they could grow on various soils, from mesotrophic to eutrophic. A species growing on oligotrophic soils was represented by *Spergula arvensis*, while *Echinochloa crus-galli* and *Urtica dioica* developed on extremely fertile soils. A mean value of soil pH index ranged between 3.6 and 4.2. The range of variability in this parameter indicated that the species under analysis were not adapted to uniform soil conditions. One of them preferred acid to moderate acid soils (R 2–3). Three of them could grow on neutral to alkaline substratum (R 4–5). For others the most favourable soil conditions were neutral or moderate acid. Nevertheless, crop fields where the weeds in question grew could have been established on fresh soils, from moderately poor to fertile and neutral.

Within the biological spectrum of the crop under scrutiny, the group of weeds was dominated by annuals, spring plants and perennials. The latter can develop in spring crops. They can also grow on crop fields established on previously untilled lands. The composition of weed species indicated a spring cultivation of rye. Nowadays, this cereal is mainly cultivated as winter crop. On crop fields, there are also encountered spring cultivars, old and younger ones, presently cultivated mainly as forecrop or feed for domesticated animals. However, it cannot be excluded that sowing of rye in the Early Middle Ages was performed in autumn. If that was the case, a large number of spring weed species within winter rye should be explained with a low crop density, creating favourable growth conditions for weeds, the germination period of which was in springtime (Wasylikowa 1983).

A significant part of weed species reaches the height of crops. There are also a few smaller plants, the maximum height of which amounts to 40–60 cm. This indicates that cereal spikes were removed with considerably long fragments of stems. Rye is a fast-ripening crop species. Under current climatic conditions, its harvest takes place in July. The blooming period of species found in the sample in question indicates that this was a very probable time of harvest of this particular crop.

## 8 Wood Utilisation

Remains of wood recovered from archaeological sites are mainly represented by fragments of firewood used in households and collected in surrounding forests in a form of brushwood. Such wood was highly available to human communities, and did not require a long-distance transportation. Anthracological examinations revealed that the charcoal produced from firewood was characterised by a high biodiversity, thanks to which the preserved wood remains can deliver information about the local ancient stands (Badal 1992; Asouti and Austin 2005; Moskal-del Hoyo 2013). For reconstruction of ancient forest stands, the most suitable is charcoal obtained from hearths. However, it should be stressed that characteristics of ancient forest plant communities based only on identification of wood remains are highly limited due to the fact that most of the charred wood fragments can be determined to the level of genus exclusively (see below). Wood, which is obvious, was also used for various constructions and buildings and production of furniture required in households.

## 9 Palaeoenvironmental Reconstructions

When describing a palaeophytocenosis, the principle of actualism is employed. A reconstruction of ancient vegetation can be based on phytosociological grounds. In such a case for every species recovered from archaeological layers, a current affiliation to a syntaxon is given, thanks to which it is possible to describe various types of plant communities that could have grown in the surroundings of ancient human settlements (Lityńska-Zając 2005). Phytosociology is based on the fact that in nature plants grow in aggregates, constituting a certain spatial entity, and referred to as a community, i.e. phytocenosis. These communities are characterised by a defined floristic composition and can be recognised based on a specific combination of species and the so-called characteristic and differential species. Plant communities of one type are named plant associations. Ecological conditions, under which the association is able to develop, are determined by ecological requirements of species that constitute this association and a competition between those species. Every species has a wider ecological amplitude than the association as a whole, and growing in the association, it exploits only a limited range of its developmental opportunities. Due to this, a strictly defined plant association is a sensitive marker of environmental conditions, under which it exists. Associations of similar floristic composition are combined into higher syntaxonomic units, which are indicators of habitat conditions. These properties of syntaxa make them helpful in synecological phytoindication, which means concluding about habitat conditions and the intensity and manner of human impact on vegetation (Medwecka-Kornaś et al. 1972; Matuszkiewicz 2001).

Employing the phytosociological method in archaeobotany is based on an assumption that the list of species found at a particular archaeological site provides the grounds for recognition of ancient plant communities. The nature of factual materials imposes considerable limitations on palaeophytosociology, which are mainly due to two facts. Firstly, we can never be sure whether the species discovered together constituted one, particular phytocenosis in the past. Secondly, presently encountered plant complexes have their history, and we do not know when they took a modern form; thus classifying species within a palaefloristic list according to their current syntaxonomic typology may lead to false reconstruction of ancient syntaxa. Therefore, when employing the phytosociological method in palaeoecological reconstructions, one should always keep in mind that the conclusions drawn are only research hypotheses that cannot be considered strong evidence used for reconstruction of the past.

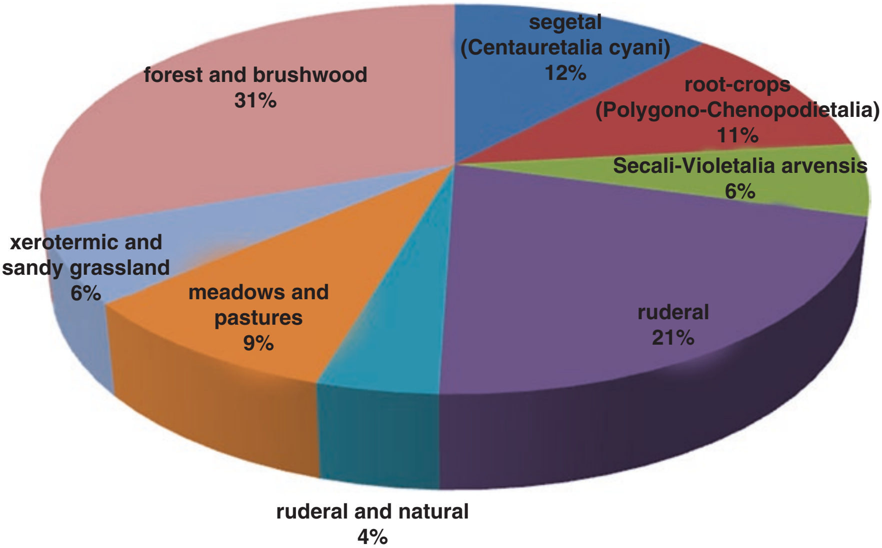


**Fig. 3** Frequency (in %) of plants from anthropogenic and natural habitats on site 2 at Kraków-Pychowice (After Lityńska-Zając 2001)

An example of plant material elaborated in the above-mentioned manner is a case study of site 2 in Kraków-Pychowice dated to the Roman Period (Lityńska-Zając 2001), where six species of cereals and two species of other crop plants were identified. Based on diaspores of wild herbaceous plants, 43 taxa were determined to the level of species. Trees and shrubs were represented by five species and nine genera. With regard to 66 species, their current taxonomic affiliation was determined. Distribution of the number of characteristic species of particular syntaxa indicated that the most numerous were plants growing in various forest and shrub communities (Fig. 3). In present-day habitats of oak-hornbeam forests, communities with oak, lime, maple, beech and hazel could have grown. In varied types of riparian forests, such tree species as alder, ash and maple occurred, while herbaceous plants were represented by *Stellaria nemorum* and *Urtica dioica*; the latter might have also grown in ruderal places. The second most frequent group of plants was field weeds, represented by species typical of cereal crops, such as *Centauretalia cyani* (e.g. *Agrostemma githago*, *Centaurea cyanus*, *Bromus secalinus* and *Papaver rhoeas*). An occurrence of this group of weeds is explained by a presence of cereal remains recorded at the site in question. The material under analysis also contained remains of weeds typical of root crops (*Polygono-Chenopodietalia*, e.g. *Echinochloa crus-galli*, *Setaria pumila* and *Polygonum persicaria*) and those encountered in both types of crops mentioned above (*Secali-Violetalia arvensis*, e.g. *Fallopia convolvulus* and *Thlaspi arvense*). The species that are presently typical of root crops could have grown with spring cereals and millet crops and in vegetable gardens. They might have also co-occurred with other cereals providing that the crop density was low. These weeds could have grown with pea crops that had to be sown in two rows in order to maintain appropriate interrows. The site in question delivered an abundant collection of ruderal plants, growing on soils rich in nitrogen, phosphates and potassium chloride, in the closest surroundings of human dwelling sites. Finally, species typical of non-forest communities, namely, meadow, pasture and grassland plants, are represented in relatively large numbers.

As evidenced by the above-mentioned example, remains of wood can be used, within certain limitations, to reconstruct plant communities, thus habitats they had lived in. However, in such a case, employing palynology would be much more beneficent. Palynology is a useful tool in reconstructions of vegetation cover having existed in ancient landscapes. It is commonly employed in archaeology to assess the vegetation at regional level. Pollen diagrams can also serve for identifying traces of cattle grazing, crop cultivation or burning of plants, which allows us to understand ancient practices associated with land preparation for farming (e.g. Behre 1981; Makohonienko et al. 1998b; Latałowa 2003).

## 10 Summary

The above-quoted examples of case studies and archaeobotanical interpretations do not close the list of all possible applications of this discipline. As mentioned above, the author aimed to present results of studies conducted at sites mainly located in the present territories of Poland.

The analysis of plant remains delivered a great number of significant information referring to plant management by prehistoric human communities. The author indicated that wild species identified in assemblages of macroscopic remains are derived mostly from communities that developed within the dwelling and economic zones of human activity. Archaeobotanical studies are highly interesting from the viewpoint of botany and agricultural sciences. They are mainly employed for resolving certain issues related to the history of cultivated and synanthropic plants. Plant remains that were properly and accurately dated are indisputable records documenting the time and place of the occurrence of particular species. With regard to cultivated species, they provide the grounds for establishing the earliest locations of their occurrence and tracing the paths of their expansion.

A significance of archaeobotany for archaeology results from the fact that it delivers materials allowing the investigators to answer certain questions referring to plant management in the past centuries. Of major significance is the possibility to reconstruct plant food consumed by humans and domesticated animals, coming from both gathering and farming. Gathering of wild plants was the only way of obtaining them within the scope of subsistence economy of the Palaeolithic and Mesolithic periods. Employing reconstructions of palaeophytocenoses makes it possible to “place” archaeological sites in their environmental context and reveal conditions, under which the ancient human communities came to live.

Based on the experience gained so far, one can also state that in order to obtain a more complex picture of plant significance in the existence of prehistoric human societies cooperation between scholars specialised in various disciplines is extremely important, enabling an exchange of information, designing of complementary studies and thorough verification of the results obtained. This wide-scope interpretative approach has been marked in the related studies of the recent years.

When making attempts to reconstruct human economy and the nature of environment, a certain dose of scepticism is recommended, keeping in mind that one of the characteristic traits of fossil materials is their incompleteness.

**Translated by Agnieszka Klimek**

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