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NEOLITHIC PLANT EXPLOITATION AT BRONOCICE

ABSTRACT

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The purpose of this article is to present the recovered plant remains and their subsistence and ecological analysis from Lublin-Volhynian, Funnel Beaker, and Funnel-Beaker-Baden culture occupations at Bronocice, dating from approximately 3800 to 2700 BC. Domesticated plants were significant in all time periods, but gathered plants supplemented the diet throughout the 1100 years under review. Some were trees and shrubs used for fodder, consumption and technological items but most were ruderals found growing in agricultural land, old fields, and pastures.

Keywords: Lublin-Volhynian culture, Funnel Beaker culture, Funnel Beaker-Baden culture, domestic plants, wild plants, usage of plants.

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INTRODUCTION

The purpose of this article is to present the results of plant remains recovered and analyzed from Funnel Beaker (FB), Lublin-Volhynian (LV), and Funnel Beaker-Baden (FB-B) culture occupations at Bronocice, dating from approximately 3800 to 2700 BC. This analysis will provide information about subsistence and various uses of domestic and wild plants. Neolithic populations in the Bronocice region depended not only on cereal cultivation but also on the raising of livestock, hunting, fishing and gathering. In this article, we will consider the following questions: 1. How important were domestic and wild plants in the archaeobotanical sample? 2. What were the frequencies of different plants? 3. What was the usage of plants? 4. Were there any changes in the frequencies of the plant remains took place through time? 5. How were different plants used for food and medicinal purposes?

The State University of New York at Buffalo and the Polish Academy of Sciences conducted a cooperative archaeological project at the Bronocice site, Świętokrzyskie Province from 1974–1978 (Fig. 1). The Director and Principal Polish Investigator of this cooperative

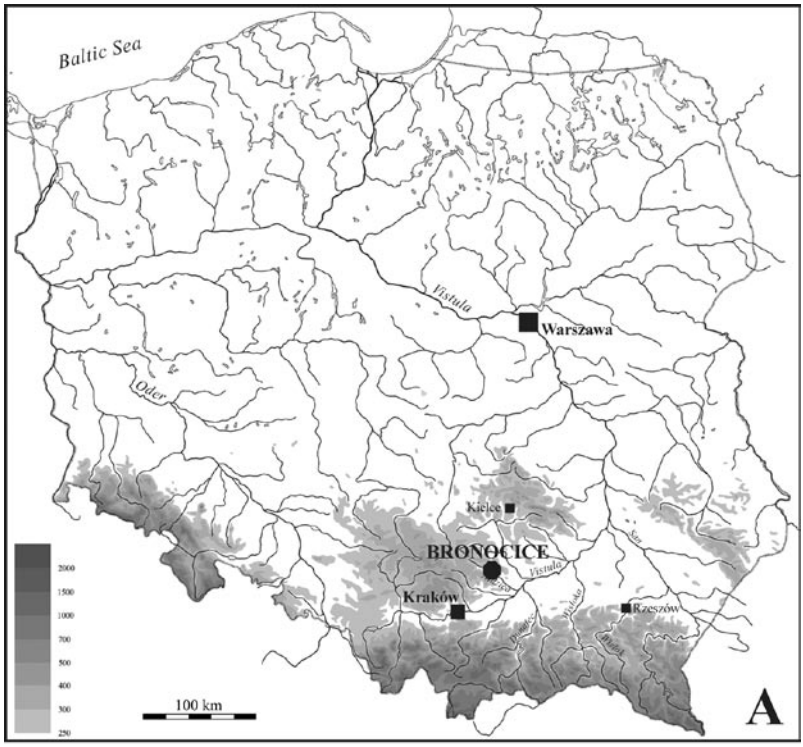

Fig. 1. Location of Bronocice in Poland

project was Witold Hensel and the Principal American Investigator was Sarunas Milisauskas. The objectives of this archaeological project were twofold: 1. to investigate the prehistoric environment, chronology, economy, settlement system, and social organization of the Middle Neolithic (TRB or Funnel Beaker culture) and Late Neolithic (Funnel Beaker-Baden) communities, and 2. to explore the origin of complex societies in the Nidzica River basin, southeastern Poland.

DESCRIPTION OF THE BRONOCICE MICROREGION

The site of Bronocice is located in the Bronocice microregion, southeastern Poland. A circle with a 10-km radius (314 km), centered on the site of Bronocice, was used to delimit the microregion. The presence of sandy soils at the northeastern edge of the microregion determined the area's radius. The Bronocice microregion is located in the southeastern (Little) Polish Uplands and the Proszowice Uplands are located in its southern part, while the northern portion falls within the Miechów Upland. The extensive valley of the Nidzica River, a left bank tributary of the Vistula, bisects the microregion from west to east.

The Bronocice microregion consists of low loess covered elevations or hills. The altitude of the hills is 250–300 m asl, but they rise only 50–100 m above the valley bottom of the Nidzica River. Various geological formations are found in the microregion. While the Miechów Upland section was formed during the Cretaceous epoch, the Proszowice Uplands were formed on the Miocene loams. These formations are covered by a layer of loess, which is over 5 m thick in some areas (Gilewska 1958). Chernozems are most commonly found in the microregion, followed by brown loam and alluvial soils. Sandy soils comprise only 8.3% of the microregion.

The Bronocice site (50°21'00" N latitude, 20°19'30" E longitude) is located on the highest local elevation above the Nidzica River floodplain in Świętokrzyskie province. Janusz Kruk discovered it in 1967 during a survey of this region, although it should be noted that as early as 1936, K. Jażdżewski reported a Funnel Beaker amphora from Bronocice. The length of the entire site is roughly 1600 meters and the width from 300 to 500 meters, totaling an area of over 50 hectares (Fig. 2). For excavation purposes, Bronocice was divided into three natural areas — A, B, and C — based on topographical variation. Areas A and B are 18 hectares in size each, while Area C is 16 hectares in size. Excavations were conducted in all three areas and the chronological, functional, and cultural variability was defined. Excavations at Bronocice recovered a large volume of diverse cultural materials, approximately 500,000 artifacts, including pottery, lithics, burials, textile production artifacts, and plant and faunal remains (Kruk, Milisauskas 1981). Furthermore, ditches of two fortifications and one enclosure were found.

Bronocice has some of the earliest evidence in Europe for the presence wheeled vehicles, dating to around 3400 BC (Bakker *et al.* 1999). These vehicles were probably pulled

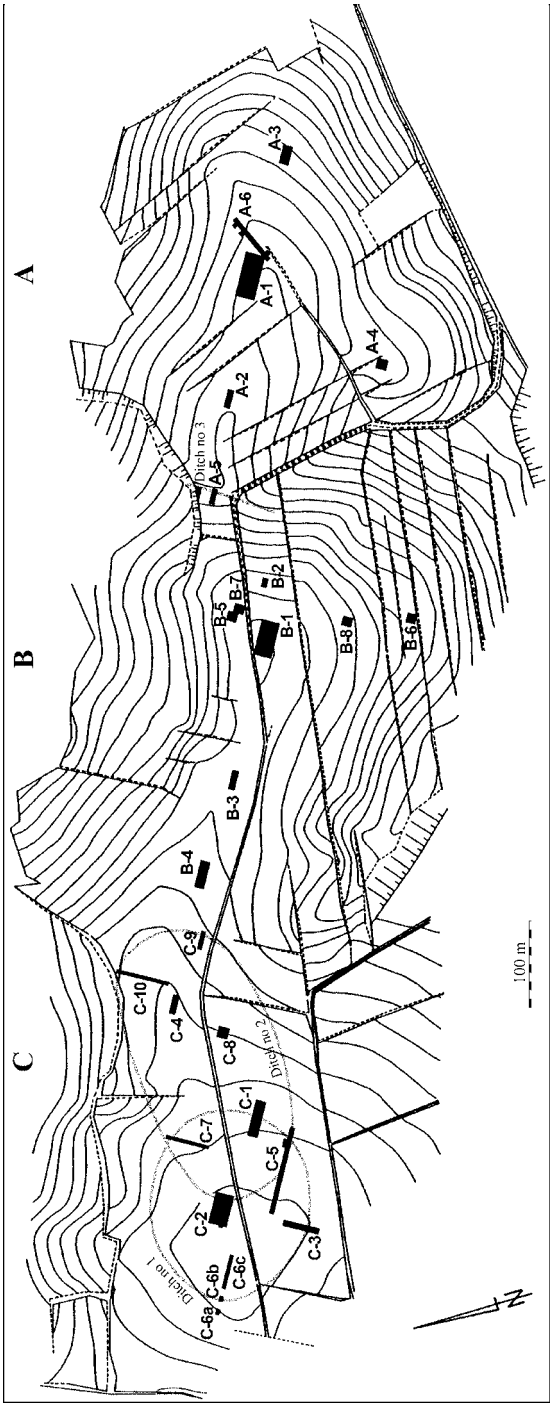

Fig. 2. Excavation Units at Bronocice

Table 1. Population and Settlement Size during the Six Phases at Bronocice

Culture and Phase	Length of occupation	Size of settlement	Population estimates
Funnel Beaker 1	100 years	2 ha	48
Lublin-Volhynian 2	50 years	2.4 ha	57
Funnel Beaker 3	250 years	8 ha	192
Funnel Beaker 4	300 years	21 ha	504
FB-Baden 5	200 years	26 ha	624
FB-Baden 6	200 years	17 ha	408

by cattle. At this time, ards were present for plowing fields in central Europe, and we assume that they were present at Bronocice.

We have suggested that the site of Bronocice was the central place in the region (Milisauskas, Kruk 1984). It is evident that in the surveyed region of 314 km^2, Bronocice was by far the largest settlement. There was a two-tier settlement system. The population and the settlement size at Bronocice were much greater than that of any other site (Table 1).

CHRONOLOGICAL AND CULTURAL SEQUENCE IN THE BRONOCICE REGION

The Linear Pottery culture is the earliest Neolithic occupation in the Bronocice region, dating from approximately 5400–4900 BC. With the disappearance of Linear Pottery ceramics, Lengyel-Polgár ceramics began to dominate in the Bronocice region around 4800–4600 BC. This stylistic change signified, in the traditional nomenclature, the beginnings of the Middle Neolithic in southeastern Poland. By 3800 BC the earliest Funnel Beaker material had appeared in the Bronocice region (Table 2). These ceramics disappeared around 3100 BC. Fortifications of the Lublin-Volhynian culture, dating to 3700 BC, were also found at the Bronocice site. Funnel Beaker-Baden, Globular Amphora and Corded

Table 2. Length of the six occupational phases at Bronocice

Phase	Culture	Dates BC cal.
1 (BR 1)	Funnel Beaker	3800-3700
2 (L-V)	Lublin-Volhynian	3700-3650
3 (BR 2)	Funnel Beaker	3650-3400
4 (BR 3)	Funnel Beaker	3400-3100
5 (BR 4)	Funnel Beaker-Baden	3100-2900
6 (BR 5)	Funnel Beaker-Baden	2900-2700

Ware material characterize the Late Neolithic in the Bronocice region. It should be noted that we have previously called Funnel Beaker-Baden material "Baden-like" or simply "Baden", but after extensive reanalysis we now conclude that these Late Neolithic ceramics at Bronocice cannot be considered typical Baden types. The earliest Funnel Beaker-Baden ceramics date to around 3100 BC and the Corded Ware material around 2700 BC. There was a Corded Ware culture burial in Area B and some pits belonging to the Middle Bronze Age, Trzciniec culture, were found at Bronocice. In addition, small quantities of pottery belonging to the Comb and Pit Ornamented Pottery culture were recovered.

BRONOCICE LANDSCAPE

In order to recreate the habitat areas of settlement at Bronocice, the method of potential natural vegetation was used as the surroundings of the site has not been palynologicaly studied, which would most fully reflect the characteristics of the past vegetation. Potential natural vegetation refers to the vegetation which would have developed after the cessation of human activity, from the elements currently present (at the time) in the flora (Kornaś, Medwecka-Kornaś 2002, 519; Matuszkiewicz 1991, 478–479). Therefore, it cannot be equated with primeval vegetation or historic vegetation, as it already existed in the environment surrounding the site. Potential natural vegetation is characterized by the properties of habitats showing the spatial variation, and which is plotted on a map. Thus in the Bronocice region, we can identify five zones: A) the seasonally flooded bottom lands, characterized by alder forests (*Carici elongatae-Alnetum*) and marshy multi-species forests, mainly ash and elm (*Fraxino-Ulmetum, Circaeo-Alnetum*), B) the valley edge, consisting of dry multi-species forests of linden and hornbeam (*Tilio-Carpinetum typicum*), (*Tilio-Carpinetum stachyetosum*), C) the slopes of the uplands, characterized by linden and hornbeam (*Tilio-Carpinetum typicum*), D) the edges of the uplands, consisting of dry multi-species deciduous forests of linden and hornbeam (*Tilio-Carpinetum typicum*) and mixed coniferous forests in some parts (*Pino-Quarcetum*), and E) the uplands, characterized by oak and pine forests (*Pino-Quercetum*) (Kruk, Przywara 1983; Milisauskas, Kruk 1984).

The Funnel Beaker, Lublin-Volhynian and Funnel Beaker-Baden occupations at Bronocice were located in Zone D. In addition to fertile soils, Zone D also possesses a sufficient amount of flat land, which is ideal for settlement location. Previous to the Funnel Beaker occupations at Bronocice, Linear Pottery and Lengyel-Polgár ceramics are found in the surrounding valleys, and it appears that these occupations had only a minor impact on the local environment.

Most Linear Pottery and Lengyel-Polgár settlements were located near low-lying areas, just above the floodplains (Kruk 1973). Oak forests dominated the local landscape (Kruk 1993). However, the majority of Funnel Beaker and Funnel Beaker-Baden sites were up-

Table 3. Plants associated with grasslands at Bronocice

Latin name	Common name	Present day plant communities
Elymus repens	Quackgrass, Wild rye	*Agropyro-Rumicion crispi*
Festuca arundinacae	Fall fescue	*Agropyro-Rumicion crispi*
Rumex crispus	Curled dock	*Agropyro-Rumicion crispi*
Rumex obtusifolius	Bitter dock	*Agropyro-Rumicion crispi*
Bromus hordeaceus	Soft brome	*Arrhenatheretalia*
Lolium perenne	Perennial rye grass	*Polygonion avicularis* or *Cynosurion*
Rumex acetosa	Garden sorrel	*Molinio-Arrhenatheretea*
Stachys recta	Yellow woundwort	*Festuco-Brometea*
Rumex acetosella	Sheep's sorrel	*Sedo-Scleranthetea*
Sparganium neglectum	Profuse bur-reed	*Phragmitetea*

land settlements. Large areas of forest were cleared by cutting with axes and probably by fire. The deforestation of the Bronocice region during the Funnel Beaker occupations changed the forest to forest-steppe and, thus, the landscape was characterized by a mosaic of open spaces covered by grasses and clusters of trees. The frequency of pine increased in the forests as a result of human activities, and this increase probably reflects an invasion of old grain fields and pastures by pine. Thus the Bronocice landscape was greatly changed by Funnel Beaker and Funnel Beaker-Baden people.

Additional evidence for landscape changes in the Bronocice region is provided by molluscan, palaeogeographical, and faunal data (Kruk *et al.* 1996). Near the end of the fourth millennia BC, the population in the Bronocice region increased and extensive agricultural exploitation of the loess uplands occurred. This time period is associated with the beginning of the Sub-Boreal climatic phase. In the Bronocice region, thick silts accumulated in river valleys and at the bottom of dry valleys at a rate of sedimentation that was three to six times greater than that of the Atlantic period. This resulted from the clearing of forests from slopes and upper elevations. Molluscan data show that intensive slash and burn farming of the uplands contributed to the formation of grasslands. Snails adapted to dry and deforested environments, and species such as *Vallonia costata* Müller, *V. pulchella* Müller, and *Pupilla muscorum* L., comprise the data (Alexandrowicz *et al.* 1984). Finally, the presence of numerous goat/sheep remains at Bronocice indicates the existence of large open areas, i.e., cleared forests around the settlement. Finally, various plants associated with different grassland are present at Bronocice (Table 3).

RECOVERED PLANT REMAINS

The analyses of flotation, charcoal and daub samples provided evidence for the presence of domesticated and wild plants. The flotation samples produced the most evidence about plant remains (Table 4). Numerous daub pieces contained plant impressions at Bronocice and their identification subsequently increased the sample size of the plant remains, particularly that of cereals. Some of the cereal grains were damaged and, thus, the species could not be determined.

Table 4. Number of Analyzed Samples of Plant Remains at Bronocice

Phase or Cultures	Number of Samples		
	Flotation Samples	Wood Charcoal	Daub Samples
1	1	7	7
2	2	7	0
3	9	9	4
4	33	21	14
5	39	33	14
6	17	18	3
Corded Ware	0	1	2
Trzciniec (Bronze Age)	1	3	4

The domesticated plants and the accompanying weeds were first introduced by the Linear Pottery culture people around 5400 BC in the Bronocice region. Therefore, some 1500 years of agriculture preceded the earliest Funnel Beaker occupation. It should be noted that in addition to the plant material, faunal remains of domestic and wild animals were recovered from Funnel Beaker, Lublin-Volhynian and Funnel Beaker-Baden pits at Bronocice.

PLANT RECOVERY PROCEDURES

The plant remains were recovered by two methods. One method involved water separation. Here, a pit fill sample of 6300 cm^3 was collected from each feature at Bronocice. These samples of pit fill were then put into a strainer with a 1 mm mesh opening and then submerged in a tank of water. The flotation samples were analyzed by Richard Ford and Maria Lityńska-Zając. The second method involved identification of plant impressions from daub pieces by Maria Lityńska-Zając and Richard Ford. Maria Lityńska-Zając and Zofia Tomczyńska analyzed the charcoal remains. Each seed, fruit, fragment of spikelet or

chaff were counted as one specimen. The number of charred diasporas was low from the flotation samples. The small number of seeds and fruit may account for the absence of some plants in the six different occupational phases. A large number (n=215) of cereal fragments from phase 4 pits were unidentifiable at the species level.

FUNNEL BEAKER AND FUNNEL BEAKER-BADEN PLANT REMAINS FROM BRONOCICE

At Bronocice, the recovered plant remains consist of 34 species, 9 genera and 3 families. Plant names are according to *Flowering plants and pteridophytes of Poland* (Mirek *et al.* 2002). Except for *Taraxacum officinale* and *Lithospermum officinale*, all seeds were burnt. It is unclear whether the *Taraxacum officinale* and *Lithosoermum officinale* remains are modern or prehistoric, as there is always the possibility of the presence of intrusive remains of modern plants in a pit. *Lithospermum* possesses a very hard pericarp (Kulpa 1974), and it is possible that they can survive as uncharred conditions in a archaeological features (van Zeist, Buitenhuis 1983). The charcoal remains produced 3 species and 7 genus. Plant remains in daub pieces were numerous and consisted of 2 species, 1 genera and 1 family. The daub contained numerous imprints of cereals and wild grasses. Phase 1 pits contained very small amounts of plant remains (Tables 5, 6), while the pits of phases 4, 5, and 6 produced the greatest number of plant remains (Tables 5, 9, 10, 11).

The Neolithic people at Bronocice cultivated a variety of plants including emmer wheat, einkorn wheat, spelt wheat, bread wheat, barley, flax, garden pea and lentils (Table 5). We have considerable information concerning the subsistence activities of the Funnel Beaker (phases 3 and 4) and Funnel Beaker-Baden people (phases 5 and 6) at Bronocice. The cultivation of a variety of plants would have been advantageous in a mixed subsistence strategy, since the failure of one crop would not necessarily result in the failure of others. Emmer wheat occurred in every phase, and was the most important cereal in the subsistence economy and probably the main source of carbohydrates. Einkorn wheat, spelt wheat, bread wheat, and barley were also cultivated (Table 5). Einkorn is found in five phases, except phase 1. Emmer is quite sensitive to soil quality variations, temperature and rainfall; consequently, to rely heavily on emmer for subsistence would have been very risky for the Bronocice people, since a bad harvest could threaten the existence of the entire community. In times when the emmer harvest was bad, the people could rely on other species such as einkorn and barley. For example, in comparison to emmer, einkorn wheat is more winter hardy. Angela Kreuz (Kreuz *et al.* 2005) have pointed out that "Einkorn is the only cultivated cereal which, due to the characteristics of its straw, keeps standing after heavy rainfall." Barley is a hardier cereal than wheat, and can be cultivated on poorer soils. Furthermore, barley does not exhaust the soil as much as wheat. Bread wheat is present first during the phase 3 occupation. The remains of rye and oats, determined only to genus

Table 5. Plant Remains Recovered at Bronocice

Latin name	Common Name	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Cerelia indet.	Corn	x		x	x	x	x
Triticum dicococcon	Emmer	x	x	x	x	x	x
Triticum monococcum	Einkorn			x	x	x	x
Triticum dicoccon vel *T. monococcum*	Emmer or Einkorn			x	x	x	
Triticum aestivum	Bread Wheat			x	x	x	x
Triticum sp.	Wheat		x	x	x	x	x
Hordeum vulgare	Barley	x	x		x	x	x
Secale cereale	Rye		x		x	x	x
Avena sp.	Oat				x	x	
Lens culinaris	Lentil	x			x		x
Pisum sativum	Pea					x	x
Linum ussitatissimum	Flax				x	x	
Elymus repens	Quackgrass			x	x		
Agrostemma githago	Corn Cockle				x		
Bromus arvensis	Field Brome				x	x	x
Bromus hordeaceaus	Soft Brome			x		x	x
Bromus secalinius	Chess	x				x	x
Bromus sp.	Brome	x		x	x	x	x
Carex sp.	Sedge				x		
Chenopodium album	Goosefoot (Fat hen)	x	x	x	x	x	
Chenopodium hybridum	Sowbane						
Chenopodium sp.	Goosefoot			x	x		

Festuca arundinacea	Tall fescue	x				x	
Galium aparine	Cleavers				x		
Galium spurium	False cleavers				x		
Lithospernmum arvense	Field Gromwell				x	x	x
Lithospermum officinale	Common Gromwell					x	
Lolium perenne	Perennial Ryegrass					x	
Lolium temulentum	Darnel						x
Malva sp.	Mallow				x		
Neslia panicula	Ballmustard						
Fabaceae indet.	Legume family				x	x	
Fallopia convolvulus	Wild Buckwheat					x	
Polygonum mite	Tasteless Water Pepper				x		
Polygonum persicaria	Ladysthumb				x		
Rumex acetosa faza?							
Rumex acetosella	Sheep's Sorrel					x	
Rumex crispus	Curled Dock					x	
Rumex obtusifolius	Broad-leaved Dock					x	
Silene sp.	Campion					x	
Sinapis arvensis	Wild Mustard				x		
Sparganium neglectum	Bur-reed				x		
Stachys recta	Perennial Yellow-woundwort				x		x
Stipa sp.	Needle grass						
Poaceae indet.	Grass family	x			x	x	x
Polygonum sp.	Buckwheat			x			
Dicotyledon	dicotyledons				x		

Table 6. Phase 1 Plant Remains at Bronocice

Latin name	*Cerealia*	*Triticum dicoccon*	*Triticum* sp.	*Hordeum vulgare*	*Lens culinaris*	*Bromus* sp.	*Chenopodium album*	*Festuca arundinacae*
Common Name	Corn	Emmer	Wheat	Barley	Lentil	Brome	Fat hen	Tall fescue
Pit No.								
40-C2		1			1	3	1	1
49-C2		1						
61-C2				1				
80-C1	1							
Daub Imprints								
20-C2	1			8				
21-C2	3		1					
32-C2	2			1				
35-C2			1					
49-C2	5		2	8				

Table 7. Phase 2 Plant Remains at Bronocice

Latin name	*Triticum dicoccon*	*Triticum* sp.	*Hordeum vulgare*
Common name	Emmer wheat	Wheat	Barley
Pit 86-C1		1	
Pit 9A-C3	1	1	1

Table 8. Phase 3 Plant Remains from Bronocice

Latin name	*Cerealia* indet.	*Triticum dicoccon*	*Triticum monococcum*	*Triticum dicoccon* vel *monococcum*	*Triticum* sp.	*Hordeum vulgare*	*Elymus repens*	*Bromus hordeaceus*	*Bromus* sp.	*Chenopodium album*	*Chenopodium* sp.	*Polygonum* sp.
Common Name / **Pit No.**	Corn	Emmer	Einkorn	Einkorn or Emmer	Wheat	Barley	Quackgrass	Soft Brome	Brome	Fat hen	Goosefoot	Buckwheat
1-A1		1				1			1			
21-A1		21			2				4			
42-A1	2	1	1		3		2	3	3	1		
66-A1	4											
73-A1	11	1										
76-A1	1											
89-A1	5											
6-A3				4							1	
7-A3	9											
Total	32	27	1	4	5	1	2	3	8	1	1	
Daub Imprints												
1-A1		1										
21-A1	1											
42-A1		1									1	1

Table 9. Phase 4 Plant Remains from Bronocice

Latin name	*Cerealia*	*Triticum dicoccon*	*Triticum monococcum*	*Triticum dicococn* vel *T. monococcum.*	*Triticum aestivum*	*Triticum spelta*	*Hordeum vulgarae*	*Avena* sp.	*Lens culinaris*	*Agropyron repens*	*Agrostemma githago*	*Bromus arvensis*	*Bromus hordeaceus*	*Bromus* sp.
Common Name	Corn family	Emmer	Einkorn	Einkorn/Emmer	Bread Wheat	Spelt	Barley	Oat	Lentil	Quackgrass	Corn Cockle	Field Brome	Soft Brome	Brome
Pit No.														
30-A1		2												
31-A1	4	1	1											
4-A1	3													1
7-A1		2			1		1							
8-A1	3													
10-A1	35	5	1							1				2
20-A1	5	10								1				2
30 and 31-A1	7	2	1											
34-A1														1
39 and 40-A1						1								
50-A1	2													

Latin name	*Carex* sp.	*Chenopodium album*	*Chenopodium* sp.	*Galium aparine*	*Galium spurium*	*Lithospernum arvense*	*Malva* sp.	Fabaceae indet.	*Polgynum mite*	*Polygnum persicaria*	*Sinapis arvensis*	*Stipa* sp.	Poaceae indet.	*Dicotyledones*
Common Name	Sedge	Fat hen	Goosefoot	Stickywilly	False Cleavers	Field Gromwell	Malva	Legume family	False Water Pepper	Ladysthumb	Wild Mustard	Needle grass	Grass family	Dicotyledons
Pit No.														
30-A1														
31-A1														
4-A1								1						
7-A1														
8-A1														
10-A1		4	3										1	
20-A1							1							
30 and 31-A1														
34-A1														
39 and 40-A1													#	
50-A1														

53-A1	4	4				4			1																		
65-A1	20						1										1										
68-A1	48	1				4					1			1					1	1		1			1	1		
71-A1		1																									
74-A1														1		1	1										
82-A1																											
91-A1	12													1													
93-A1		14	11	11				1					1	3												2	
95-A1																											
96-A1			1				2							1													
103-A1		17												2													
4-A4																											
1-B1																											
25-B1																											
45-B1																											
63-B1			1																								
9-B2	58	10				39			1			1		5													
5-B5 and 6-B6	5	1												2									1	1			
7-B5						2																					
57-B1	1																										
Total	226	68	15	11	1	51	4	1	2	2	1	1	1	22		5	4	1	1	1	1	2	1	1	1	1	#	
Daub Imprints																											
Pit No.																											
4-A1		6																									
7-A1	2		1																							1	

Table 9 cont. Phase 4 Plant Remains from Bronocice

Latin name	*Cerealia*	*Triticum dicoccon*	*Triticum monococcum*	*Triticum dicococn* vel *T. monococcum.*	*Triticum aestivum*	*Triticum spelta*	*Hordeum vulgarae*	*Avena* sp.	*Lens culinaris*	*Agropyron repens*	*Agrostemma githago*	*Bromus arvensis*	*Bromus hordeaceus*	*Bromus* sp.	*Carex* sp.	*Chenopodium album*	*Chenopodium* sp.	*Galium aparine*	*Galium spurium*	*Lithospernum arvense*	*Malva* sp.	Fabaceae indet.	*Polgynum mite*	*Polygnum persicaria*	*Sinapis arvensis*	*Stipa* sp.	Poaceae indet.	*Dicotyledones*
Common Name	Corn family	Emmer	Einkorn	Einkorn/Emmer	Bread Wheat	Spelt	Barley	Oat	Lentil	Quackgrass	Corn Cockle	Field Brome	Soft Brome	Brome	Sedge	Fat hen	Goosefoot	Stickywilly	False Cleavers	Field Gromwell	Malva	Legume family	False Water Pepper	Ladysthumb	Wild Mustard	Needle grass	Grass family	Dicotyledons
30-A1	1	1		1											1													
34-A1		9		1		2																						
54-A1	3	14	1																								2	
68-A1		5				2		1																				1
82-A1	4	6												1													2	
95-A1	1					3																					1	
96-A1		7						1																			1	
25-B1	8,x	2																										
45-B1	5																											
68-B1	x																											
80-B1	x																											

Table 10. Phase 5 Plant Remains from Bronocice

Latin name	*Cerealia* indet.	*Triticum dicoccon*	*Triticum monococcum*	*Triticum dicoccon* vel *monococcum.*	*Triticum aestivum*	*Triticum spelta*	*Hordeum vulgarae*	*Secale cereale*	*Avena* sp.	*Pisum sativum*	*Linum ussitatimum*	*Bromus arvensis*	*Bromus hodeaceus*	*Bromus secalinus*	*Bromus* sp.	*Chenopodium album*	*Festuca arundinacea*	*Lithospernum arvense*	*Lithospernum officinale*	*Lolium temulentum*	Fabaceae indet.	*Fallo[pia convolvulus*	*Rumex acetosella*	*Rumex crispus*	*Rumex obtusifolius*	*Silene* sp.	Poaceae indet.
Common Name	Corn	Emmer	Einkorn	Einkorn or Emmer	Bread Wheat	Spelt	Barley	Rye	Oat	Pea	Flax	Field Brome	Soft Brome	Chess	Brome	Fat hen	Tall fescue	Field Gromwell	Common Gromwell	Darnel	Legume family	Black Bindweed	Sheep's Sorrel	Curled Dock	Broad-leaved Dock	Campion	Grass family
Pit No.																											
2-A1		1																									
36-A1	16	2												1													1
97-A1	3																										
1-A2	16	2	2			3			1																	1	
8-A2	11																										10
9-A2	11	3				4								2	5												
2-A3	8	5			1																						
12-A3	12	1												1													
14-A3	24	1	1			1						1	4		5												
26-A3	2	1																									

Table 10. cont. Phase 5 Plant Remains from Bronocice

Latin name	**Common Name**	6-B1	17-B1	19-B1	28-B1	33-B1	34-B1	47-B1	54-B1	56-B1	62-B1
	Pit No.										
Cerealia indet.	Corn	7	6	1			5	5	12		5
Triticum dicoccon	Emmer		4		1				14		
Triticum monococcum	Einkorn						1				
Triticum dicoccon vel *monococcum.*	Einkorn or Emmer							5			
Triticum aestivum	Bread Wheat	1									
Triticum spelta	Spelt		1								
Hordeum vulgarae	Barley									1	
Secale cereale	Rye										
Avena sp.	Oat										
Pisum sativum	Pea							1			
Linum ussitatimum	Flax										
Bromus arvensis	Field Brome										
Bromus hodeaceus	Soft Brome						1				1
Bromus secalinus	Chess										
Bromus sp.	Brome		1			1		1			
Chenopodium album	Fat hen										1
Festuca arundinacea	Tall fescue										
Lithospernum arvense	Field Gromwell										
Lithospernum officinale	Common Gromwell							1			
Lolium temulentum	Darnel										
Fabaceae indet.	Legume family			1							
Fallo[pia convolvulus	Black Bindweed			1				1			
Rumex acetosella	Sheep's Sorrel							1			
Rumex crispus	Curled Dock							1			
Rumex obtusifolius	Broad-leaved Dock							1			
Silene sp.	Campion										
Poaceae indet.	Grass family	1		1							

64-B1								1		1																	
69-B1	2		1	7		2					1	1	4		5			1	1			1	1				
113-B1		3																									
115-B1																			1								
4-B4		1																									
8-B5	5																										
2-B6																											
7-B6						4																					
10-B6						2															1						
6-B8																											
6-B6	1																1			1							
Total	152	39	5	12	2	17	1	1	1	2	1	2	10	4	18	1	1	1	3	1	2	3	2	1	1	1	13
Daub Imprints																											
29-B1	xx																										
10-B1	8																										
34-B1	x	1																									
36,37,38-B1	x	3																									
52-B1	x																										
55-B1						2																					
61-B1		1																									
95-B1	x					1																					
xx=more than 100																											

Table 11. Phase 6 Plant Remains from Bronocice

Latin name	*Cerealia*	*Triticum dicoccum*	*Triticum monococcum*	*Triticum aestivum*	*Triticum spelta*	*Hordeum vulgarae*	*Secale cereale*	*Lens culinaris*	*Pisum sativum*	*Bromus arvensis*	*Bromus hordeaceus*	*Bromus secalinus*	*Bromus* sp.	*Lithospermum arvense*	*Lolium temulentum*	*Sparagnium neglectum*	Poaceae indet.
Common Name	Corn	Emmer	Einkorn	Bread Wheat	Spelt	Barley	Rye	Lentil	Pea	Field Brome	Soft Brome	Chess	Brome	Field Gromwell	Darnel	Bur-reed	Grass Family
Pit No.																	
2-A2		1			1	6											1
29-A3																	
5-B1	135	11		3	50	8	1						2				1
32-B1	4		1							1			1		1		1
39-B1																	
49-B1		3											1				
53-B1	2	2	1					1									
70-B1		2									1			1			
99-B1																	
2-B2	25	11				2						2	1			1	
8-B2					6												
4-B3	12				1												
1-B4	11				1	1		1					1				1
3-B4	3				3												
12-B5	1								1								
17-B5	21																
74-C1																	
Total	214	30	2	3	62	17	1	2	1	1	1	2	6	1	1	1	4
Daub Imprints																	
5-B1	1																
70-B1	x, x	1															

Table 12. Weeds associated with cultivation of cereals (*Centauretalia cyani*) at Bronocice

Latin name	Common name
Agrosthemma githago	Corn cockle
Bromus arvensis	Field brome
Bromus secalinus	Rye brome
Galium spurium	False cleavers
Lithospermum arvense	Corn gromwell
Lolium temulentum	Poison darnel
Neslia paniculata	Ballmustard

level may represent weeds which grew wild amidst the domestic cereals (Wasylikowa 1983; Behre 1992; Lityńska-Zając, Wasylikowa 2005). In cereals fields grew different segetal weed species (Matuszkiewicz 2001), whose remains are preserved in Bronocice; Table 12). Field peas, lentils, and flax were likewise cultivated.

There are numerous grinding stones at Bronocice, suggesting the production of flour from these cereals. Bread wheat flour was likely used in the making of bread at the site, as suggested by the presence of preserved bread from contemporaneous Swiss lakeside settlements (Währen 1995; Behre 1991).

Therefore, cereals, especially emmer wheat, must have played the most important role in the diet. However, we should not forget that animal husbandry supplied meat and milk for the Bronocice people (Milisauskas *et al.* 2012). It should be pointed out that red meat and cereals play different roles in the diet: cereals yield carbohydrates for day-to-day survival, while meat yields high-quality protein which is needed less frequently. Cereals must have supplied the greatest amount of food in the Funnel Beaker and Funnel Beaker-Baden people's diet, since the amount of meat available for human consumption was probably not very great.

It is difficult to infer the usage of cereals in rituals, although we assume that there were various harvest rituals. Ksenija Borojević (2006, 19) has noted that "There are many rituals connected with wheat in general, which are documented in historical records as well as in folklore of many peoples. Wheat is also present in Egyptian, Greek, Roman, and Christian religions as being a sacrificial food and a symbol of resurrection".

MEASUREMENTS OF CEREAL GRAINS

Length, width and thickness of whole emmer wheat grains were measured from phases 4, 5, and 6 (Table 13). The length of grains from phase 4 grains ranges from 3.6 mm to 5.6 mm, the width ranges from 2.2 mm to 3.9 mm, and thickness ranges from 1.6 mm to 2.4 mm. The length of grains from phase 5 ranges from 3.7 mm to 5.2 mm, the width ranges from

2.0 mm to 2.8 mm, and the thickness ranges from 1.9 mm to 2.4 mm. The length of grains from phase 6 ranges from 3.9 mm to 5.0 mm, the width ranges from 1.8 mm to 2.8 mm, and the thickness ranges from 1.8 mm to 2.8 mm.

Table 13. Length, width and thickness of *Triticum dicoccon* whole grains (mm)

Pit	Phase	Length	Width	Thickness
10-A1	4	5.0	3.1	1.8
10-A1	4	4.0	2.2	2.4
10-A1	4	5.6	3.9	1.8
10-A1	4	4.3	2.4	1.6
10-A1	4	4.6	2.8	-
53-A1	4	5.5	3.1	2.1
53-A1	4	3.6	2.2	2.0
53-A1	4	4.2	2.4	1.9
1-A2	5	4.8	2.0	2.3
1-A2	5	4.6	2.5	2.2
9-A2	5	4.6	2.7	2.3
9-A2	5	5.2	2.4	2.3
2-A3	5	5.0	2.8	2.2
2-A3	5	3.7	2.2	1.9
2-A3	5	4.3	2.7	2.4
26-A3	5	4.5	2.8	2.3
6-B1	5	4.7	2.7	2.4
4-B4	5	4.0	2.2	1.9
2-A2	6	5.0	2.7	2.2
2-B2	6	5.0	2.8	2.4
2-B2	6	4.2	2.4	1.8
2-B2	6	4.3	2.1	2.1
2-B2	6	3.9	2.0	1.8
2-B2	6	4.6	2.8	2.8
2-B2	6	4.7	2.6	2.1
2-B2	6	4.4	1.8	-
2-B2	6	4.0	2.7	2.0

HARVEST

The blooming period of the wild plants found at Bronocice indicates that the Bronocice people harvested cereals at the end of July or August (Table 14). These plants were brought to the site when they had already bloomed, as fruits were found at the settlement (Lityńska-Zając 1997b; 2005). *Fallopia convolvulus* (dumort) has the latest blooming period, which occurs in July, and this period coincides with the end of blooming for most of the other plants. The cereals were sown in the spring, and after crops were harvested, cattle, sheep and goats could graze stubble from these fields.

Table 14. Blooming (flowering) months of field plants at Bronocice

Latin name	Common name	Start Month	End Month
Agrostemma githago	Corn cockle	6 (June)	7 (July)
Bromus arvensis	Field brome	5	7,10
Bromus secalinus	Rye brome	6	6
Galium spurium	False cleavers	5	9
Lithospermum arvense	Corn gromwell	4	6
Lollum temulentum	Poison darnel	6	7
Neslia paniculata	Ballmustard	5	7
Fallopia convolvulus	Black bindweed	7	9
Sinapis arvensis	Charlock	5	7
Elymus repens	Quackgrass, Wild rye	6	9

ECOLOGICAL INDICATORS

We used Ellenberg (1950; 1979) three indices, moisture, trophic values and acidity, for the analysis of plants as indicators of environmental factors at Bronocice. The index is based on a scale from 1 to 5 for each variable, and the higher numbers indicate increasing requirements of a particular plant. A similar system was applied to the Polish flora (Zarzycki 1984; Zarzycki *et al.* 2002). Using subfossil material we can present the conditions that existed in the past around the contemporary site. We used two groups of plants for this analysis at Bronocice: weeds occurring in cultivated fields (Table 15) and plants from meadows, pastures, and other non-forested areas (Table 16).

The moisture index ranges from 2 to 4, however, most plants which have greater range of ecological tolerance have an index of 3. The greatest variation is shown by trophic values,

which range from 2 to 5. Most species can grow with index 3 on mesotrophic soils. In reference to acidity most species prefer neutral soils (R4). Based on this, we can deduce that the cultivated fields were established in fresh habitats and with moderately poor and neutral acidity.

In non-forest communities (Table 16), the moisture index indicates at least two groups. One group of species prefers dry habitats (W-2), while the preference of others ranges from fresh to moist habitats (W from 3 to 5). *Sparganium neglectum* is a species that can grow on water. The range of indices for trophism is from 2 to 5 and acidity is 3 to 5. Species

Table 15. Ecological numbers for plants occurring in cultivated fields at Bronocice

Species	Common name	W	Tr	R
Agrostemma githago	Corn cockle	3	3-4	4-5
Bromus arvensis	Field brome	2-3	2-3	3-4
Bromus secalinus	Rye brome	3	3	3-4
Chenopodium album	Goosefoot	3	4-5	4
Chenopodium hybridium	Maple-leaved goosefoot	3	4	4-5
Elymus repens	Quackgrass, Wild rye	3	3-4	3-5
Galium aparine	Cleavers	4-3	4-5	4
Galium spurium	False cleavers	2-3	3	5
Lithospermum arvense	Corn gromwell	3	3-4	3-4
Neslia paniculata	Ballmustard	2-3	3	4-5
Polygonum persicaria	Pink persicaria	3	4-3	4
Sinapis arvensis	Charlock	3	4	4-5

Table 16. Ecological numbers for plants which occur in meadows, pastures, and other non-forest areas at Bronocice

Latin name	Common name	W	Tr	R
Elymus repens	Quackgrass, Wild rye	3	3-4	3-5
Fetsuca arundinacae	Fall fescue	3-4	4	4
Lithospermum officinalle	Common gromwell	2-3	3	5
Polygonum mite	Water pepper	4-5	4-5	4-5
Rumex acetosella	Sheep's sorrel	2	2	2-3
Rumex crispus	Curled dock	3-4	4	4
Rumex obtusifolius	Bitter dock	3-4	4-5	3-5
Sparganium neglectum	Profuse bur-reed	6		
Stachys recta	Yellow woundwort	2	3	5

associated with non-forested communities of herbaceous plants appeared in various habitats, including those with fresh soils, moist soils, mesothropic soils, eutrophic soils, and moderately acid. *Rumex acetosella and Stachys recta* are distinct species growing on dry soils. The former (*Rumex a)* grows in (Tr 2) poor habitats and in acid and moderately acid soils (R2-3). The latter grow in mesothropic soils (Tr 3) with pH value above 7 (R 5).

UTILIZATION OF STRAW

The remains of straw were found in pits of phases 4 and 6. Straw could have been used for fodder, especially the straw of spring cereals, which grow less woody on account of a shorter growing season. In addition, straw can be used for bedding and to cover stacks or mounds. If the cereals were cut high, straw can remain on the field as organic fertilizer (Domańska *et al.* 1978; Lityńska-Zając 1997b, 69-70). Straw was also added to clay for building purposes, as shown by the impressions found in daub.

WILD PLANTS

A variety of weeds, shrubs and tree remains were recovered at Bronocice. There are nine wild plant assemblages (Table 17). The frequencies of weeds were very low at Bronocice. Grasses are very prevalent in the weed assemblage. As previously mentioned, the charred remains of plants are rare in the pits. Relying heavily on weeds to demonstrate various crop husbandry practices, Amy Bogaard (2004) produced an excellent study about farming during the Neolithic in central Europe. Unfortunately, the small samples at Bronocice

Table 17. Number of wild plant assemblages at Bronocice

Plant communities	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Centauretalia cyani				5	2	3
Secali-Violetalia arvensis			1	1	1	
Rudero-Secalieteae	1		2	4	2	1
Agropyro-Rumicion crispi	1			1	2	
Arrhenatherethum			1	2	1	1
Molino-Arrhenetheretea	1					
Festuco-Brometea				1		
Sedo- Scleranthetea					1	
Phragmitetea						1
Unidentified	1		4	8	5	2

prevent us from doing any statistical analyses. Borojević (2006, 39) cites Wasylikowa (1981, 11–23) that "different weed communities develop on the same soil depending on the tilling techniques". "When an ard (scratch plow) is used for plowing many biannual and perennial plants are present in crop fields" (Borojević 2006, 39).

Most weeds occur in the phase 4, 5 and 6 pits, and the following weeds were recovered at Bronocice:

Boraginaceae (Borage family):

Lithospermum officinale L. (common gromwell), 3 non-charred fruits in the phase 5 pits. The average measurements were 3.7 x 1.9 x 2.1 mm.

Lithospermum ravense L. (field gromwell), 3 charred fruits in the pits of phases 4, 5 and 6. The average measurements were 3.1 x 2.2 x 1.9 mm.

Caryophyllaceae (Pink family):

Agrostemma githago L. (corn cockle), 1 charred seed, 3.1 mm in length and 2.2 mm in width.

Silene sp. (Campion), 1 charred seed in phase 5 pit. The measurements were 1.4 x 0.9 x 0.8 mm.

Chenopodiaceae (Goosefoot family):

Chenopodium album L. (goosefoot), 7 charred seeds. The average measurements were: diameter 1.3 mm and thickness 0.8 mm.

Chenopodium hybridum L. (sowbane), 1 charred seed, 1.6 x 0.8 mm.

Chenopodium sp. (Goosefoot family), 8 damaged charred seeds.

Asteraceae (Aster family):

Taraxzcum officinale F. H. Wigg. 1 uncharred fruit in phase 5 pit.

Brassicaceae (Mustard family):

Neslia paniculata (L.) Desv. (ballmustard), 1 charred fruit, 2.3 x 2.6 x 1.8 mm.

Sinapis arvensis L. (wild mustard), 1 charred seed in phase 4 pit, diameter 1.6 mm.

Cyperaceae (Sedge Family):

Carex sp. (sedge), 3 charred fruit in phase 4 pits. The average measurements were 1.2–1.4 mm, 4 x 1.1 mm.

Poaceae (Grass family):

Bromus secalinus L. (chess), 4 charred grains in the pits of phases 1, 5 and 6. The average measurements were 5.8 x 1.6 x 1.7 mm.

Bromus hordeaceus L. (soft brome), 15 charred grains in the pits of phases 3, 5 and 6. The average measurements were 5.6 x 1.5–1.8 x 0.6–0.7 mm.

Bromus arvensis L. (field brome), 4 charred seeds in the pits of phases 4, 5 and 6. The average measurements were 5.8 x 1.2 x 0.9 mm.

Bromus sp. (brome), 52 damaged charred grains.

Lolium perenne L. (perennial rye grass), 2 charred grains in the pits of phase 5, measurements 4.0 x 1.5 x 1.2.

Lolium temulentum L. (darnel), 1 charred grain in phase 6 pit, 4.0 x 2.1 x 1.2 mm.

Festuca arundinacae Schreb. (tall fescue) 2 charred grains in the pits of phases 1 and 5, 3.1 x 1 x 1.0 mm.

Elymus repens (L.) Gould (coach grass), 2 charred grains in the pits of phases 3 and 4, 3.9 x 1.0 x 0.8 mm.

Poaceae indet. (grasses), 68 damaged charred grains.

Stipa sp., 1 charred fragment of awn

Fabaceae (Legume family), 4 charred seeds in the pits of phases 4 and 5.

Malvaceae (Mallow family):

Malva sp. (mallow), 1 charred schizocarp in phase 4 pit, diameter 1.6 mm, thickness 1.2 mm.

Polygonaceae (Knotweed family):

Polygonum mite Schrank. (tasteless water pepper), 1 nut in phase 4 pit, 3.0 x 1.7 x 1.4 mm.

Polygonum persicaria L. (ladysthumb), 1 charred nut, 2.4 x 1.8 x 1.4 mm.

Fallopia convolvulus (L.) Á. Löve (wild buckwheat), 1 whole nut and a fragment of a nut, 2.8 x 1.9 mm.

Rumex acotosella L. (sheep sorrel), 2 charred fruits in phase 5 pits, 1.2 x 0.9 mm.

Rumex obtusifolius L. (broad-leaved dock), 1 fruit in phase 5 pit, 2.5 x 1.2 mm.

Polygonum sp. 1 charred nut.

Rubiaceae (Bedstraw family):

Galium aparine L. (cleavers) — 1 charred fruit in phase 4 pit, diameter 4.9, thickness 2.9 mm.

Galium spurium L. (false cleavers), 1 charred fruit in phase 4 pit.

Lamiaceae (Mint family):

Stachys recta L. (perennial yellow woundwort), 1 charred fruit in phase 6 pit, 2.2 x 1.6 x 1.1 mm.

Caprifoliaceae (Honeysuckle family):

Sambucus ebulus L. (elderberry), 1 charred seed, 2.5 x 1.7 x 0.8 mm.

Sambucus sp., a fragment of a charred seed.

Sparganiaceae (Bur-reed family):

Sparganium neglectum Beeby, 1 charred fruit in phase 6 pit, 5.1 x 2.6 mm.

Rosaceae indet. (Rose family), 1 charred fragment of a seed.

POTENTIAL PLANTS FOR FOOD

Linum usitatissimum (flax) is found by phase 4 at Bronocice. Flax can be used for a variety of purposes. For example, its leaves can be used for fodder, its stalks can provide linen by retting and oil can be obtained from its crushed seeds. Flax seeds contain 38–44% fat. Since flax was already present in central Europe during the Early Neolithic, it was

probably utilized by earliest inhabitants of Bronocice for fiber and cordage (Kruk 1980; Willerding 1980). *Chenopodium album* (goosefoot) also likely played a role in the diet, as its leaves are high in protein, minerals, and calcium and its seeds can be ground into flour and cooked as porridge. Reynolds (1976) mentions that until the introduction of cabbage and spinach in England, goosefoot was the main green vegetable. In addition, cattle, pigs and sheep can consume its leaves.

Evidence of the usage of tree resources is present in nut hulls, charcoal and seeds. Nut food is reflected in rare hazelnut shell finds. Probably hazelnuts were collected in the late summer, and we assume that acorns were also used for food because of the abundant charcoal. Wild plum and wild pear likewise provided seasonally edible fruits and they were harvested during the summer months. Leaves of alder, birch and ash could have been collected for animal fodder. Some trees may have been "managed", for example, *Corylus avellana* (hazel) may have been pruned to obtain straight canes for arrows and basket stays. Pruning also helps the nut harvest, and pruned wood can be used for fuel because it burns very well. Other potentially "managed" trees include *Malus* (apple), *Pyrus* (pear), *Salix* (willow), *Sambucus* (elder) and *Prunus* (plum). These opportunistic plants are rare, yet when they are present they are very valuable for insight into probable food and crafts during different cultural periods at Bronocice.

Utilization of Wild Plants

Wild plants can be utilized for food, medicine and technological purposes such as the production of artifacts. We divided the wild plants found at Bronocice into 3 groups: 1. Wild plants which could have been used for human consumption based on Early Medieval analogies (Twarowska 1983); 2. Wild plants which can be used for medicinal (healing) purposes (Kuźniewski, Augustyn-Puziewicz 1986); and 3. Plants utilized for technological purposes (Podbielkowski 1985).

Wild Plants Utilized for Food

Twenty one species of wild plants could have been utilized for food (Table 18). Most of the wild plants could have been used for making flour and porridge: *Elymus repens, Bromus arvensis, Bromus secalinus, Chenopodium album, Fallopia convolvulus, Polygonum persicaria, Lolium temulentum, Rumex crispus, Sinapis arvensis* and *Quercus* sp. The seeds and fruits of these plants contain large amounts of starch and protein. Knörzer (1971) has suggested that the caryopsis of the rye brome (*Bromus secalinus*) were used as food already by the Linear Pottery people.

Table 18. Wild Plants Utilized for Food

Taxa name	Place of Occurrence	Type of Usage
Agrosthemma githago	Cultivated fields	Drinks
Fallopia convolvulus	Cultivated fields	Fruit
Bromus arvensis	Cultivated fields	Flour and porridge
Bromus secalinus	Cultivated fields	Flour and porridge
Chenopodium album	Ruderal area	Flour, porridge, green parts
Elymus repens	Meadows, pastures	Flour, porridge, drinks
Galium aparine	Ruderal area	Green parts
Galium spurium	Cultivated fields	Green parts
Lolium temulentum	Cultivated fields	Flour and porridge
Polygonum persicaria	Cultivated fields	Fruit
Rumex acetosa	Meadows, pastures	Green parts
Rumex crispus	Cultivated fields	Fruits
Sinapis arvensis	Cultivated fields	Flour and porridge
Acer sp.	Forest/scrub forest	Drinks
Alnus sp.	Forest/scrub forest	Leaves/animal fodder
Betula sp.	Forest/scrub forest	Leaves/animal fodder
Corylus avellana	Forest/scrub forest	Nuts
Fraxinus excelsior	Forest/scrub forest	Leaves/animal fodder
Pinus sylvestris	Forest/scrub forest	Sap and bast
Quercus sp.	Forest/scrub forest	Acorns
Tilia sp.	Forest/scrub forest	Young shoots/leaves

Tree Species

Various tree species have been identified from wood charcoal found in pits (Milisauskas *et al.* 2004). Analysis of charcoal remains provides information about subsistence, vegetation and various domestic uses of wood (Smart, Hoffman 1988; Lityńska-Zając 1997b). Most charcoal pieces belong to oak (*Quercus* sp.) and Scotch pine (*Pinus sylvestris*). Also present in the charcoal assemblage are birch (*Betula* sp.), hazel (*Corylus avellana*), maple (*Acer* sp.), ash (*Fraxinus excelsior*), linden (*Tilia* sp.), beech (*Fagus sylvatica*), alder (*Alnus* sp.), poplar (*Populus* sp.), willow (*Salix* sp.), mistletoe (*Viscum* sp.), wild plum (*Prunus* sp.), wild pear (*Pyrus* sp.) and rose (*Rosaceae*) family. In addition a seed of elder was recovered. These species formed a much smaller percentage. Schweingruber (1973) has suggested that the low frequencies or total absence of charcoal samples of soft wood species may be the result of decay. Charcoal fragments of hard woods are better preserved (Milisauskas *et al.* 2004).

Medicinal Plants

The number of plants used for medicinal purposes is not great, consisting of *Elymus repens, Agrostema githago, Fagus sylvatica, Galium aparine, Rumex acetosa* and probably *Lithospermum officinale* (see discussion Baczyńska, Lityńska-Zając 2005). The various parts of plants possibly used for medicinal purposes are presented in Table 19.

Table 19. Medicinal plants found at Bronocice

Latin name	Common name	Utilized part
Agrostemma githago	Corn cockle	green parts
Elymus repens	Quackgrass, Wild rye	stolon (runner)
Fagus sylvatica	European beech	leaves
Galium aparine	Cleavers, goosegrass	green parts (herb)
Rumex acetosa	Garden sorrel	leaves, fruits, roots
Lithospermum officinale	common gromwell	fruit

CORDED WARE CULTURE PLANT REMAINS

Data on Corded Ware culture plant utilization in central Europe are predominantly derived from the analysis of plant imprints in ceramics. In addition, the Bronocice burial produced some plant remains from the pit fill and from the contents of a Corded Ware pot. In addition, charcoal samples were analyzed from a Corded Ware burial. One oak and 55 pine charcoal fragments from five samples were recovered from the Corded Ware burial pit.

Despite the unusual source of the evidence and the small sample size, it appears the Corded Ware culture was dependent upon domesticated plants for subsistence (Table 20). Cereals such as emmer wheat (*Triticum dicoccon*) predominated at Bronocice; however, garden crops were also found, and include garden peas (*Pisum sativum*) and lentils (*Lens culinaris*) (Table 20). The remains of wild plants consisted of brome (*Bromus* sp.) and goosefoot (*Chenopodium album*). From this evidence, it is clear that the Corded Ware people were cultivating cereals and garden crops at Bronocice. The Bronocice burial is dated to the Cracow-Sandomierz II phase, a post-Funnel Beaker-Baden occupation, when only the Corded Ware people inhabited the microregion. At this time, there was no possibility for them to obtain cereals through trade. Thus, the Corded Ware people were at least part-time farmers by 2640 ± 225–2480 ± 165 BC (2100–2000 bc) in the Bronocice Microregion, and there was probably a gradual shift to farming by the Corded Ware people in the Bronocice microregion.

Table 20. Corded Ware Plant Remains from Bronocice

Latin name	Common Name	Pit Fill Sample	Pot No. 1	Daub-Imprints
Cerealia indet.	Corn	7	41	7
Triticum dicoccon	Emmer	3	4	
Triticum aestivium	Bread Wheat		1	
Triticum spelta	Spelt	1		
Hordeum vulgare	Barley		4	
Lens culinaris	Lentil	1		1
Pisum sativum	Pea		2	
Bromus sp.	Brome grass		1	
Chenopodium album	Fat hen	2		
Poaceae indet.	Grass Family	1		

ECONOMIC ORGANIZATION AND PRACTICES AT BRONOCICE

The recovered faunal and plant data from Bronocice indicate a heavy reliance on domestic animals and plants. The basic diet was dependent on plants and to lesser extent on meat from animals. We assume that milk was consumed at Bronocice, since evidence for this is found in other regions during the Neolithic (Craig *et al.* 2005). Remains of wild animals and wild plants occur in small numbers, but this does not necessarily indicate a less significant role in the economy, rituals, trade and various social activities. For example, some wild plants such as *Elymus repens* probably were used for medicinal purposes. Domesticated plants played an important role in a balanced diet, with proteins from pulses, starch from cereals and fat from oil plants. However, as Küster (2000, 1228) has noted, the "variety of nutriments available in the Neolithic was severely limited. Because there were very few crops, no herbs and spices, and no cultivated fruits, all meals must have tasted very nearly the same, day in and day out, save on those rare occasions when a meat dish was available". That said, it is likely that meat was not as rare a commodity for Neolithic societies as might be thought, given that methods of meat preservation including salting and smoking were most likely utilized by Neolithic peoples. Nor does the slaughter of an animal necessarily require its immediate consumption. Furthermore, the great varieties of wild plant remains at Bronocice strongly suggest that the diet was not as monotonous as Küster suggests. Indeed, Ebersbach (2003, 78) has pointed out that wild plants for the Neolithic communities of Lake Zűrich "may have been important for vitamins, for spices and herbs and to broaden the array of dishes".

The estimated amount of land needed for agricultural purposes varied during the different phases at Bronocice. We assume that cereal cultivation played a major role in the subsistence strategy of Funnel Beaker populations, while the Funnel Beaker Baden people relied more heavily on herding of cattle and sheep. As previously mentioned, many Funnel Beaker sites are located in the uplands, which led to more extensive clearing of forests. Kruk (1980) has suggested that this movement to the uplands indicates the practice of slash and burn agriculture. The cultivated fields were rotated frequently, which prevented a complete regeneration of forests and necessitated the use of a scrub-fallow rotation of fields.

COMPARISON OF BRONOCICE EVIDENCE TO OTHER SITES

Maria Lityńska-Zając (1997a; 2007) surveyed the plant remains from sites occurring of the loess uplands of western regions of southeastern Poland. Lityńska-Zając also examined charred remains and impressions in daub for the presence of plants at the Funnel Beaker sites of Kraków-Prądnik Czerwony (Rook, Nowak 1993), Zawarża (Lityńska-Zając 2002), Niedźwiedź (Burchard, Lityńska-Zając 2002) and Smroków (Lityńska-Zając 2010). As at Bronocice, emmer, einkorn, spelt, and bread wheat were present at Zawarża, while emmer and einkorn were present at Niedźwiedź and Smroków. Almost all sites also produced barley. At Kraków-Prądnik Czerwony the large deposits of emmer and einkorn grains were found. It should be noted, however, that the use of flotation and daub samples at Bronocice produced a greater variety of wild plant remains than from daub alone.

Table 21. Cereal Species Identified on Funnel Beaker and Funnel Beaker-Baden Sites of the Loess Uplands of Western Regions of Southeastern Poland

Latin name	Common name	Number of sites with cereals	
		Funnel Beaker	Funnel Beaker-Baden
Avena sp.	Oat	1	1
Hordeum vulgare	Barley	5	2
Triticum monococcum	Einkorn	4	1
Triticum dicoccon	Emmer	7	2
Triticum monoccum vel *T. dicoccon*	Einkorn or Emmer	14	2
Triticum spelta	Spelt wheat	2	1
Triticum aestivum	Bread wheat	3	1
Panicum miliaceum	Millet		1

Cereal remains were found at eight Funnel Beaker sites and two Funnel Beaker-Baden sites (Bronocice and Smorków — Lityńska-Zając 2010; see Table 21). Bronocice has all the cereal species occurring during the Funnel Beaker and Funnel Beaker-Baden occupations of southeastern Poland. Probably southeastern Poland was too small to exhibit regional differences in subsistence strategies.

CONCLUSIONS

This article has presented the recovered plant remains and their subsistence and ecological analysis from Funnel Beaker, Lublin-Volhynian, and Funnel Beaker-Baden culture occupations at Bronocice, dating from approximately 3800 to 2700 BC. Domesticated plants were significant in all time periods, but gathered plants supplemented the diet throughout the 1100 years under review. Some were trees and shrubs used for fodder, consumption and technological items but most were ruderals found growing in agricultural land, old fields, and pastures. Furthermore, the small sample of plant remains from the Corded Ware burial indicates cultivation of domesticated plants around 2600 BC. This supports Kadrow's (1994) observation that the early Corded Ware populations practiced pastoralism in southeastern Poland. However, around 2600 BC Funnel-Beaker-Baden farmers were disappearing, and later Corded Ware groups incorporated farming in their subsistence strategy.

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References

Alexandrowicz S. W., Śnieszko Z. and Zajączkowska E. 1984. Stratigraphy and Malacofauna of Holocene Deposits in the Sancygniówka Valley near Działoszyce. *Quaternary Studies in Poland* 5, 5–25.

Baczyńska B., Lityńska-Zając M. 2005. Application of *Lithospermum officinale* L. in early Bronze Age medicine. *Vegetation History and Archaeobotany* 14, 77–80.

Bakker J. A., Kruk J., Lanting A. E. and Milisauskas S., 1999. Bronocice, Flintbek, Uruk, and Jebel Aruda: the earliest evidence of wheeled vehicles in Europe and the Near East. *Antiquity* 73, 778–790.

Behre K.-E. 1991. Zum Brotfund aus dem Ipweger Moor, Ldkr. Wesermarsch. *Berichte zur Denkmalpflege in Niedersachsen* 1, 1–9.

Behre K.-E. 1992. The history of rye cultivation in Europe. *Vegetation History and Archaeobotany* 1, 141–156.

Bogaard A. 2004. *Neolithic Farming in Central Europe: An archaeobotanical study of crop husbandry practices*. London and New York: Routledge.

Borojević K. 2006. *Terra and Silva in the Pannonian Plain* (= *British Archaeological Reports. International Series* 1563). Oxford.

Burchard B. and Lityńska-Zając M. 2002. Plant remains from a Funnel Beaker Culture site at Niedźwiedź, Słomniki commune, Małopolska province. *Acta Paleobotanica* 42(2),171–176.

Craig O. E., Chapman J., Heron C., Willis H. L., Bartosiewicz L., Taylor G., Whittle A. and Collins M. 2005. Dairy food production in Europe. *Antiquity* 79, 882–894.

Domańska H., Droese H., Gawrońska-Kulesza A., Kowalski S., Roszak S., Śmierzchalski L., and Trzecki S. 1982. *Ogólna uprawa roli i roślin*. Warszawa: PWN.

Ebersbach R. 2003. Paleoecological reconstruction and calculation of calorie requirements at Lake Zűrich. In J. Kunow and J. Műller (eds.), *Forschungen zur Archäologie im Land Branderburg* 8.

Ellenberg H. 1950. *Landwirtschaftliche Pflanzensociologie I: Unkrautgemeinschaften als Zeiger fűr Klima und Boden*. Stuttgart: Eugen Ulmer.

Ellenberg H. 1979. *Zeigerwerte der Gefässpflanzen Mitteleuropas* (= *Scripta Geobotanica* 9). Göttingen.

Gilewska S. 1958. *Rozwój geomorfologiczny wschodniej Wyżyny Miechowskiej* (= *Prace Geograficzne* 13). Warszawa: Instytut Geografii PAN.

Kadrow S. 1994. From nomadism to the sedentary way of life. A case of the evolution of the late Neolithic and the early bronze communities in south-eastern Poland: 2900–1650 BC. *Baltic-Pontic Studies* 2, 71–85.

Knörzer K.-H. 1971. Urgeschichtliche Unkräuter im Rheinland. Ein Beitrag zur Entstehung der Segetalgesellschaften. *Vegetatio* 23, 89–111.

Kornaś J., Medwecka-Kornaś A. 2002. *Geografia roślin*. Warszawa: PWN.

Kreuz A., Marinova E., Schäfer E. and Wiethold J. 2005. A comparison of early Neolithic crop and weed assemblages from the Linearbandkeramik and the Bulgarian Neolithic cultures: differences and similarities. *Vegetation History and Archaeobotany* 143, 237–258.

Kruk J. 1973. *Studia osadnicze nad neolitem wyżyn lessowycyh*. Wrocław: Ossolineum.

Kruk J. 1980. *Gospodarka w Polsce południowo-wschodniej w V–III tysiącleciu p.n.e*. Wrocław: Osolineum.

Kruk J. 1993. Rozwój społeczno-gospodarczy i zmiany środowiska przyrodniczego wyżyn lessowych w neolicie (4800–1800 bc). *Sprawozdania Archeologiczne* 45, 7–17.

Kruk J. and Milisauskas S. 1981. Wyżynne osiedle neolityczne w Bronocicach, woj. kieleckie. *Archeologia Polski* 26(1), 65–113.

Kruk J. and Milisauskas S. 1985. *Bronocice, Osiedle obronne ludności kultury lubelsko-wołyńskiej (2800–2700 lat p.n.e.)*. Wrocław: Ossolineum.

Kruk J., Milisauskas S. Alexandrowicz S. W. and Śnieszko Z., 1996. *Osadnictwo i zmiany środowiska naturalnego wyżyn lessowych*. Kraków: Instytut Archeologii i Etnologii Polskiej Akademii Nauk.

Kruk J. and Przywara L. 1983. Roślinność potencjalna jako metoda rekonstrukcji naturalnych warunków rozwoju społeczności pradziejowych. *Archeologia Polski* 28, 19–50.

Kulpa W. 1974. *Nasionoznawstwo chwastów*. Warszawa: Państwowe Wydawnictwo Rolnicze i Leśne.

Küster H. 2000. Northern Europe — Germany and Surrounding Regions. In K. F. Kiple and K. C. Ornelas (eds.), *The Cambridge World History of Food*. Cambridge: Cambridge University Press, 1226–1231.

Kuźniewski E. and Augustyn-Puziewicz J. 1986. *Przewodnik ziołolecznictwa ludowego*. Warszawa: PWN.

Lityńska-Zając M. 1997a. Środowisko i uprawa roślin w czasach pra-i wczesnohistorycznych. In K. Tunia (ed.), *Z archeologii Małopolski. Historia i stan badań zachodniomałopolskiej wyżyny lessowej*. Kraków: Instytut Archeologii i Etnologii PAN, Oddział w Krakowie, 459–481.

Lityńska-Zając M. 1997b. *Roślinność i gospodarka rolna w okresie rzymskim*. Kraków: Instytut Archeologii i Etnologii Polskiej Akademii Nauk.

Lityńska-Zając M. 2002. Odciski roślinne na polepie z osady kultury pucharów lejkowatych w Zawarży. In A. Kulczycka-Leciejewiczowa, *Zawarża osiedle neolityczne w południowopolskiej strefie lessowej*. Wrocław: Instytut Archeologii i Etnologii Polskiej Akademii Nauk, 129–134.

Lityńska-Zając M. 2005. *Chwasty w uprawach roślinnych w pradziejach i wczesnym średniowieczu*. Kraków: Instytut Archeologii i Etnologii PAN.

Lityńska-Zając M. 2007. Early Neolithic agriculture in south Poland reconstructed from archaeobotanical plant remains. In S. Collegde and J. Conolly (eds.), *The Origins and Spread of Domestic Plants in Southwest Asia and Europe*. London: University College London, Institute of Archaeology Publications, 315–326.

Lityńska-Zając M. 2010. Botanical analysis of the multicultural site in Smroków, Słomniki commune. *Sprawozdania Archeologiczne* 62, 335–352.

Lityńska-Zając M. and Wasylikowa K. 2005. *Przewodnik do badań archeobotanicznych* (= *Vademecum Geobotanicum*). Poznań: Sorus.

Matuszkiewicz W. 1991. Szata roślinna. In L. Starkel (ed.), *Geografia Polski. Środowisko przyrodnicze*. Warszawa: PWN, 445–494.

Matuszkiewicz W. 2001. *Przewodnik do oznaczania zbiorowisk roślinnych Polski* (= *Vademecum Geobotanicum* 3). Warszawa: PWN.

Milisauskas S. and Kruk J. 1984a. Settlement Organization and the Appearance of Low Level Hierarchical Societies during the Neolithic in the Bronocice Microregion, Southeastern Poland. *Germania* 62(1), 1–30.

Milisauskas S. and Kruk J. 1984b. Grób niszowy kultury ceramiki sznurowej z Bronocic, woj. kieleckie. *Sprawozdania Archeologiczne* 36, 29–38.

Milisauskas S. and Kruk J. 1989. Economy, Migration, Settlement Organization, and Warfare During the Late Neolithic in Southeastern Poland. *Germania* 67(1), 77–96.

Milisauskas S., Kruk J., Ford R., Lityńska-Zając M. and Tomczyńska Z. 2004. Neolithic Forest Composition as Reflected by Charcoal Analysis from Bronocice Poland. *Sprawozdania Archeologiczne* 56, 271–288.

Milisauskas S., Kruk J., Pipes M.-L. and Makowicz-Poliszot D. 2012. *Butchering and meat consumption in the Neolithic: The exploitatian of animals at Bronocice*. Kraków: Instytut Archeologii i Etnologii.

Mirek Z., Piękoś-Mirkowa H., Zając A. and Zając M. 2002. Flowering Plants and Pteridophytes of Poland, A checklist. In Z. Mirek (ed.), *Biodiversity of Poland*. Kraków: W. Szafer Institute of Botany, Polish Academy of Sciences,1–442.

Podbielkowski Z. 1985. *Słownik roślin użytkowych*. Warszawa: PWRiL.

Rook E. and Nowak M. 1993. Sprawozdanie z badań wielokulturowego stanowiska w Krakowie — Prądniku Czerwonym, w latach 1990 i 1991. *Sprawozdania Archeologiczne* 45, 35–71.

Reynolds P. J. 1976. *Farming in the Iron Age*. Cambridge: Cambridge University Press.

Schweingruber F. 1973. Holzarten. In J.-P. Farruggia, R. Kuper, J. Lüning and P. Stehli (eds.), *Der bandkeramische Siedlungsplatz Langweiler 2*. Bonn: Rudolf Habelt, 152–156.

Smart T. L. and Hoffman E. S. 1988. Environmental Interpretation of Archaeological Charcoal. In C. A. Hastorf and V. A. Popper (eds.), *Current Paleoethnobotany*. Chicago: The University of Chicago Press, 167–205.

Twarowska E. 1983. Zdobywanie pożywienia (zbioractwo wczesnośredniowiecze w Polsce). In J. K. Kozłowski and S. K. Kozłowski (eds.), *Człowiek i środowisko w pradziejach*. Warszawa: PWN, 218–231.

Wasylikowa K., 1981. The role of fossil weeds for the study of former agriculture. *Zeitschfrift für Archäologie* 15, 11–23.

Wasylikowa K. 1983. Antropogeniczne zmiany roślinności w holocenie. In J. K. Kozłowski and S. Kozłowski (eds.), *Człowiek i środowisko w pradziejach*. Warszawa: PWN, 53–71.

Währen, M., 1995. Die Urgeschichte des Brotes un Gebäcks der Schweiz. *Helvetia Archaeologica* 25:75–89.

Willerding U., 1980. Zum Ackerbau der Bandkeramiker. *Materialhefte zur Ur –und Frűhgeschichte Niedersachsen* 16, 421–456.

Zarzycki K., 1984. *Ekologiczne liczby wskaźnikowe roślin naczyniowyck Polski*. Kraków: Instytut Botaniki. Polska Akademia Nauk.

Zarzycki K., Trzcińska-Tacik H., Różański W., Szela Z., Wołek J. and Korzeniak U. 2002. *Ecological indicator values of vascular plants of Poland*. In Z. Mirek (ed.), *Biodiversity of Poland*. Kraków: W. Szafer Institute of Botany, Polish Academy of Sciences, 183.

Zeist W. van, Buitenhuis H. 1983. A palaeobotanical study of the Neolithic Erbaba, Turkey. *Anatolica* 10, 47–89.