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ORIGINAL PAPER

Plant economy and vegetation of the Iron Age in Bulgaria: archaeobotanical evidence from pit deposits

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Abstract Major social and economical changes occurred in human societies during the Iron Age of Southeastern Europe: increasing structuring of societies, intensifying production and metal technologies and the establishment of a market economy. However, the related plant economy of the region is still poorly studied and understood. The Iron Age 'pit field sites' (groups of pits distributed over a certain area) in south-eastern Bulgaria were recently intensively excavated, and their study provides rich archaeobotanical assemblages, which are used for filling this gap in our knowledge. The current study presents the archaeobotanical information from 196 flotation samples from 50 Iron Age pits. The results show a wide range of annual crops, the most important of which seem to be hulled wheats (mainly einkorn), barley and also millet. A variety of pulses and fruits is retrieved, each in small quantities. Some species like *Olea europaea* and *Cucumis melo* are an indication for contacts with adjacent regions (especially the Mediterranean area). The archaeobotanical assemblages also documented the environment and land use, revealing the exploitation of a variety of habitats like cropland, open grassland, shrub land and wetland. The archaeobotanical analyses of the Iron Age pit fields show that this type of structures can be an important source of information on the Iron Age plant economy in the region.

Keywords archaeobotany · charred plant macrofossils · Iron Age agriculture · plant economy

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Introduction

The transition between the Late Bronze Age and the onset of the Iron Age (twelfth to eleventh century BC) in Southeastern Europe was a period when lower settlement activity was recorded, and generally, this was a time of uncertainty and conflict in regions adjacent to the study area, like the Aegean and the Eastern Mediterranean (Ward and Joukowsky 1992). Later on, in the second half of the first millennium BC, large urban centres (like Kabyle and Sevtopolis) emerged inland. Their establishing was connected with diverse social and economic factors which were related with the state formation processes and political and cultural interactions with the adjacent regions (Popov 2007; Teodossiev 2011). Important development during the Iron Age is the widespread and the large application of metallurgy which, together with increasing population density and more intensive agriculture and animal husbandry, had also as a consequence the intensification of the exploitation of natural resources. This is manifested also through the first visible on large scale and clearly detectable in the paleoecological archives of Southeastern Europe traces of anthropogenic activities (Marinova et al. 2012). From the Iron Age onwards, the region from where the considered archaeobotanical evidence comes was part of a network of intensive contacts and exchange with the Eastern

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Mediterranean. The cultural interaction of the indigenous population with Greek civilizations is a further interesting aspect of the chosen time span and was enhanced by the foundation of Greek colonies in the Black Sea coast from the eighth century BC onwards. According to written sources, the usual exports from Thrace included slaves, livestock, honey, beeswax, grain, wine, timber, charcoals, tar, metals, etc., while imports into the Thracian hinterland consisted of Attic black- and red-figure pottery, silver and gold vessels, luxury bronze tableware, gold and silver jewellery, weapons, wine, olive oil and other goods (overview given by Teodossiev 2011 and cited there in literature). The basis of the subsistence of this period, the agro-pastoral economy, had experienced a new level of intensification; moreover, the trade and cultural exchange characteristic for the period lead also to the introduction of new crops and agricultural practises. In contrast to the written sources, direct evidence on the agricultural developments preserved in the archaeological sites from the considered period is provided by the archaeobotanical finds of crops, their weeds and—wild—vegetation possibly used as fuel wood, timber, fodder or medicinal purposes. However, until now, there is very few information on the Iron Age agriculture and plant use from Bulgaria compared with the previous prehistoric periods like the Neolithic period and the Bronze Age (see Popova 2009).

One of the most common traces of Iron Age human occupation in Southeastern Europe and more specifically the Thracian plain are the so-called pit fields (example shown on ESM 1), and until now, they are one of the main sources of archaeological and archaeobotanical information for that period. In general, the existence of pit field covers different time intervals from the end of the second and during the entire first millennium BC, and there is rather intensive occurrence of such structures between the six and the third century BC. The Iron Age pit field sites consist of differently shaped pits and sometimes ditches. The pit fields usually take enormous flat areas (up to some tens of square metres) and frequently are situated close to water sources. The depth of the pits varies between 0.30–2.00 m. Shapes are variable: cylindrical, narrow upper part and widening down part (‘bell’-shaped), wide upwards and cylindrical downwards. Most of the pits contain dark grey loamy sediment, and close to the bottom, it becomes lighter and similar to the sterile substrate. The infill shows a variety of cultural and bioarchaeological finds (complete and fragmented vessels, ceramic and metal objects, coins, spindle whorls, loom weights, wattle and daub fragments, hearths, millstones, animal bones and sometimes human bones, wood charcoals and other plant remains). Some of them are quite rich in archaeological and archaeobiological finds like whole vessels, some luxury objects and in some cases whole animal and human skeletons (see EMS 1) which gave arguments to some scientists to associate the pits with rituals (Tonkova and Savatinov 2001; Georgieva 1991, 1999; Valcheva 2002; Tonkova 2010). In contrast to this, the find assemblages of some pits contain materials, which represent refuse remains and can even be related with waste disposal or refuses from specific activities (Popov 2007). In Bulgaria, pit field sites are studied mainly by rescue excavations and on a limited area, which makes it difficult to determine if they were connected with settlement structures or not, and until now, only for few of the pit field sites was possible to be directly related with settlement contexts. The lack of fully studied sites related to those pit fields makes their interpretation rather challenging. The fills of many of these pits contain charcoal and ash layers including a variety of charred plant remains, which draw also the interest of the excavators for archaeobotanical sampling and studies.

The published archaeobotanical evidence from seven pit field sites in South Bulgaria (Fig. 1, indicated with grey circle) provides information on the general tendencies of the plant economy of the period: Koprivlen (Popova 2005a), Vratitsa (Popova 2001), Krastina (Popova 2005b), Kumsala, Dvora (Tonkova and Savatinov 2001), Malko Tranovo (Tonkova and Bozkova 2008) and Svilengrad (Popova 2006, 2008). According to these studies, barley and millet are the most significant cereal crops, followed by the different species of wheat, mostly free threshing wheat. Glume wheats—einkorn and emmer—occur rarely and in smaller quantities. Pulses, represented by peas, lentils and bitter vetch, are also only sporadically found. Apart from annual crops, viniculture could be suggested by the frequent findings of grapevine pips in those sites. The results of those studies indicate that the archaeobotanical evidence from Iron Age pits can provide a variety of information concerning the cultivated plants and partly on the land use of the period in the study area even if they could not clearly be related with settlement contexts.

In this paper, the archaeobotanical evidence from 50 Iron Age pits from five locations in south-eastern Bulgaria (Fig. 1, indicated with black circle) is considered in order to analyse how the plant remains entered the pit deposits and therefore to identify possible functions of the pits. Furthermore, the main archaeobotanical finds (staple crops, their weeds and other used plants) were put in the context of other evidence from the studied period, and this was compared with the data from neighbouring regions. Finally, an attempt is made to consider the archaeobotanical evidence from the pits as a source of information on past environment and land use in the region for the period from 1000 BC to the Roman Period (first century AD).

Study area

The sites considered are situated in the hilly country and plains of south-eastern Bulgaria (Fig. 1). The climate has a sub-Mediterranean character with an average annual temperature

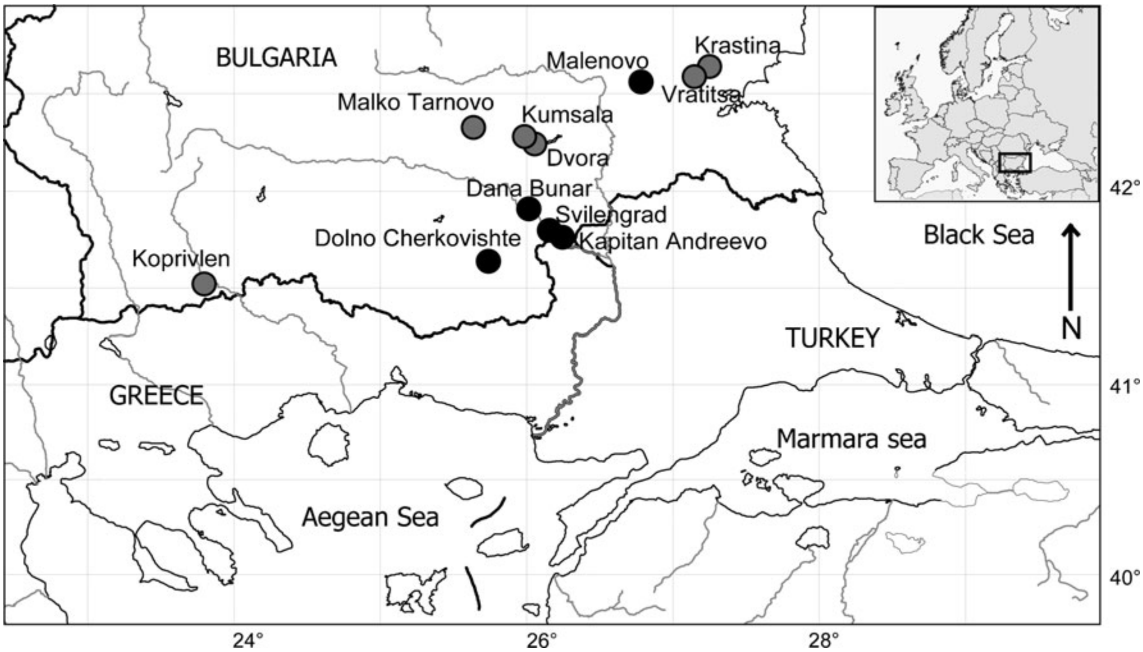

Fig. 1 Map of the study area; *square in the upper left corner* indicates the location of the study area within the territory of Europe (sites of the own study considered in detail (*black dots*) and further sites mentioned in the discussion and Table 2 (*grey dots*))

of 12–13 °C and pronounced droughts in summer (July–August). The mean annual precipitation is between 560 and 500 mm with two maxima (November and June). The dominating soils in the region are chromic luvisols, vertisols and cambisols (Kopralev 2002). The natural vegetation consists of oak forests (mainly dominated by *Quercus frainetto*, *Quercus cerris* and *Quercus pubescens*), rich in undergrowth of shrubs (*Carpinus orientalis*, *Fraxinus ornus*, *Cornus mas*, *Acer tataricum*, *Ligustrum vulgare*, *Corylus avellana*, *Paliurus spina-christi*, *Phillyrea latifolia*, *Juniperus oxycedrus* and *Cotinus coggygria*) and diverse herbs. In Eastern Thrace, also steppe-like vegetation is developed, and it is alternated by groups of *Q. pubescens*, *Ulmus minor*, *C. orientalis*, *P. spina-christi*, *Prunus spinosa*, *Pistacia terebinthus* and *Pyrus elaeagrifolia* (Bondev 1991).

Archaeological settings

The current paper focuses on the analysis of pits from five archaeological sites: Malenovo, Dolno Cherkovishte, Svilengrad, Kapitan Andreevo and Dana Bunar, all situated in south-eastern Bulgaria (Fig. 1, black dots). Most of them belong to the Early Iron Age (EIA)—1100/900—550 cal BC. An exception is only the site Dana Bunar, which is dated to the Late Iron Age (LIA)—end of the sixth century BC to the first half of the fourth century BC

The site of Malenovo is a pit field site, where over 60 pits were excavated. They differ in shape, dimensions and filling. Archaeobotanical samples have been taken from 28 pits. According to the radiocarbon and archaeomagnetic dating, the site can be attributed to the period between the end of twelfth century BC and the beginning of eighth century BC (Bozkova and Petrova 2010, 2011).

Three pits from the site of Dolno Cherkovishte were studied; these are part of a bigger pit complex dated in the second phase of the EIA (eighth to sixth century BC). Undoubtedly this pit complex was connected with the sanctuary of Aul Kaya and the necropolis of Hambar Kaya, both simultaneous and situated in the close proximity (Nehrizov and Tsvetkova 2009).

The site of Svilengrad (ESM 1) consists of over 200 Iron Age pits and several from Early Bronze Age and Middle Ages (Nehrizov and Kecheva 2011). Only the archaeobotanical finds from the Iron Age pits, mostly dated to the EIA, are presented here. Traces of fire are often obvious. The excavators interpret the Iron Age pits as part of a sanctuary, which functioned between the beginning of first millennium BC to the fourth to third century BC (Nehrizov 2006; Nehrizov and Tsvetkova 2008).

The site of Kapitan Andreevo includes several chronological periods—Early Bronze Age, Early Iron Age, Hellenistic period and Early Middle Ages. The Iron Age pits, that are subject of the current study, are part of a pit field site attributed mainly to tenth to sixth century BC; it also includes several pits that are dated to the transition between Early and Late Iron Age (sixth to fifth century BC) (Popov et al. 2007; Popov and Grozdanova 2008).

Dana Bunar is a pit field site, which includes pits from Late Bronze Age, Late Iron Age and Late Antiquity. The pits from the LIA cover the period from the end of the sixth century BC to the first half of the fourth century BC. The fill of the pits consists of dark brown, light grey to black grey soil and includes pottery, mainly concentrated close to the bottom (Nikov 2007).

Material and methods

The archaeobotanical evidence considered here consists of charred and mineralized plant macrofossils (seeds, grains, chaff, etc.), which were accumulated in the deposits of the Iron Age pits. Charring of those plant remains could occur in the course of the various activities of a prehistoric site when the organic matter comes in contact with fire in combination with anoxic conditions (Jacomet 2007). The mineralization of the plant remains occurs when the organic matter comes into contact with nitrates or phosphates by changing dry and wet conditions (Green 1979). The archaeobotanical samples were collected from multiple depth levels within each of the pits, preferably in areas with visible concentration of charred plant remains, which could be promising for retrieving plant remains (usually dark or ashy layers) or when such are not visible in each 10–20 cm along the depth of the pit. The samples (volumes comprising 5–15 l of sediment) were processed by means of flotation in order to obtain the whole variety of preserved plant material. The information on amount of samples and structures studied as well as sample volumes and of plant remains density per site is summarized at Table 1.

The retrieved plant remains were sorted and identified under a binocular with magnification up to 40× (see Table 1 and ESM 2). The botanical nomenclature follows mainly Kozhuharov (1992), with the exception of the cultivated plants for which the nomenclature of Zohary et al. (2012) was applied. The density (or concentration) per litre sediment was calculated for each sample; based on these, an average value was estimated for each site. The ubiquity of each plant taxon was calculated per site as percentage proportion of the total number of pits studied to the pits in which the given taxon occurs (ESM 2). To achieve a more reliable picture on the agriculture and plant economy during both phases of the Iron Age, own data were compared with this from seven previously studied sites (Table 2).

Results

The average density of the plant remains varies in the different sites between 1.7 and 9.5 items per litre sediment. Each of the sites contains pits without archaeobotanical finds or pits with a very low density of plant remains (less than 1 identifiable item per litre sediment). On the contrary, some pits have higher densities, over or around 10 items per litre (ESM 2).

From the site of Malenovo, archaeobotanical analyses were carried out on 28 pit structures; however, only in 14 of the pits, sufficient plant remains were found. The density and the amount of the plant remains both vary considerably in the different pit structures studied—from no archaeobotanical finds to pits with more than 500 identifiable items per pit (ESM 2). The dominating plant finds are einkorn (*Triticum momococcum* L.), emmer (*Triticum dicoccum* Schrank.), barley (*Hordeum vulgare* L.) and millet (*Panicum miliaceum* L., ESM 3). Millet is the most frequent crop occurring in 43 % of the pits, while the other dominant cereals appear in 32–36 % of the structures. Pulses as well as the gathered or cultivated fruits are found sporadically and only as single items.

From the site of Dolno Cherkovishte, only three pits (from which three samples were analysed) were studied archaeobotanically. The results are therefore not sufficient to make reliable conclusions about the economy of the site but are considered in the general context of the current study. Cereals are the only found crops at the site, and they are represented by einkorn, barley and millet. There are no finds of pulses, fruits and gathered from the wild species. Possible weeds, from which remains were found, are *Bilderdykia convolvulus* (=*Fallopia convolvulus*), *Trifolium* sp., *Lithospermum* sp. (Table 1).

Nine flotation samples from four pits from the site of Svilengrad were analysed here. All of them belong to Early Iron Age occupation phase of the site. Interesting here is the presence of spelt (*Triticum spelta*, ESM 3), which is the dominant cereal in all four pits. Finds of this crop are in general quite rare on the territory of Bulgaria. Other cereals typical for the site are einkorn, emmer and barley (Table 1). One grapevine pip as well as seeds of several weed species (*Chenopodium album* L., *Lolium* sp., *Portulaca oleraceae* L., *Adonis aestivalis* L.) was also found. These results fit well with the evidence obtained from previously published archaeobotanical research, based on ca. 50 Iron Age pits at this site—Table 2 (Popova 2006; Popova 2008; Nehrizov and Tsvetkova 2008), indicating that spelt together with free threshing wheat were the staple crops; other important cereal species recovered at this site were barley and millet. As for the pulses, single seeds of lentil, bitter vetch (*Vicia ervilia* L., ESM 3) and grass pea (*Lathyrus sativus* L.) were found, as well as several finds of grapevine and raspberry/blackberry (*Rubus* sp.).

Three of the four studied structures from Kapitan Andreevo (five samples in total) belong to the EIA and one to the transitional period between EIA and LIA. Barley and hulled wheat (especially einkorn) are the dominant species in the samples from the EIA. Leguminous crops are presented only by a single item of grass pea. The olive (*Olea europea* L.) stone is an interesting find as well. Potential weeds are found in small amounts,

Table 1 The plant taxa found at the studied sites given by periods in absolute number and ubiquity of the finds

Site	Malenovo		Svilengrad		Dolno Cherkovishte		Kapitan Andreevo		Dana Bunar	
Period	12–8 c. BC		EIA		EIA		10–5 c. BC		6–4 c. BC	
Total number studied pits	28		4		3		4		11	
Total number samples studied	85		9		3		5		94	
Total volume of studied samples [l]	237.4		45		15		25		470	
Total no. of plant remains	1487		78		35		244		950	
Average concentration per litre	6.3		1.7		2.3		9.5		2	
Cereals	Number of plant remains	Ubiquity (%)	Number of plant remains	Ubiquity (%)*	Number of plant remains	Ubiquity (%)*	Number of plant remains	Ubiquity (%)*	Number of plant remains	Ubiquity (%)
Triticum monococccum L.	64	32	6	75	3	33	19	75	12	45
Triticum monococccum chaff	19	7					4	25	5	18
Triticum dicocccum Schrank.	58	32	4	50	1	33	8	75	1	9
Tr. monococcum/*dicoccum*	22	25	2	25			11	25	17	27
Tr. monococcum/*dicoccum* chaff	123	32	1	25			2	25	47	91
Tr. cf. *timofeewi* (new type) chaff	15	14								
Tr. spelta			9	75						
Tr. spelta-chaff			1	25						
Tr. aestivum L./*durum* L.	30	29					5	50		
Triticum sp.	153	36	4	50					11	64
Hordeum vul. var. *vulgare* L.	10	7								
Hordeum vulgare L.	69	36	6	75	2	67	13	50	70	82
Hordeum vulgare-rachis	11	14								
Panicum miliaceum L.	88	43	2	25	1	33	82	50	53	64
Cerealia	496	75	17	50	18	67	39	75	184	100
Pulses										
Lathyrus sativus L./*cicera* L.							1	25	10	36
Lens culinaris Medik.	3	7							7	55
Pisum sativum L.	1	4							1	9
Vicia ervilia L.									5	27
Fabaceae	7	18	1	25			1	25	17	82
Cultivated or gathered fruits										
Cornus mas L. (stone fruit)	2	4								
Ficus carica L.	2	4							1	9
Olea europaea L. (stone fruit)							1	25		
Sambucus sp. L.									1	9
Vitis vinifera L.	2	7	1	25			1	25	1	9
Fruit stone	1	4							1	9

Table 1 (continued)

Site	Malenovo		Svilengrad		Dolno Cherkovishte		Kapitan Andreevo		Dana Bunar	
Vegetables										
Cucumis melo/ *sativus* L.									1	9
Potential weeds and others										
Adonis aestivalis L.	1	4	2	25						
Apiaceae									1	9
cf. Asteraceae									1	9
Asperula arvense L.	1	4								
Avena sp. L.									1	9
Bilderdykia (=Fallopia) convolvulus (L.) Dum.	48	25			2	33			5	18
Brassiaceae									1	9
Bromus sterilis L./ *tectorum* L.									1	9
Bromus sp. L.	27	21					1	25	5	18
Carduus sp. L.			1	25						
Carex sp. L.									4	18
Chenopodium album L.	7	14	3	50					68	73
Chenopodium hybridum L.	1	4								0
Chenopodium rubrum L.									2	18
Coronilla sp. L.									1	9
Cyperaceae			4	25			9	25		
Dasypyrum cf. *villosum* (L.) Borbás									1	9
Echinochloa crus-galli Beauv.	1	4							2	18
Echinochloa sp. Beauv.	2	4								
Eleocharis palustris (L.) R. Br.									2	18
Euphorbia sp. L.									1	9
Festuca sp. L.	1	4								
Galium aparine L.	1	4								
Galium spurium L.	12	29							1	9
Galium sp. L.	10	21					2	50	9	36
Hordeum sp. L.	5	7					1	25		
Hyoscyamus sp. L.									1	9
Lallemantia iberica (M.Bieb.) Fisch. et Mey.					1	33			3	18
Lamiaceae	1	4							6	27
Lolium sp. L.	6	18	3	25			3	25		0
Lithospermum sp. L.	5	11			1	33			3	18
Malva sp. L.									3	18
Medicago sp. L.									1	9
Panicoideae	2	4								
Phleum cf. *pratense* L.									2	18

Table 1 (continued)

Site	Malenovo		Svilengrad		Dolno Cherkovishte		Kapitan Andreevo		Dana Bunar	
Phleum sp. L.	2	7							1	9
cf. *Poa* sp. L.			1	25						
Poaceae	6	14					1	25	2	18
Polycnemum arvense L.	15	25					5	25	30	27
Polygonum aviculare L.	7	14	1	25			2	25		
Polygonum lapathifolium (L.)S. Grey	1	4								
Polygonum sp. L.									1	9
Portulaca oleraceae L.	6	11	2	50					60	45
Ranunculus arvensis L.	1	4								
Rumex sp. L.	10	18							5	27
cf. *Salvia* sp. L.									1	9
Scleranthus annuus L.									1	9
Schoenoplectus lacutris (Rchb.) Palla							24	25	1	9
Secale sp. L.							1	25	2	18
Setaria cf. *italica* (L.) Beauv.	1	4							1	9
Setaria cf. *pumila* (Poir.)									2	9
Setaria verticillata/ viridis (L.) Beauv.	8	18							5	36
Setaria sp. Beauv.	4	11							1	9
cf. *Stipa* sp. L.									1	9
Taeniatherum sp. Nevski	10	21								
Thymelaea passerina (L.) Coss et Germ.	2	7								
Trifolium sp. L.	5	11			5	33			8	36
Ventenata macra (Steven) Balansa ex Boiss	1	4								
Vicia sp. L.	3	11								
bud	1	4					1	25	2	18
Bread/Porridge fragment							1	25		
Indet (carbonized)	96	57	7	100	1	33	6	75	15	36
Indet (mineralized)	1	4							241	82
sum	1487		78		35		244		950	

With light grey are given values of ubiquity which are not reliable due to low sample number studied

EIA Early Iron Age, *LIA* Late Iron Age

consisting mostly of *Polycnemum arvense*, *Lolium* sp., *Galium* sp. and *Polygonum aviculare* L. There are also fragments of charred matter that showed the morphological features of 'bread/porridge' (Fig. 2). The fragments have rather homogenous porous structure, and by higher magnification, also fragments of cereal pericarps were observed.

From the site of Dana Bunar, 11 LIA pits (94 samples in total, i.e. multiple samples per pit, see ESM 2) have been studied. In spite of the bad preservation of the plant remains

Table 2 Archaeobotanical evidence from the Iron Age in Southern Bulgaria

Site abreviation	M	KA	Dch	Sv	Sv	DB	Kop	MT	Kum	Dvora	17 Vra	Kr	Ubiquity %
Period	EIA	EIA	EIA	EIA	EIA + LIA	LIA	LIA	LIA	LIA	LIA	LIA	LIA	
Cereals													
Triticum monococccum	x	x	x	x	x	x	x	x	x	x	x	x	100
Triticum monococccum (chaff)	x	x				x							25
Triticum dicoccum	x	x		x	x	x			x		x		58
Tr. monococcum/dicoccum	x	x	x	x		x							42
Tr. monococcum/dicoccum (chaff)	x	x		x		x							33
Tr. aestivum/durum	x	x		x	x		x	x	x	x	x	x	83
Tr. spelta				x	x								17
Tr. spelta-chaff				x									8
Triticum sp.	x	x		x	x	x							42
Hordeum vulgare	x	x	x	x	x	x	x	x	x	x	x	x	100
Panicum miliaceum	x	x	x	x	x	x	x	x		x			75
Secale cereale		cf.			x		x	x	x	x			42
Avena sativa							x	x					17
Pulses													
Lathyrus sativus/cicera		x			x	x		x					33
Lens culinaris	x				x	x	x		x	x	x	x	67
Pisum sativum	x					x	x		x				33
Vicia ervilia					x	x	x	x	x	x	x		58
Fabaceae	x	x		x		x							33
Cultivated and gathered fruits													
Cerasus vulgaris												x	8
Cornus mas	x						x		x	x			33
Ficus carica	x					x							17
Juglans regia									x				8
Olea europaea		x											8
Prunus avium							x	x	x				25
Rubus sp.					x								8
Sambucus sp.						x							8
Vitis vinifera	x	x		x	x	x	x	x	x	x	x		83
Fruit stone	x					x							17

The presence and absence data for the own data and previous studies; if not mentioned behind the plant name, the remains represent seeds or fruits

DB Dana Bunar (this paper), *Kop* Koprivlen (Popova 2005b), *MT* Malko Tranovo (Tonkova and Bozkova 2008), *Sv* Svilengrad (Popova 2006, 2008 and this paper), *Kum* Kumsala (Tonkova and Savatinov 2001), *Dvora* Dvora (Tonkova and Savatinov 2001), *17 Vra* site 17 Vratitsa (Popova 2005a), *KA* Kapitan Andreevo (this paper), *ML* Malenovo (this paper), *Kr* Krastina (Popova 2005a)

(many are fragmented and/or identifiable just as 'Cerealia' or 'cultivated pulses' due to abrasion of the surface or deformation), about 50 plant taxa were identified. They consist of cereal crops, pulses, fruits, vegetables, possible weeds and other wild-growing plants (Table 1). The majority of the plant remains are preserved in charred state, but some of the samples contain also mineralized plant material. The amount and the diversity of the plant remains in the different negative structures fluctuate considerably. The dominant and most frequent species is barley, followed by millet. The large number of glume bases of *Triticum monococcum/dicoccum* is remarkable. They occur in almost all of the studied pits (ubiquity 91 %) but in small quantities and are clearly dominated by einkorn, while emmer appears just as a single item (Table 1, ESM 2). The most common leguminous crop, present in 55 % of the pits, is lentil. *L. sativus/cicera* is also quite common and occurs in 36 % of the pits. A seed from grapevine, a fragment of fruit stone and a fruitlet of fig are also found. Vegetables are represented only by one find of *Cucumis melo/sativus* (ESM 3). Most common potential weeds are *C. album*, *Galium* sp., *P. oleraceae*, *B. convolvulus* (=*F. convolvulus*).

Specific for the site of Dana Bunar is the considerable amount of mineralized material. Mineralized plant remains occur at this site in 82 % of the pits. No regular pattern is

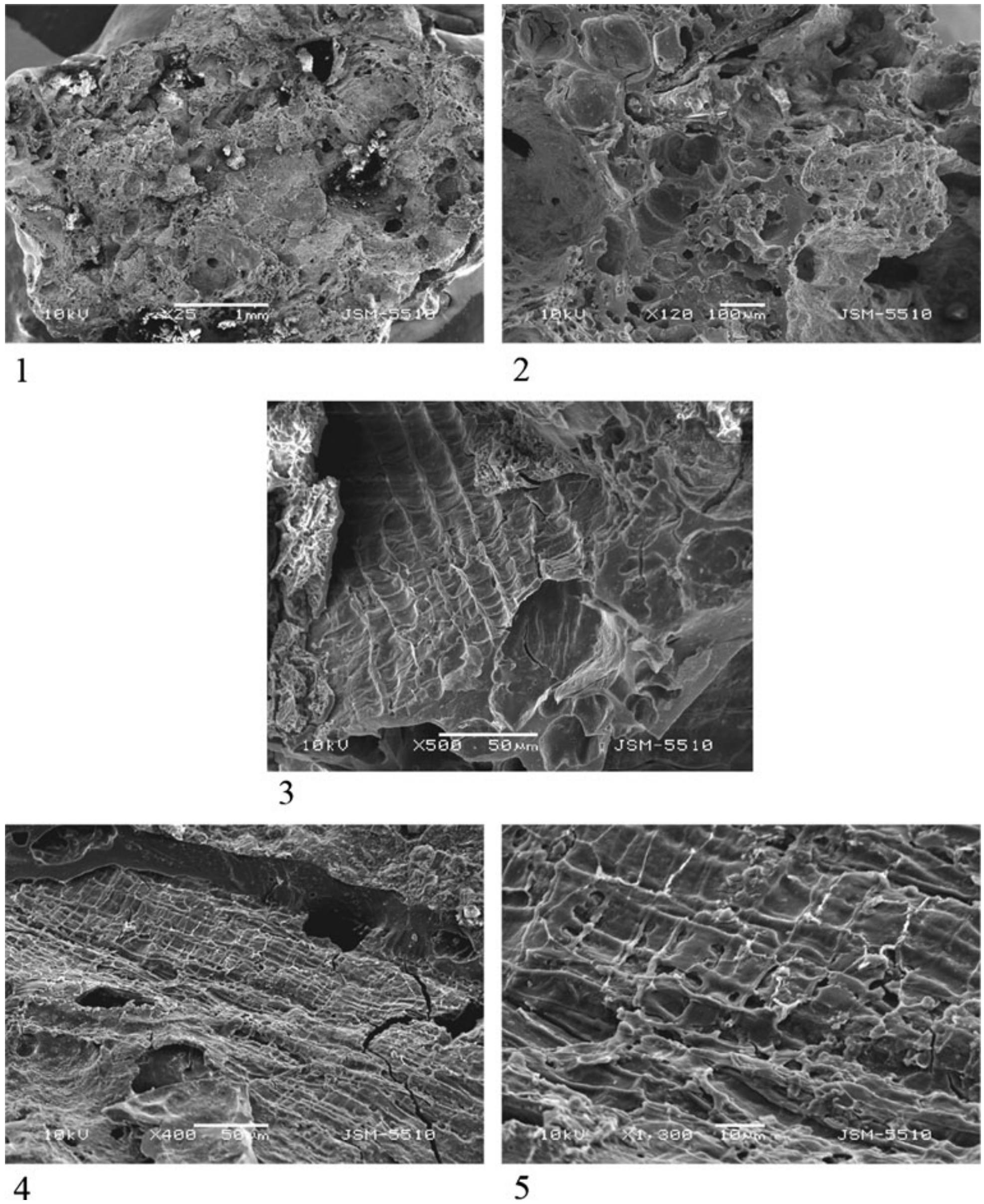

Fig. 2 Microscopic view of the surface of the food remain (bread/gruel) from the site Kapitan Andreevo. Overview of their porous structure (1 and 2); detail view of cereal pericarp and bran fragments (*3*–*5*)

visible in their occurrence through the depth of the pits as they were found in the upper, middle or lower part of a pit or even in some cases in all samples throughout the depth of a pit. Most of them are so strongly altered/deformed by the mineralization that it is not possible to come to further identification, except as cultivated pulses or cereals.

Discussion

Taphonomy or possible ways for deposition of the plant remains in the pits

The observed variation in density of plant remains between the studied samples (ESM 2) could be related to the different functions or intensity of use of the pits. For example, those with higher concentrations of charred remains could be interpreted as storage pits in which some material remained after lighting fire while preparing them for subsequent use in order to make it impossible for germs to multiply (Currid and Navon 1989). Cereal grains and chaff remains take rather high proportions in all of the studied sites (ca. 42–75 %, Fig. 3), which suggest that those archaeobotanical finds represent, at least partially, the remains of cereal storages or even food preparation (see Reynolds 1974; Tiverios et al. 2013). The latter can be assumed, as in many cases, the surface of the plant remains is damaged and also many of them have an altered shape. As a consequence, the majority (ca. 30 to 50 %) of the charred cereal grains cannot be further identified than to the level of 'large cereal grain' (Cerealia) as also

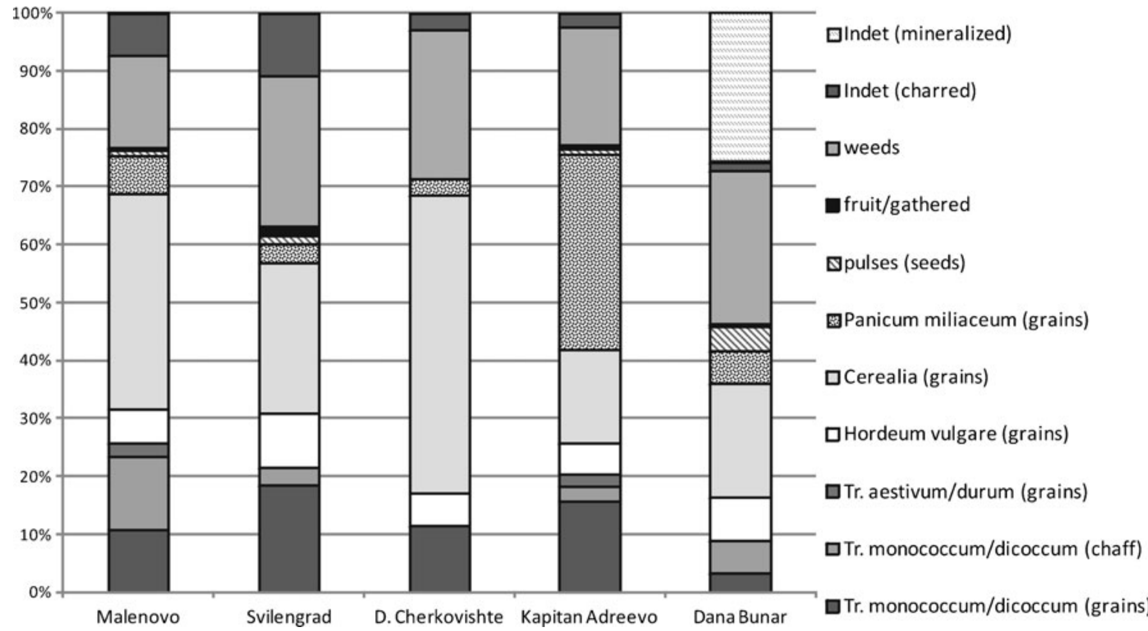

Fig. 3 Percentage proportions of the most important groups of plant remains for the studied sites

observed at the site Karabouraki, Northern Greece (Tiverios et al. 2013). It is quite difficult to prove if the pits were used or not as storages, based only on the archaeobotanical remains. To get a reliable answer on this question, detailed sampling and correlation of different archaeological, biological and geochemical proxies are needed (Ivanova et al. 2016). For example, storage pits from archaeological contexts are usually filled with soil or rubbish, which is not connected with their primary use (Fairbairn and Omura 2005). Also, if the pit was used for storage, it is not absolutely necessary to find cereal grains because usually, the stored cereals were taken out of the pit, and if there was no fire, the remained grains decayed (Currid and Navon 1989).

At the sites studied, weeds and chaff remains together represent ca. 30 % (ca. 15–25 % weeds and 3–10 % chaff remains—Fig. 3) of the archaeobotanical finds. These chaff remains and weeds can be interpreted as by-products of crops processing. Chaff is also preserved when wheat ears or whole sheaves are burnt, and this burning can be interpreted as a part of a ritual (Popova 2002). When crop sheaves are burnt, it is possible that chaff or weeds get incorporated in the pit deposit (Heiss 2014). This makes the interpretation of the results quite difficult because the same kind of plant remains can be interpreted as residue of burning everyday waste, dung etc. or coming from ritual action (see Heiss 2014). Chaff and other crop processing by-products can also be used as livestock food as also ethnographic observations have revealed (Jones 1990; Peña-Chocarro and Zapata Peña 2003; Hajnalová and Dreslerová 2010). They pass through the animal digestive tract, appear whole in their dung (Valamoti and Charles 2005) and through this way could be incorporated in the cultural layers including pit deposits. Dung cakes prepared by mixing animal dung with by-products of crop processing (Charles 1998) are used as fuel in regions where wood resources are scarce. Based on archaeobotanical finds, Valamoti (2005) assumes that such cakes were used in Northern Greece. The geographic proximity of south-east Bulgaria to Greece and similarities in their natural resources makes the use of dung fuel plausible providing another possible explanation for the presence of chaff and weeds in pits. Therefore, the presence of those remains into the pits might also result from the deposition of ashes from fireplaces.

The quantitative and qualitative distribution of the plant material within the pit fills can give an idea about their taphonomy and function. At the two sites (Malenovo and Dana Bunar) where a larger number of pits are analysed, it is obvious that there is no clear pattern in the distribution of the plant remains within the pits (ESM 3). In some of them, the greatest concentration of material is at or near the bottom of the pit, while in others, it is in the middle or the upper layers of the fill. In some pits, the plant material is distributed equally throughout the whole pit and most probably reflects continuous filling. This kind of deposition suggests that in the most cases, we deal with refuse disposal.

Mineralized plant remains are absent in most of the sites presented here. An exception is the site of Dana Bunar where significant amounts of mineralized remains were found (Fig. 3). This indicates the presence of phosphate and calcium salts in combination with changing soil humidity (Green 1979; McCobb et al. 2003). High phosphate and carbonate concentrations in archaeological contexts mostly result from faecal material and are typical for latrines, cesspits, sewerage systems, middens, etc. The presence of mineralized plant remains can therefore be used as an indication of faeces in the deposits (Jacomet 2003). This gives a hint for the possible function of the pits at this site or at least for the composition of part of the organic matter deposited in the pits which were probably used for discarding refuse or as latrines.

In one of the pits at the site of Kapitan Andreevo, amorphous charred matter resembling bread/porridge or fruit flesh was also found (Fig. 2). This most probably represents food remains or kitchen waste. Food remains were also considered as having a ritual character in some other pit field sites (Georgieva 1999) or in sites related with ritual offerings (see Heiss 2014). To consider a ritual function of these pits, we should first answer the question what we regard as 'ritual' and as 'symbolic artefact' and bear in mind that one and the same activity can be interpreted both as practical and symbolic, as very often, the ritual and symbolic practises are inseparable from everyday life (Brück 1999). Therefore, it seems that the most plausible interpretation remains to consider the finds as refuse deposited in the pits.

Plant subsistence through the Iron Age and its regional context

The most common archaeobotanical finds throughout the entire period are the cereal crops einkorn and barley (Table 2). The presence of hulled wheat and especially einkorn in the Iron Age pits indicates that they were grown in the study area until the end of the first millennium BC. This has also been observed in neighbouring regions such as the Aegean (Kroll 2000; Nesbitt 1995; Riehl and Nesbitt 2003). At Kastanas, Northern Greece, einkorn cultivation decreases and other cereals (like free threshing wheat and millet) become more important during the transition period from the Bronze Age to Iron Age and during the whole Iron Age (Kroll 1983; Valamoti 2009). In the study area, millet becomes more important during the Late Bronze Age, and it was one of the staple crops during the whole Iron Age, present in 75 % of the studied pit field sites (Table 2). The remains of free threshing wheat are also quite frequent. Published data of other Iron Age sites show that lentil and bitter vetch seem to be the most important leguminous crops, while grass pea and pea occur in 33 % of the sites.

Fruits and gathered wild plants are not typically found in pit fields. Within this group, grapevine seeds are the most common and are present in 83 % of the sites (Table 2). Its frequent occurrence could be an indication for viticulture and wine production which were well developed during the Iron Age in Northern Greece (see Valamoti et al. 2015; Tiverios et al. 2013; Becker and Kroll 2008; Kroll 1983). However, single seeds only are presented at all sites, and this is not sufficient as proof for wine production. For proving this, research on settlement contexts with more numerous finds is needed. The presence of wild plants, subject of gathering during the Neolithic, Chalcolithic and Bronze Age (like elder and cornel), indicate that they were also a food resource during the Iron Age. Fig fruitlets were found at Malenovo and Dana Bunar and an olive stone at Kapitan Andreevo; both fruits are typical for the Mediterranean area. While fig trees can grow and produce fruits in the study region, olive trees cannot. The olive stone therefore represents with certainty import from a region—with a true Mediterranean climate where olives are grown. This find is most probably indicative for trade connections with the Aegean region, the closest area with olive cultivation. Another interesting find, which can be considered in this context, is *C. melo*/*sativus*. Archaeological remains of *C. melo* are common for the Bronze Age in the eastern Mediterranean and Egypt, and it was argued that those were most probably not sweet varieties but eaten as vegetable. *C. melo* was known in Mesopotamia at least from the beginning of the second millennium BC and in Greece from LBA (Stika and Heiss 2013). It seems that the occurrence of *Cucumis* in the study area is one of the earliest finds in the inland north from the Aegean region. Introduction of Mediterranean crops or their import is also visible in other regions of Europe during the Iron Age (see Matterne 2001; Kreuz and Schäfer 2008; Kohler-Schneider et al. 2015), and therefore, these finds reflect general developments which are typical for this period on supra-regional scale.

Environmental conditions, land use and human impact on the vegetation

The available paleoecological information on the vegetation development and climate in the lowlands of south-eastern Bulgaria during the last 3000 years (i.e. the Subatlantic period) is rather scarce and incomplete. Palynological evidence from a pollen profile in the north-east of the Thracian plain (Tonkov et al. 2008) shows the presence of mixed oak forests and stands of pine (most probably *Pinus nigra*) which covered the slopes of the hills near the studied pollen profile during the Late Bronze Age. These results (Tonkov et al. 2008) indicate that the Bronze Age settlements had already considerably influenced the natural woodland. The most marked human impact on the landscape and natural vegetation in the study area is however observed during the Iron Age and led to the formation of secondary plant communities with oriental hornbeam (*C. orientalis*) and juniper (*Juniperus* sp.); pollen of anthropogenic indicators such as *Cerealia*-type, *Xanthium*, *Rumex* and *Cirsium* suggest the presence of crop fields and stock breeding in the surrounding (Tonkov et al. 2008). Archaeological evidence confirms the existence of well-developed agriculture in this part of the country during the middle of the first millennium BC (Popov 2007). Another pollen diagram from the village of Ezero, Nova Zagora, (Chapman et al. 2009) suggests the increasing exploitation of natural resources and the destruction of forest vegetation during the Iron Age. The minor increase of several tree taxa during the Early Iron Age (Chapman et al. 2009) was interpreted as a shift in climate (ca 850 BC), with an increasing moisture availability in combination with decreasing temperatures during the summer months. Increasing moisture availability during the onset of the Iron Age in the region was also observed in the palynological records from the nearby mountain ranges. For example, the majority of *Sphagnum* peat bogs in the Central Rhodopes and Sredna Gora Mountains started to develop from around 900–800 BC onwards (Lazarova 2003; Filipovitch et al. 1998) and demonstrate an increase in moisture conditions in these mountains. Those favourable climate conditions during the Iron Age, together with new social developments and technological innovations, most probably positively affected the agricultural activity of the population in SE Bulgaria. Since 800 BC and especially around 500–400 BC, human impact on the vegetation becomes clearly pronounced and continuous on a large scale (Marinova et al. 2012). This is also clearly visible in the pollen records from adjacent Aegean areas (Lazarova et al. 2012; Kouli 2012).

The archaeobotanical evidence presented here also fits well in this picture. Plants that grow in open and stony places like *Dasypyrum* cf. *villosum*, *Hordeum* sp., *Phleum* cf. *pratense*, *Stipa* sp. and *Taeniatherum* sp. indicate the close presence of such habitats near the sites. Further, direct evidence of open vegetation like shrub land (*Cornus mas*, *Sambucus* sp.) and disturbed by human activities (*C. album*, *Galium* sp., *Lolium* sp., *P. arvense*, *P. aviculare*, *P. oleraceae*) are also frequently suggested by the archaeobotanical assemblages found in the pits.

Together with the potential weeds/ruderals and other wild-growing plants, the finds of cultivated fruits (grape, fig) and vegetables (melon) give information on further aspects of the land use strategies, i.e. presence of areas reserved for gardens. This can be interpreted as an enhancement of the agricultural practises which started already in the Late Bronze Age in this region (Kroll 2000; Marinova and Valamoti 2014; Stika and Heiss 2013). However, the small number of finds up to now (Table 1) does not allow firm conclusions on this matter.

Conclusions

The studied archaeobotanical assemblages from Iron Age pit fields have shown a wide variety of cultivated and wild-growing plants and therefore are a quite promising source of information on the plant economy in the study area.

The lack of consistency or regularity in the deposition of plant remains throughout the depth of the pits suggests that the botanical material cannot be the result of primary activities but points towards secondary infill of the pits. The majority of the botanical remains represent species that are included in the daily diet of the population, combined with numerous weeds, wood charcoal, ashes and mineralized organic matter (incl. plant macrofossils). Such assemblages easily can be interpreted as indication for waste products of everyday life, which originate from plants used for fuel, crop processing, food preparation, etc.

Considering the high amount of Cerealia grains in some of the pits, it can be concluded that they first were used as storage pits and, after abandonment, were filled with refuse or in some cases used as cesspits. The archaeobotanical evidence itself can give only few hints on the primary (storage, latrines) and secondary (refuse) functions of the pits and should be considered in combination with the archaeological, other bioarchaeological and archaeometric evidence.

The main annual crops, hulled wheat and barley, are the same as those which dominated agricultural production during the previous periods. On the other hand, millet, and to a lesser extend free-threshing wheat, had gained importance during the Iron Age. Pulses, vegetables and gathered and possibly cultivated fruits also formed part of the Iron Age economy in south-eastern Bulgaria. However, their low numbers and the ubiquity of the finds do not allow for reliable estimations on their importance so far. Some of them, like olive fruit stones, can be considered as an indication for trade connections with the Mediterranean, because olive cannot thrive in the study region. Finds of crops that are typical for the Late Bronze Age and Iron Age plant economy of the Eastern Mediterranean, like *C. melo* and *Ficus carica*, are other hints for such connections and most probably reflect new introductions of cultivated plants into the region.

Apart from the cultivated plants, the archaeobotanical evidence from the studied pits shows not only a variety of field weeds but also representatives of open and ruderal vegetation, shrub land and wetlands, which allow to get insight into the environmental conditions and diverse land use practises during the Iron Age.

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