ANTHROPOLOGIE • L/4 • pp. 391–409 • 2012

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LITHIC RAW MATERIAL AND LATE PALAEOLITHIC STRATEGIES OF MOBILITY: A CASE STUDY FROM SOWIN 7, SW POLAND

ABSTRACT: The mobility strategies of people who inhabited the northern part of Central Europe during the second Pleniglacial and just after this period (GS-3–GI-1) are one of the most intriguing issues. It is widely accepted that the mobility of hunter and gatherer is strictly linked with climatic conditions and distribution of food sources. However, the direct data concerning the Late Pleistocene climatic and environmental conditions are seldom discovered at archaeological sites. In this context lithic assemblages regarding the provisioning and consumption of raw materials shed some light on above mentioned issues. We suppose that the raw materials management, as an important component of the technological organisation, was often integrated with an existing mobility strategy. The aim of this paper is to present the mobility strategy used by late Gravettian/Epigravettian and Magdalenian groups. Presented conclusions are based on the results of analyses of the Late Palaeolithic assemblages from the site 7 in Sowin (Łambinowice commune, Opole district, SW Poland) located in the area where deposits of well quality erratic flints occur. In the light of our studies it seem that the late Gravettian/ Epigravettian groups leaned towards refugial system, while the Magdalenian ones towards the logistic or both strategies. Finally, it is worth mentioning that the Sowin 7 site in terms of use and management of stone raw materials is similar to other Late Palaeolithic sites located north of Carpathians and Sudetes.

KEY WORDS: Late Palaeolithic – Mobile strategies – Raw material – Poland

INTRODUCTION

It is well known that the mobility strategies of hunters and gatherers were not universal. Their variation was generally dependent on two key factors: the quality and quantity of food resources as well as the demographic background (Binford 1980, 2001, Bousman 1993, Kelly 1983, 1995). We face many difficulties trying to characterise the mobility strategies of hunter and gatherer groups in the late Pleistocene, because we do not have

Received 18 March 2013; accepted 10 June 2013.

full knowledge of the aforementioned factors. We are forced to utilise indirect data, which may indicate the use of a certain mobility system. The indirect data can be obtained by the analysis of the most common remains, i.e. lithic artefacts, focusing on raw materials management. We believe that raw materials management, as an important component of the technological organisation, was often integrated with an existing mobility strategy (see, Shott 1986). In other words, raw materials were obtained and processed in different ways by groups, which for demographic and climatic reasons, applied more often the foraging strategy than the logistic strategy. The more or less exact selection must have resulted in diverse raw material in respect of volume and quality. These features could have been manifested themselves in the quality and quantity of products (e.g. Andrefsky 2005: 241).

In this paper, we aim to determine the mobility strategies of human groups by assessing the management of lithic raw materials based on late Palaeolithic assemblages from site 7 in Sowin, Łambinowice commune, Opole district, SW Poland (Furmanek *et al.* 2001, 2011). The choice of Sowin 7 for testing the relationship between mobility strategy and the treatment of raw material was for several reasons. Firstly, Sowin 7 is located on deposits of glacial origin, where there are many siliceous rocks, commonly called erratic flint, which were used as the basic raw material for the tool production (*Figure 1*). Siliceous rocks had to be easily accessible on the surface of sediments during the last glacial period because this area is a part of upland. Thus, the region had an area supplying stone material, which is proved by the concentration of sites (Furmanek 2001, Ginter 1974, Kozłowski 1964, Kurtz 1930, Wiśniewski *et al.* 2010). It is also worth mentioning that Sowin 7 is located in a region of potential sources of food and organic raw material, for just a few hundred meters from it stretches a vast basin depression with traces of Pleistocene river beds (*Figure 1b*). An important reason for choosing Sowin 7 for testing the relationship between mobility strategy and raw material treatment, apart from its location, is the presence of the superposition of at least two levels with artefacts representing different cultural units. This allows for the examination of the relationship between raw material and mobility in the diachronic perspective, and at the same time, allows for the determination as to whether hunters and gatherers of both cultural units, i.e. Epigravettian (or late Gravettian) and Magdalenian had different mobility strategies. It is assumed that groups of these cultural units could have varied in their manner of occupying the territory, which is located in the northern part of the Carpathians and the Bohemian Massif (e.g. Svoboda, Nowak 2004).

This paper, apart from the necessary information from the field of geology and archaeological stratigraphy as well as the assemblages' structure includes data on the potential of the resource base. Furthermore, an attempt to reconstruct the treatment of the raw material based on the comparison of petro-archaeological data on potential resources with archaeological data will be presented.

MOBILITY STRATEGIES AND LAND USE STRATEGIES

Anthropological and ecological perspective

The mobility strategies of hunters and gatherers, due to the use of ethnoarchaeological studies and optimal-foraging models have become an inspirational source of discussion on the variability of the behaviour of Palaeolithic humans. There are two models of mobility: after Binford (1980) and after Kelly (1983, 1995: 120–121). A simplified model proposed by Binford based on Murdock's data (Binford 1980) is most commonly used by archaeologists. Binford distinguished two strategies: foragers and collectors, showing variations depending on climatic and environmental conditions. According to this model, foragers exploited land by moving from place to place in large groups, while collectors settling in one camp exploited the land with small special task-groups. The use of these strategies, according to Binford, depended on the nature of food resources, which could have been available in distant areas or were evenly spread over a given territory. As demonstrated by further, more detailed analyses, this distinction is a considerable simplification (Kelly 1983, 1995) but despite this, we shall use it because it is very useful for incomplete data on mobility in the Palaeolithic.

For the research presented in this paper, it is essential to answer the question concerning in which way these strategies are manifested in material remains. According to some researchers, the mobility strategies manifest themselves in procedures related with tool manufacturing. It is believed that typical foragers reduce the preparation time by investing less effort and being more flexible hunters and gatherers. Collectors, on the other hand, invest a lot of effort in the preparation and maintenance of their tool kits (Bousman 1993: 77). Theoretically, the former are more likely to rely on tools that perform multiple functions, while collectors tend to manufacture specialised equipment. It is generally believed that foragers minimise the time spent, and the collectors maximise profits.

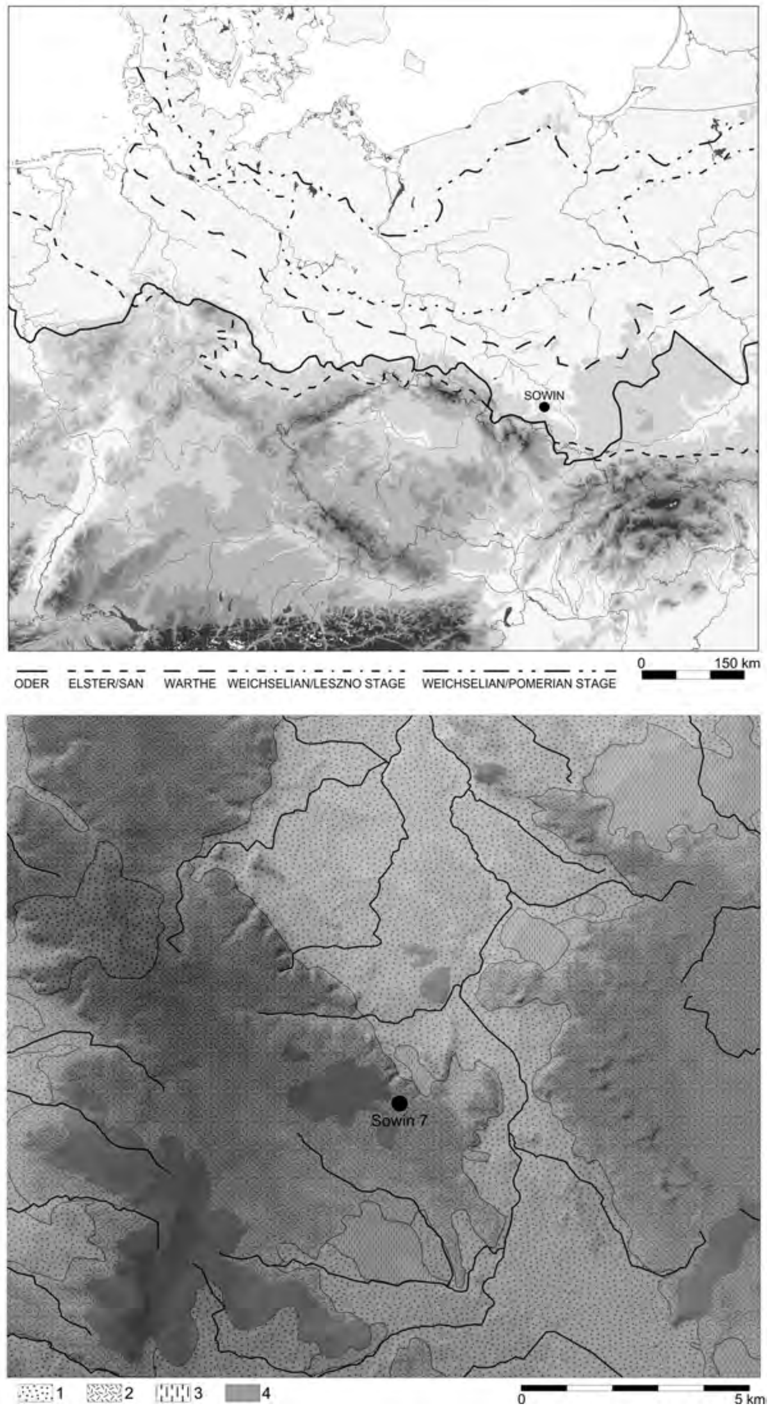

FIGURE 1. Glacial deposits. Above: limits of the main Pleistocene glaciations in Central Europe and location of the Sowin 7 site. Below: geological sediments in the proximity of Sowin 7 site. 1, fluvial deposits within valley rivers; 2, pre-glacial sediments (Gozdnica series) covered with fluvioglacial deposits; 3, glacial clay deposits; 4, Holocene peat plains (2 and 3, potential area of raw material supply). According to Przybylski, Badura (2001).

According to some researchers, the type of mobility had a decisive influence on the nature of manufactured tools. Some argue that the foraging mobility type led to the more frequent production of maintainable type tools, while the logistic strategy used reliable type tools (see the division after Bleed 1986, Bousman 1993: 71). The former could be sharpened and processed without serious consequences; the latter required the replacement of some parts. It seems that at the end of the Pleistocene in Central Europe, we are dealing with industries, which often use the reliable type tools, but also sometimes maintainable ones. It seems that reliable tools were used more frequently during specific seasons and in high-risk specific situations (Bleed 1986, Bousman 1993, Torrence 1989).

It is believed that the variation in tool manufacturing by foragers and collectors, according to S. Kuhn's model (1995), was due to a need to equip individuals or provision a place. The first strategy was more frequently used by foragers and was linked with the manufacturing of reliable mobile equipment. Such preparation enabled relatively free movement and the use of hunting weapons or other tools. The collectors' strategy had to be more characteristic for a well-established logistic system of land exploitation, whose principle was specialisation. It should be noted, however, that logistic strategy group members had to be equipped with individual tools (e.g. Graf 2009: 214). These tools also had to be repaired or replaced.

From these observations comes an obvious conclusion that mobility strategies must have had a large impact on the organisation of raw material procurement and their qualitative and quantitative features. If a group exploited land in a manner similar to that of the logistic strategy, the obtaining of raw materials (for example, lithic ones) must have been considered a choice characterised by fairly strict criteria. Minimising randomness in this case had to be associated with higher costs according to the theory of the prey choice model (Krebs, Davies 2001). The costs are mainly time and the energy used during the search. On the other hand, in the case of the other mobility strategy linked with lesser tools requirements, we would expect a less careful selection of raw materials, which could have taken less time. Minimising the time spent on the collection of raw materials reduces energy expenditure and increases the time budget for other activities. This procedure resembles the principle of "one never knows what may happen in the next moment" (Krebs, Davies 2001: 67).

An interesting issue is the stability of these mobility strategies. It seems that in the changing Pleistocene environment, groups who preferred the logistic strategy were prepared for this change (see, Bousman 1993: 77). A decision affecting strategy changes could have resulted from many causes, of which the most significant were risk and profitability. Hence, the obvious conclusion is that one should be cautious in a too general evaluation concerning the Pleistocene strategies of the exploitation of environmental resources over large areas.

For this reason, in this paper we are focused on a small area surrounding one site. The site's buffer zone contained a potential food resource located in the basin depression (water, plants and animals) as well as a source of stone raw material, which according to geological assessment was available during the whole period of the land exploitation by humans in the late Pleistocene (J. Badura personal communication).

A comment on the mobility of hunters and gatherers northwards from the Carpathians during the GS-3–GI-1 period

Some elements of the above-discussed mobility patterns can be recognised within remains located northwards from the Carpathians, and they correspond chronologically with the period from GS-3 to GI-1, i.e. the time of the formation of the two cultural horizons on Sowin 7. To illustrate the patterns, a table that contains information about the most important sites from this period was used. These remains are linked with the so-called Epigravettian and Magdalenian complex (*Table 1*). The variables in the table refer to, amongst others, chronology, the stone raw material supply, the type of manufacture and the basic activity of hunters and gatherers, as well as the general structure of discarded remains.

A summary of data concerning the Epigravettian leads to the conclusion that the traces of the exploitation of the area situated to the north of the Carpathians are dated to the period of the maximum of the last glaciation (GS-3–GS-2). Unfortunately, the individual sites do not contain too many numerical dates except for a series from Targowisko (Wilczyński 2009), and Deszczowa Cave (Żarski, Nadachowski 2009: 72) which reduces their reliability. While in Targowisko, dates show a high degree of similarity, in Deszczowa Cave they are largely scattered. Generally, the last dates based on the AMS method are older than those previously established by the traditional measurement (see, Cyrek *et al.* 2000: Tab. 9).

Nevertheless, it is noticeable that most of the remains have common features. Firstly, they are known mainly from Lesser Poland, and above all, from open-air sites.

TABLE 1. Regional data concerning Epigravettian and Magdalenian sites. In case of Magdalenian only the richest assemblages obtained during systematic excavation have been contained (> 100 artefacts). Cutural units: Eg, Epigravettian; Md, Magdalenian. Raw materials used for blank and tool production: Bf, Bircza flint; Chf, chocolate flint; Crf, Cretaceous erratic flint; E, erratic flint; Gr, grey-spotted beige flint; Jf, Jurrasic flint (subcategories); Lmn, limnoquartzite; Mh, Mikuszowicki hornstone, Ob, obsidian; Q, quartzite; Rd, radiolarite; Rf, Rauracki flint; Sikf, Sikornik flint; Swf, Świeciechów flint; Vf, Volhynian flint.

Site/layer	Cult. unit	Dating (uncalibrated)	*N*	Raw material	Supply	Manufacture	Activity	Flakes *N*	Flakes %	Blades *N*	Blades %	Cores *N*	Cores %	Tools *N*	Tools %	Others *N*	Others %	Source
Deszczowa Cave, Layer VIII–VIIIa	Eg?	17,480 ± 150 (Gd-10212); 16,150 ± 280 (Gd-9464); Range: 28,600 ± 400–19,250 ± 120	8	Jf	Local	Use and repairing the tool kit	Short term camp	1	12.5					3	37.5	4	50.0	Cyrek 2000; Żarski, Nadachowski 2009
Kraków Piekary IIa, Layer 5, 9 Sector XXII	Eg		2123	Jf (A, C, E)	Local	Production of blanks and cores (?)	Short term camp	1988	93.7	119	5.6	6	0.3	3	0.1	7	0.3	Wilczyński 2006
Kraków-Spadzista B + B1, Layer 5	Eg		1532	Jf (A, C), Gr, Sikf, Lmn, E	Local, regional	Production of blanks and cores (?)	Short term camp	1052	68.6	399	26.0	20	1.3	48	3.1	13	0.8	Wilczyński 2007
Kraków-Spadzista C2, Level I, Layer 5	Eg	17,400 ± 310 (Ly-2542)	510	Jf, E, Chf	Local, regional	Production of blades	Short term camp for hunting or raw material supply	141	27.6	98	19.2	8	1.6	19	3.7	244	47.8	Sobczyk 1995; Kozłowski, Sobczyk 1987
Targowisko 10	Eg	Range: 14,820 ± 70–14,520 ± 70	4690	Crf, Chfs, Mh, Bf, Rd, Ob	Local and oriental	Production of blanks and cores (?)	Temporary camp	593	12.7	821	17.5	38	0.8	66	1.4	3172	67.6	Wilczyński 2009
Zawalona Cave, Layer E	Eg?	15,380 ± 340, 14,060 ± 340	19	Jf	Local	?	Short term camp	7	37.0	7	37.0	1	5.0	2	10.5	2	10.5	Alexandrowicz *et al.* 1992
Ćmielów 95 (Mały Gawroniec)	Md		175,000	(?)	(?)	Production blanks and tools, use of tools	Base camp (?)											Przeździecki *et al.* 2011a, 2011b

TABLE 1. Continued.

								Flakes		Blades		Cores		Tools		Others		
Site/layer	Cult. unit	Dating (uncalibrated)	*N*	Raw material	Supply	Manufacture	Activity	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	Source
Dzierżysław 35	Md	14,150 ± 70 (Poz-10136) 12,150 ± 70 (Poz-7318)	39,922	E, Rd, Q	Local, oriental	Production blanks and tools, use of tools, repairing toolkits	Base camp inhabited recurrently	35,907 (blades, flakes and chips)			89.9	522	1.3	2728	6.9	765	1.7	Ginter, Połtowicz 2010; Ginter *et al.* 2002
Grzybowa Góra, Rydno II/59	Md		746	Jf, Chf	Oriental, regional	Production of blanks	Short special tusk camp	320	43.0	383	51.3	4	0.5	38	5	1	0.13	Schild 1965
Hłomcza 1	Md	13.5 ± 2 (TL)	147	Bf, Swf, Vf,	Oriental	Production of tools (?)	Short term camp	78	53.0	34	23.1	4	2.8	31	21.1			Valde-Nowak 1998 Valde-Nowak, Muzyczuk 2000
Klementowice -Kolonia 20	Md		7352 (80); 3332 (2007-2010)	E (Baltic), Swf, Chf	Local, oriental	Production blanks and tools, use of tools	Seasonal hunting camp	2566 (2007–2010)	77.0	398 (2007–2010)	12.0	27 (2007–2010)	0.8	755 (80); 341 (2007–2010)	10.3 10.2	222 (stone slabs: 2007–2010)		Jastrzębski, Libera 1987; Wiśniewski *et al.* 2012
Kraków-Brzoskwinia, BII/75/1	Md		11,942	Jf, Chf, E, Rd	Local, oriental	Production of blanks	Workshop											Sobczyk 1993
Kraków-Brzoskwinia, BII/75/2	Md		22,705	Jf, Chf, E, Rd	Local, oriental	Production of blanks	Workshop											Sobczyk 1993

TABLE 1. Continued.

Site/layer	Cult. unit	Dating (uncalibrated)	*N*	Raw material	Supply	Manufacture	Activity	Flakes		Blades		Cores		Tools		Others		Source
								N	%	*N*	%	*N*	%	*N*	%	*N*	%	
Maszycka Cave	Md	15,155 ± 60 (KIA-39228)–14,855 ± 60 (KIA-39225)	289	Jf (A, B, D), Crf	Local, regional	Manufacture composite tools, use flints	Multifunctional camp, hearth, storage	91	31.5	97	33.9	13	4.5	59	20.4	29	10.2	Kozłowski *et al.* 1993
Podgrodzie 16	Md		3000	Chf, Swf, Rf	Local, regional, oriental ?	Production of blanks and tools, use of tools	Short term camp (?)											Przeździecki *et al.* 2011b
Wierzawice 31	Md	11,560 ± 40 (Poz-36901)	2600	E, Chf, Jf, Bf, Vf	Local, regional and others	Production of blanks and tools	Temporary camp	2600	96.0			16	1.0	74	> 3			Bobak *et al.* 2010
Wilczyce	Md	13,020 ± 60 (Poz-14891)–12,870 ± 60 (OxA-16729)	>50,000	Jf; Q	Local, oriental	Production of blanks, use of tools	Seasonal hunting camp (?)											Fiedorczuk, Schild 2002; Irish *et al.* 2008
Wołowice, T II/73	Md		6091	Jf	Local	Production of blanks	Workshop											Bańdo *et al.* 1992; Sobczyk 1993
Zalas Cave, Layer 7–9	Md		554	Jf	Local	Production of blanks	Workshop	504	91.0	28	5.5	13	2.3	9	1.6			Bocheński *et al.* 1985
Zalas Cave, Layer10–11	Md		107	Jf	Local	Production of blanks	Workshop	91	85.1	8	7.5	4	3.7	4	3.7			Bocheński *et al.* 1985

Unfortunately, the cave sites provided sparse and thus difficult to interpret traces. Secondly, stone artefacts were made mainly from local raw materials, with the addition in some cases of a certain amount of regional rocks (> 30 km) and rocks coming from distant places (*Table 1*). The latter were imported from the south or southeast. Their quantity is usually small, which rather indicates that on the analysed sites there were the discarded remains of old tool kits. Thirdly, the assemblages are similar in terms of the core preparation (e.g. a flat striking platform) and the form of the blade blanks in a different variety within the same unit (e.g. Targowisko 10). It is difficult to perceive in the remains of the blade production any standardisation attempt. Cores were often discarded at various stages of manufacture. A very wide range of artefacts was produced. The production debris is usually accompanied by tools representing the traditional spectrum of formal and expedient tools (e.g. Kozłowski, Sobczyk 1987, Sobczyk 1995, Wilczyński 2007, 2009). Data on the management of the raw materials seem to indicate a strategy of equipping individuals with tools, and sometimes cores and blanks (Wilczyński 2007). Taking into account the number of finds and the structure of the assemblages (including a few bone remains), the traces should be considered as the remnants of short-term camps. Some of them could be related with hunting, butchering practices, food preparation and even short rests. There were no traces of dwelling structures but occasionally hearths were evident. The size of the assemblages and the absence of a stratigraphical series indicate the very unstable character of the settlement. The existing traces can be interpreted in two ways. Probably, most of them are the remains of forays that were associated with hunting (reindeer, horse) and incidentally also with replenishing the stone raw material. Based on the oriental raw materials circulation (imported from distant sources), it can be assumed that the autumn and winter camps of this population were likely located on the inner side of the Carpathians (see, Kozłowski 2007). Whether the sites included to the so-called Kasovian, known from Slovakia and Moravia, are parts of the same system as the Polish finds (Kozłowski 1990, 1999, Svoboda 2007: 208, Svoboda, Novák 2004) remains, at the present stage of the research, an unanswered question. This scenario is suggested by southern raw materials (radiolarite, obsidian or limno-quartzite) found at Polish sites and vice versa, raw materials from the northern region at Slovak sites (Kozłowski 1992). In respect of typo-technological characteristics, the Polish assemblages are rather different from the finds from Germany, belonging to Badegoulian (Terberger, Street 2002). It cannot be ruled out that some of the Polish sites are the remains of eastwards migrations.

Taking this data under consideration, one should describe these activities rather as visits than as an occupation of the territory northwards from the Carpathians. It is also difficult to determine clearly what kind of mobility strategy could have then been preferred. Given the instability of the climate, a wide spread of food sources and probably a small demographic base, it can be speculated that the more efficient form was the foragers' strategy.

Data on the colonisation of the area northwards from the Carpathians and the Sudeten by Magdalenian communities have been at least doubled over the last decade (Połtowicz-Bobak 2009, for there further literature, see, Połtowicz-Bobak 2012). Hence, many sites await their monographs and that is the reason for some gaps in *Table 1*. Regardless of this, the number and quality of data is significantly larger than for the earlier period. Most of the remains are dated from GS-2b to GI-1b (see, for example, Bobak *et al.* 2013: Fig. 6). Only one site, Maszycka Cave, which determines the *Magdalénien à navettes* phase, is nearly 1000 years older than the others (Kozłowski *et al.* 1993, 2012).

A picture based on the current data indicates changes in the mobility strategies compared to the previous period. Magdalenian is known mainly from open-air sites (Połtowicz-Bobak 2012). Not too many traces come from caves. The exception is Maszycka Cave. It is not impossible though that remains were removed during the attempt to use caves in the Middle Ages and later. Locales occurred in mountainous areas, foothills, highlands and their northern edges.

The mobility strategy in this period can be determined by the distribution of rock raw materials. It is noticeable that a larger than before share of raw materials were transported from regional stone material supply areas as well as from sources located even more than a 100 km further away (e.g. Świeciechów flint – Podgrodzie 16; Jurassic flint – Grzybowa Góra). It should be noted that, in contrast to the previous period, there is a perceptible tendency to supply both individuals as well as places. The latter ones manifest themselves in areas of larger sites formed as a result of repeat visits, which can be interpreted according to Street *et al.* (in press) as aggradation camps: Dzierżysław 35; Klementowice-Kolonia; Ćmielów (Mały Gawroniec) (Ginter *et al.* 2005, Przeździecki *et al.* 2011b, Wiśniewski *et al.* 2012). It is possible that the other structures were sometimes supplied in the same way (Fiedorczuk, Schild 2002, Irish *et al.* 2008). The combined equipment of individuals/places in turn could be prepared in places that acted as special task camps: Wierzawice (Bobak *et al.* 2010). Specific places of activity related logistically with hunting activity or activity in base camps were workshops situated in outcrops: Kraków-Brzoskwinia or Wołowice (Sobczyk 1993). Certainly, some of these sites were visited many times. We omit here the possibility of individual long distance excursions, which for example, may be indicated by quartzites found in Wilczyce (Irish *et al.* 2008).

Flint production also has links with mobility strategy. In aggradation camps there are traces of semi-sedentary technology. Raw material, sometimes collected in special storage places, was transformed into expedient or formal tools (e.g. Dzierżysław 35; Ginter *et al.* 2005 and presumably Ćmielów (Mały Antoniów); Przeździecki *et al.* 2011b). In the remains of special task camps, the traces of the production or "rejuvenation" of formal tools dominates instead (Wierzawice; Bobak *et al.* 2010). In workshops the traces of blank and core manufacture to take away dominate. The production of formal tools from blades or bladelets was, like in the western part of the Magdalenian ecumene, highly standardised because of the widespread occurrence of, for example, composite hunting weapon as sagaies (Kozłowski *et al.* 1993).

Data on the settlement dynamics and structures indicate the possibility of the operation (at least for some time) of the logistic strategy in home base camps and special task camps. Due to the still incoming data on new Magdalenian sites and because work on many others is not finished, it is difficult at present to answer the question concerning the cultural border of the Magdalenian complex (Połtowicz-Bobak 2012). In the light of new data on mobility strategy, that border is determined by a cluster of sites in the area of the Sandomierz Highland and the Moravian Gate and its foreground. In the past, it was believed that traces from the Lesser Poland region resulted from small-scale activity aimed at obtaining stone raw materials that were to be transported to refugia located, for example, in Moravia (Bocheński *et al.* 1985: 49). The lack of evidence for such transport has already been pointed out, because in Moravian caves only a small amount of Jurassic flint semi-products were discovered (see, Sobczyk 1993: 69, Valoch 2001: 123–125). The current state of research confirms that under favourable interstadial conditions in highland areas, refugia with logistic strategies may have appeared. Some traces indicate that the Magdalenian population could have remained hunting on the northern edges of the highlands region in autumn. In Klementowice-Kolonia, the slaughter of horses occurred in the late summer or early autumn (Wiśniewski *et al.* 2012: 319). In addition, the structure of sites like Klementowice, Dzierżysław or Ćmielów (Mały Antoniów) allows us to assume that we are dealing with the remains of settlement structures lasting at least several weeks and recurring.

MATERIALS AND METHODS

We are going to discuss this key issue based on artefacts from the first two seasons of excavations of Sowin 7 carried out by M. Furmanek and A. Rapiński (Furmanek *et al.* 2001). The site was comprised of two cultural horizons. The lower cultural horizon (Epigravettian) was recognised in the top layer of sands and silts. The remains are represented in the form of lithic artefacts. 476 artefacts were found during the excavation seasons described in this paper.

The upper cultural horizon (Magdalenian) is related with the top layer of sands. The lithic artefacts were also deposited in modern soils developed on these sediments. Although this level had to be affected by slope processes and modern farming, in the first seasons some clusters were found. 4284 artefacts were recovered in the seasons 2000–2001.

The products were classified using typological classification, and then basic measurements of the cores and blades using a digital calliper were made. For the basic calculation, the STATISTICA 10 package was used.

To assess the site area's raw material potential, we used a method involving the examination of the quantity and quality of the rocks within the equally sized surface probing trenches. This method was used for the first time in Central Europe by C. Pasda (1996). An area of 1.14 ha was selected for testing. It was a field where the topsoil is a residue of pebbles and erratic flint chunks. Probing trenches were selected by sampling using the ArcGIS software. Seven sites were selected of which five were analysed. At these points, the probing trenches of 1 m^2 area were set. Every metre was explored to the bottom of the residue which had pebbles of rocks. We selected rocks fractions over 3 cm. The material was analysed for petrographic and metric (the largest diameter) diversity. The analysis was carried out by one of the authors (MB). The results are presented in some histograms.

RESULTS

Stratigraphy

The artefacts of the lower horizon, which we call the Epigravettian, were located within the top of sands and silt cemented by a ferruginous substance. These deposits result from the washing of the top deposits of glacial origin. The precise chronology of the artefacts is an open question. However, we believe that the products of the lower horizon are younger than the pessimum of the late Pleniglacial (MIS2). This assumption is based on the fact that these artefacts were not found in the loess or under the loess, which appeared to the north of the site. It is a well-known fact that these loess deposits in southern Poland accumulated during the pessimum of the late Pleniglacial (the so-called Leszno-Brandenburg Phase) of the last glaciation (Jary 2009). The horizon consists of lithic artefacts. There was also scattered charcoal. The lithic artefacts are very well preserved and without patinas. Some of them create tool refittings in form of burins and burin spalls. Refittings linked with core reduction are rare (*Figure 2:6*). We believe that the artefacts were found on the spot of human activity. The artefacts occurred in clusters or were scattered. The cluster in trench I/2001 was quite large and had a diameter of about 6 m. It is worth mentioning that artefacts in this horizon were also numerous in trenches excavated in 2002 and 2012.

The upper cultural horizon represented by Magdalenian artefacts was found in the top layer of aeolian sands and in the modern soil. The level of sands was altered due to solifluction, frost contraction and by farming. Some artefacts were moved within the vertical cracks. Based on techno-typological analogies these artefacts can be linked to assemblages dating from GS-2b to GI-1c (Bobak *et al.* 2013). The horizon is represented by clearly perceptible artefact clusters. The detailed analysis of artefacts provided for numerous refittings. The refitted blocks are represented by cores, blanks and debris (*Figure 2:1–3*). It is worth mentioning that in the other parts of the site (seasons 2002–2005, 2009 and 2012) much more Magdalenian artefacts were discovered. They are currently under examination.

The structure of the assemblages, technology and activity

The structure and size of assemblages represented two horizons is different due to the different activities of hunters and gatherers. In both horizons the siliceous rock, commonly called erratic flint was used for tool manufacturing. Only hammerstones and supposed anvils were made of other rocks (*Table 2*).

TABLE 2. Diversity of raw material at the Sowin 7 site.

	Lower horizon		Upper horizon	
Raw material	*N*	%	*N*	%
Erratic flint	435	99.77	4275	99.79
Quartzite	1	0.23		
Schist			7	0.16
Sandstone			1	0.02
Others			1	0.02
Total	436	100.00	4284	100.00

TABLE 3. Typological diversity at the Sowin 7 site.

	Lower horizon		Upper horizon	
Category	*N*	%	*N*	%
Chunks/Nodules	6	1.38	100	2.33
Cores	9	2.06	32	0.75
Flakes	202	46.33	3206	74.84
Blades	83	19.04	576	13.45
Tools	57	13.07	67	1.56
Others	79	18.12	303	7.07
Total	436	100.00	4284	100.00

TABLE 4. Flint cores, pre-cores and chunks/nodules at the Sowin site 7.

	Lower horizon		Upper horizon	
Category	*N*	%	*N*	%
Chunks/Nodules	6	40.00	100	76.34
Pre-cores	2	13.33	5	3.82
Initial cores	1	6.67	1	0.76
Flake cores	2	13.33		
Blade cores	3	20.00	17	12.98
Exploited forms	1	6.67		
Others			9	6.87
Total	15	100.00	131	100.00

In the group of Epigravettian horizon artefacts, the quartering waste in the form of individual nodules, pre-cores, exploited cores, blades and flakes dominates (*Table 3*). Cores and their fragments contain traces of the pre-flaking surface, sides and striking platforms. Both flake and blade cores occurred (*Table 4*). The blade cores show a unidirectional strategy of obtaining blanks.

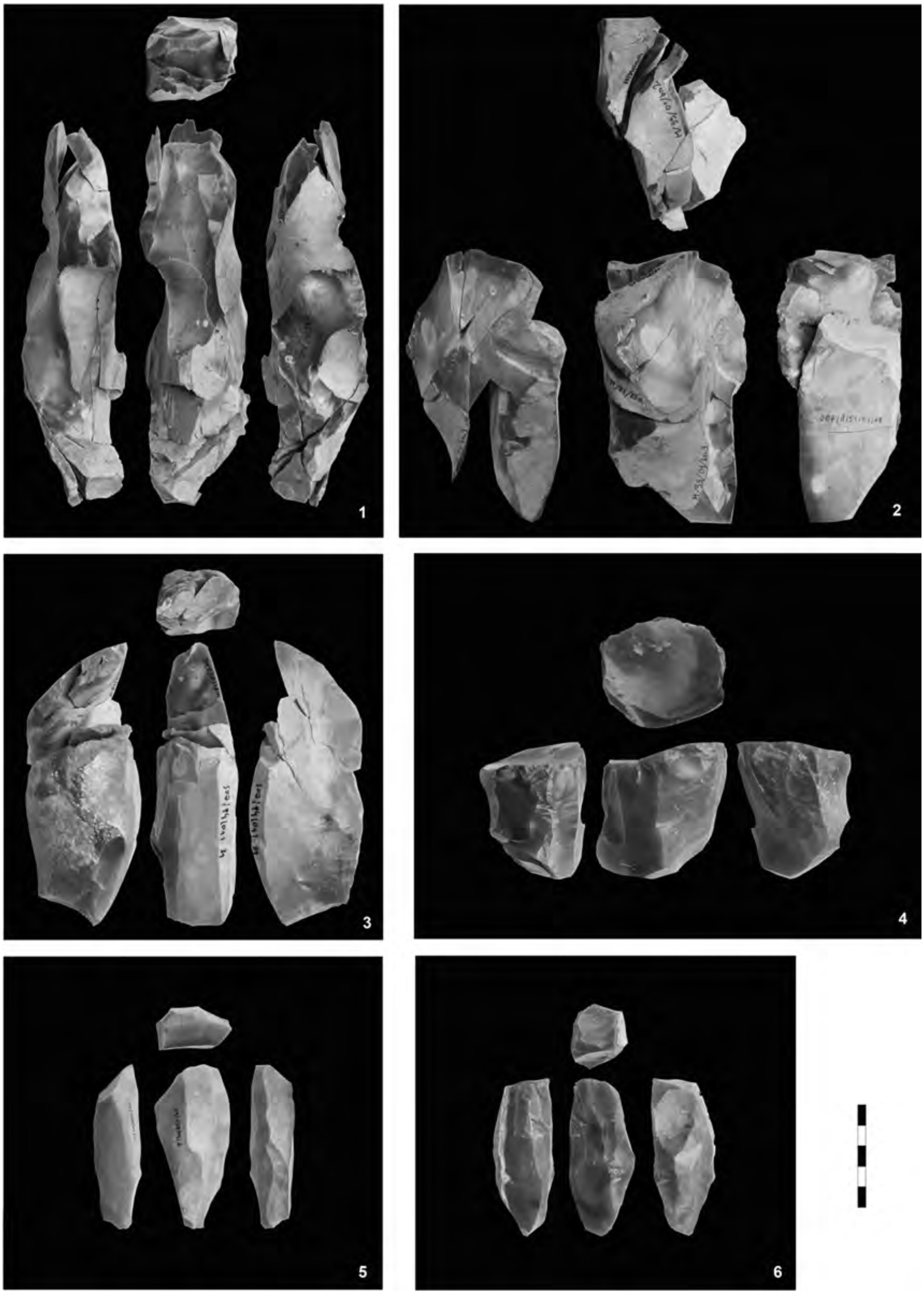

FIGURE 2. Flint cores and refittings from the Sowin 7. 1–3, partial reconstruction of flint nodules based on conjoined flakes and cores, Magdalenian horizon; 4–6, cores with single refitted flakes, Epigravettian horizon.

Flaking surfaces at the stage of advanced reduction are rounded. The cores' striking platforms were prepared by single blows (*Figure 2:5–6*). The edges of the striking platforms show traces of abrasion. These features link the cores with the Gravettian technological environment (Płonka, Wiśniewski 2004). The blades' butts are flat. Blades are visibly curved at the distal ends.

A relatively large number of retouched tools (approximately 13%, *Table 3*) were noticeable in the lower horizon. It indicates that the archaeological excavation uncovered a place of their production and use. Among the tools, various types of burins are dominant. The majority of them were made of flakes or massive blades. Traces of contact with hard, medium-hard and soft organic materials (B. Kufel-Diakowska personal communication) were identified on their surfaces. It may be suggested that they were used for the processing of bone or wood and leather. Amongst the tools, forms of curved backed pieces were also more numerous (*Table 5*).

Based on the available data, a simplified scenario of the activity that led to the formation of the lower horizon can be put forward. Probably, parts of composite tools in the form of backed bladelets were brought to this place and then left there. It is likely that core reduction was undertaken as well as blades being made in this place, and during their production a series of flakes were formed. A large portion of the blades were transported away from the area covered by the excavations, because it was not possible to perform refittings. Burins were made from flakes and single blades. They were discarded after use. Generally, the data point to very dynamic activity that involved discarding previously made tools, the on site production and use of expedient tools as well as the transfer of the cores and blades as formal objects to the outside.

TABLE 5. Typology of retouched tools from the lower horizon of the Sowin 7 site.

Group	Category	*N*	%
Endscrapers	Others	2	4
Burins	Dihedral déjeté	7	12
	On truncation	7	12
	On broken end	1	2
	Single blow	7	12
	Others	8	14
Backed bladelet	Straight and curved backed bladelets	7	12
Retouched flakes, blades and bladelets	With one edge retouched /continuous/	8	14
	With edge retouched /partial/	6	11
Others	Others tools (side-scrapers, chopping tools etc)	1	2
	Fragments of undetermined	3	5
Total		57	100

The Magdalenian horizon assemblage differs from the Epigravettian one. Firstly, it is more numerous which may mean that it was created as a result of several visits (*Table 3*). Cores in this assemblage could have passed the pre-cores and the test phase. Among the cores showing signs of advanced reduction only blade core forms occurred, mostly with a single striking platform (and less frequently with a double striking platform), indicating a very narrow range of production (*Table 4*). The cores bear traces of classic preparation covering the pre-flaking surface, sides, back parts and also pre-striking platform (*Figure 2:1–3*). Forms of narrow surface flaking cores and ones with rounded flaking surfaces appear among the remains. The cores' striking platforms have marks forming their passive and active parts, whose purpose was to isolate the point of percussion. Cores are accompanied by debitage and part of the blade products that were not transferred from the site. Blades have classic spur butts (*en éperon*, e.g. Inizan 1999: 134, Fig. 62: 8, Surmely, Alix 2005). Blade blanks are slightly curved. The assemblage contains statistically a small number of retouched tools, dominated by burins (including single Lacan type), backed bladelets as well as retouched blades and flakes (*Table 6*).

The manner of activity in the area occupied by Magdalenian group(s) consisted of bringing raw material, which had probably been partially tested, for on the spot intensive cores reduction, which led mainly to the making of blades, and perhaps, ready-made core production. A small number of the tools, mainly the expedient ones could have been involved in secondary activities.

To summarise, we are dealing with fragments of assemblages representing different periods, different complexes of mental patterns and different settlement dynamics. It is interesting whether the patterns and particularly the settlement dynamics could have affected any other way of using the raw material originating from the same resource?

An attempt to assess the quantity and quality of the raw material in the lower and upper horizons

The evaluation of raw material used for blanks and tool manufacturing in both horizons was based on the

TABLE 6. Typology of retouched tools from the upper horizon of the Sowin 7 site.

Group	Category	*N*	%
Endscrapers	Others	2	3
Burins	Dihedral median	1	1
	Dihedral *déjeté*	1	1
	On truncation	2	3
	A transversal break	2	3
	On unretouched end	5	7
Perforaters	Others	2	3
Backed bladelet	Straight and curved backed bladelets	1	1
	Back with partial retouch	1	1
	Fragments	7	10
Truncated pieces	Double	1	1
	With transversal straight or arched truncation	1	1
	With oblique truncation (< 60°)	1	1
	Others	2	3
Raclettes		1	1
Retouched flakes, blades and bladelets	Small retouched flak es	5	7
	With denticulated retouch	2	3
	With one edge retouched /continuous/	4	6
	With edge retouched /partial/	7	10
Others	Core-axe tool etc.	2	3
	Others tools (side-scrapers, chopping tools etc.)	3	4
	Fragments of undetermined	14	21
Total		67	100

characteristics of pre-cores, cores and blade products. It should be noted that in the lower horizon a smaller number of artefacts appear, therefore, the data are not as reliable as for the upper horizon.

The lower horizon

Based on a sample of pre-cores it can be concluded that they were rather small in size (*Table 7*). The pre-cores are up to 100 mm in length. The average length of the cores instead is only 68 mm. It is noticeable that the raw material bears signs of frost fractures and consisted of fragments of naturally separated nodules. In most cases blades are represented by fragments. Based on the few fully preserved specimens it can be established that their length did not exceed 99 mm. Despite the small sample size, it is evident that the nodules, cores and blades' sizes are not impressive.

The upper horizon

The discarded pre-cores have an average length of 88 mm, which makes them slightly larger than the ones from the lower horizon. Cores in turn have an average length of 99 mm. In the case of the Magdalenian ones, it was possible to reconstruct several refit blocks consisting of cores and other debitage elements. Fragments or almost complete flint nodules are from nearly 13 cm to 25 cm in length. Reconstructed nodules have a cortex and only rare traces of mechanical fractures. Blades, like those in the lower level are heavily fragmented. The average length of intact forms is about 77 mm but the largest are up to 130 mm long. These data indicate a distinct advantage in volume and measurements of the nodules used by the Magdalenian population compared to the Epigravettian ones.

TABLE 7. Mean of measurements of flint cores from upper and lower horizon at the Sowin 7 site.

	Lower horizon				Upper horizon					
Measurement	*N*	Mean (mm)	SD	SE	*N*	Mean (mm)	SD	SE	*P*-value (Levene test)	*P*-value (two-tailed)
Length	3	68.3	13.1	7.5	13	99.4	22.2	6.2	0.268	0.038
Width	3	42.6	12.9	7.5	13	40.6	9.4	2.6	0.471	0.759
Thickness	3	32.2	14.1	8.1	13	51.6	10.5	2.9	0.561	0.160

SD, standard deviation; SE, standard error of the mean.

Comparison of cores from the archaeological horizons

Taking into account the basic measurements of the cores from the upper and lower a difference in average length is noticeable. The average length of the Magdalenian cores is much greater than the average length of the Epigravettian ones. A Student's *t*-test for independent samples was performed (*Table 7*). Its results show that the difference in average length can be considered as an essential feature ($P < 0.05$). In contrast, the width and thickness of cores from both levels did not differ significantly ($P > 0.05$). The comparison shows that the average Epigravettian cores were approximately 30 mm smaller when they were discarded.

Assessment of the resource base on the probing field

The area of the theoretical resource base is located in a place where cobble clasts occur on the surface of modern topsoil, as result of the erosion of the glacial tills of the Oder glaciation (MIS6) (Badura, Przybylski 2001: 18–19, Lewandowski 1988, Salamon 2012). Generally, in the rock material collected in different probing trenches a significant share of quartz is evident, which dominates in finer fractions (more than 50% of particles in the fraction of 3–5 cm; *Figures 3, 4a*). This is considered a typical feature of glacial tills in the eastern Sudeten foothills (Badura, Przybylski 1996: 16). The share of crystalline rocks of undetermined origin, mainly

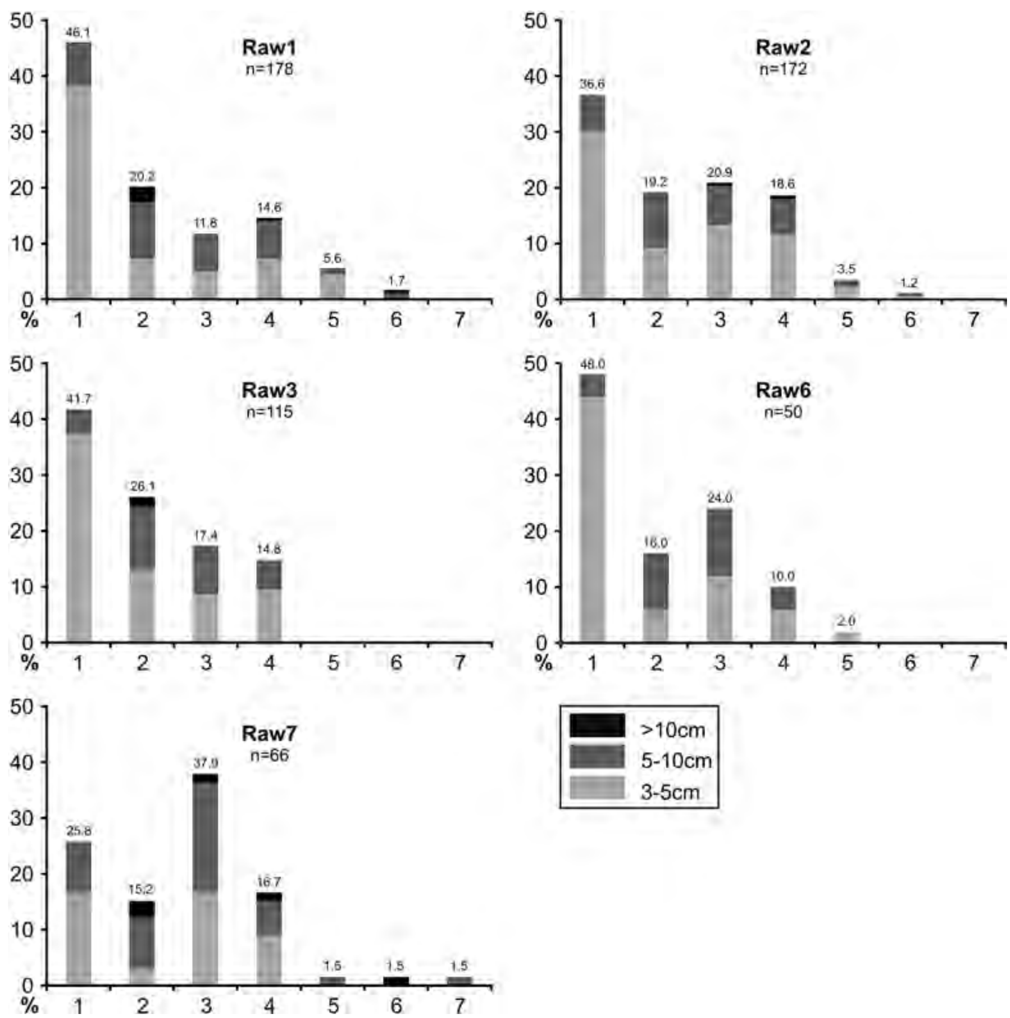

FIGURE 3. Raw material composition in probing trenches close to the Sowin site 7. Number of raw material per size of clasts: 1, quartz (with minor amounts of strongly recrystallised quartzites); 2, various igneous and metamorphic rocks (granitoids, rhyolitoids, gabbroids, amphibolites, gneisses) of indeterminate origin; 3, flint; 4, sandstones; 5, lydite; 6, basalt; 7, limestone.

granitoids, clearly increases along with the size of grains (13% in the fraction of 3–5 cm, 56% in the fraction larger than 10 cm). Basalts (about 1% of all grains) probably represent the tertiary volcanic rocks occurring just a few kilometres from the site.

The most interesting feature is, however, the share of erratics. The lowest percentage share of flint was recorded in the rock material from the probing trench Raw1 (12% of the grains; *Figure 3*). The highest content of flint was instead found in the probing trench Raw7 (38% of the grains) in which the coarsest sediment appeared. In the majority of trenches, the amount of flint grains in fractions of 3 to 5 cm and of 5–10 cm was similar (Raw3, Raw6) or grains which belonged to the fraction of 5–10 cm were slightly more numerous (Raw1, Raw7). Flint grains belonging to the fraction of 3–5 cm were definitely only the most numerous in probing trench Raw2 (64% flint grains in this trench). The presence of several flint grains larger than 10 cm was recorded only in trenches Raw7 and Raw2.

The general share of flint in the total sample was 20% of the grains. The largest percentage of this component was found among the fractions of 5–10 cm (27% of the grains; *Figure 4b*). Significantly, a lower amount of flint grains was recorded in fractions of 3–5 cm (16% of the grains) and more than 10 cm (13% of the grains). Due to the sediment granulometry (the prevalence of fractions of 3–5 cm, 64% of the grains) in the given sample, the amount of flint grains of 3–5 cm was slightly larger than flint grains of 5–10 cm though.

DISCUSSION AND CONCLUSION

It is essential to assess the manner of the raw material supply of both the Magdalenian and Epigravettian communities. It would enable us to try to determine their mobility strategies. We will use the results of the analysis of artefacts and rock material samples from the probing field.

Based on the comparison of average cores' sizes as well as sizes of the refitted blocks with the sizes of the erratic flint nodules from the probing field, it can be concluded that the requirements of Epigravettian hunters allowed them to supply the proper raw material without any limitations. The Epigravettian debitage material fits within the flint fractions from the probing field. Collection of this fraction probably did not require much time.

The Magdalenian hunter in turn, to meet his needs had to use a much larger area than the probing field. This was associated with greater effort, of course, and was more time-consuming. This assumption is based on the dimensions of the cores, as well as the refits. As was mentioned above, it enabled us to determine that the fraction of flints selected by the Magdalenian population could have ranged from 13 to 25 cm. In samples from the probing field, flint fractions larger than 15 cm are not represented at all.

Taking into account the manner of raw material selection and the method of its processing (reduction), it may be stated that on Sowin 7 we are dealing with

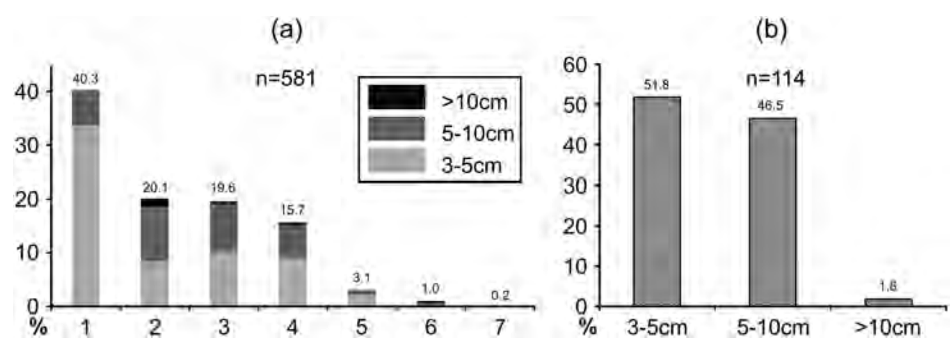

FIGURE 4. General composition of raw material in Sowin based on samples from five trenches (see, *Figure 3*). (a) Number of raw material per size of clasts. 1, quartz (with minor amounts of strongly recrystallised quartzites); 2, various igneous and metamorphic rocks (granitoids, rhyolitoids, gabbroids, amphibolites, gneisses) of indeterminate origin; 3, flint; 4, sandstones; 5, lydite; 6, basalt; 7, limestone. (b) Number of flints per size of clasts.

TABLE 8. Assessment of technical behaviour concerning provision and consumption of flint raw material at Sowin site 7.

Basic features	Lower horizon	Upper horizon
Preferences	Changeable	Standing
Requirements/ Needs	According to the average of source	Above the average of source due to specific criteria
Time of supplying	Short	Longer
Operation on cores	Basic Upper Palaeolithic mode	Extended system of core preparation
Techno-diversity of blanks and debris	Great	Narrow
Production to take away	Yes	Yes
Consumption of the artefacts on the spot	Significant	Minor
Type of provisioning	Individuals	Places and individuals

remains of two different strategies (*Table 8*). The Epigravettian population spent less time seeking raw material and what they obtained was more varied in size and of lower quality. During the core reduction, both formal and expedient methods were applied. Some cores contain natural striking platforms. Amongst the tools, a division into formal and expedient tools is also evident. The Epigravettian assemblage is therefore more diverse than the Magdalenian one. It was probably linked to the greater flexibility of the production system and a different range of tasks. Some of these tasks were associated with blades and blade tools' production, while the other with the on the spot production and the use of variety of tools of the burin type. Considering all this, it seems that the production was intended to provision individuals (Kuhn 1995) for the duration of their activity in the Sowin area and for the distant future.

Magdalenian hunters meticulously selected raw material taking into account the size (length) of the nodules, and probably their shape and quality. This was due to their purpose, which was primarily the production of a series of relatively long and properly wide blades, designed to be transported (see, remarks of Valentin 2008: 7). Cores might have been also transferred. In this assemblage, unlike in the Epigravettian one, formal cores dominate. The narrow range of tasks limited to portable production was implemented by classic core reduction under the precise control of the shape and striking platform inclination. In the assemblage a small percentage of tools occur that do not seem to be designed to be transferred but served as auxiliary tools, for example to repair an individual hunter's equipment. Considering the high degree of homogeneity of the waste, it may be assumed that the production was designed to provide products that were transported to seasonal camps. Of course, the remains of camps with a large number of expedient tools, damaged formal tools as well as raw material or core caches are to be found in destination places located probably to the south of Sowin (e.g. Dzierżysław 35).

Let us consider whether the characteristic activities of hunters and gatherers from Sowin 7, and more precisely the patterns of the supply and treatment of raw materials, have analogies at other sites to the north of the Carpathians and are linked to the same chronological and cultural horizons. If there are similarities in this respect, it may mean that the manner of acquisition and the treatment of the raw material under unlimited conditions was subjected to some well-established customs, which in this case can be considered as elements of a cultural-adaptive system. If not, it will mean that the manner of acquisition and the mobility strategies were very loosely linked and were not subject to any cultural and environmental rules.

The lower level in our opinion corresponds quite well to the finds from sites Piekary IIa and Kraków, Spadzista street B + B1, layer 5. The similarity manifests itself in the use of a limited selection of raw material and poor preparation of cores as well as the size of blade blanks. For example, the average size of blades at the Piekary IIa site, layer 5, was 47 mm (Wilczyński 2006). At the Targowisko site, in turn, the blades' length did not exceed 100 mm (Wilczyński 2009). It is also noticeable that the similarity of the profile of production was designed to be transferred and there was a wide spectrum of activity within relatively small assemblages (see, *Table 1*). All of this indicates activities under the foragers' strategy. It seems that the mobility of a residential type creates a practical method for the recolonisation of Central European highlands after the LGM climate crisis.

The upper level, in turn, contains a number of features in common with Magdalenian sites. These are the remains of repeated visits whose purpose was the manufacture of blade blanks, including hunting weapons. The similarity manifests itself in the raw material selection. In assemblages from Brzoskwinia and Wołowice, analysed by K. Sobczyk (1993: 20) the maximum length of Jurassic flint nodules ranges from

139 to 193 mm, while the minimum from 42 to 62 mm. The length of blanks (despite the different materials) also seems to be very similar to the products from the upper horizon at the Sowin 7 site. At the Brzoskwinia site, complete blades without a cortex in cluster 1 had a maximum length of 67 mm, and in cluster 2, 97 mm (Sobczyk 1993: 46–47). In Wołowice, in turn, the maximum length of blades without a cortex was 93 mm (Sobczyk 1993: 48). Sites like Podgrodzie 16, Kraków Brzoskwinia or Wołowice show many similarities in terms of a narrow production profile with a relatively small proportion of retouched tools. It also appears that they resulted from a well-established land exploitation system, which could have taken the form of the logistic and sometimes the residential strategy.

Taking into account these data and the results of their analysis, it appears that the remains from Sowin 7 reflect raw material resource management strategy at the turn of GS-2 and GI-1, which is a response to the prevailing mobility strategy: 1. the unstable Epigravettian highlands exploitation system with settlement centres located on the inner side of the Carpathians; 2. the complex Magdalenian system with the remains of several residential camps on the line or to the north of the Carpathians and Sudetes.

ACKNOWLEDGEMENTS

We are indebted to Maksym Mackiewicz, Anna Mikołajczyk and Arkadiusz Sałata for their help in the graphics preparation. Special thanks to Darek Bobak, Tomasz Płonka and Katarzyna Pyżewicz for valuable information. Helpful comments from a reviewer are also acknowledged.

REFERENCES

ALEXANDROWICZ S. W., DROBNIEWICZ B., GINTER B., KOZŁOWSKI J. K., MADEYSKA T., NADACHOWSKI A., PAWLIKOWSKI M., SOBCZYK K., SZYNDLAR Z., WOLSAN M., 1992: Excavations in the Zawalona Cave at Mników (Cracow Upland, southern Poland). *Folia Quaternaria* 63: 43–77.

ANDREFSKY W. JR., 2005: *Lithics. Macroscopic approaches to analysis*. Second edition. Cambridge University Press, Cambridge.

BADURA J., PRZYBYLSKI B., 1996: Analiza petrograficzna glin lodowcowych południowo-wschodniej części Dolnego Śląska. *Acta Universitas Wratislaviensis*, *Prace Instytutu Geograficznego, seria A* 8: 5–26.

BADURA J., PRZYBYLSKI B., 2001: *Objaśnienia do szczegółowej mapy geologicznej Polski 1:50000 – arkusz Niemodlin*. Państwowy Instytut Geologiczny, Warszawa.

BAŃDO C., DAGAN-GINTER A., HOLEN S., KOZŁOWSKI J. K., MONTET-WHITE A., PAWLIKOWSKI M., SOBCZYK K., 1992: Wołowice. Province of Krakow. Flint extraction and processing site. In: J. K. Kozłowski, J. Śliwa (Eds.): *Recherches Archéologiques*. Pp. 5–25. Kraków.

BINFORD L. R., 1980: Willow smoke and dogs' tails: hunter-gatherer settlement systems and archaeological site formation. *American Antiquity* 45: 4–20.

BLEED P., 1986: The optimal design of hunting weapons: maintainability or reliability. *American Antiquity* 51: 737–747.

BOBAK D., ŁANCZONT M., NOWAK A., POŁTOWICZ-BOBAK M., TOKARCZYK S., 2010: Wierzawice, st. 31 – nowy ślad osadnictwa magdaleńskiego w Polsce południowo-wschodniej. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 31: 63–78.

BOBAK D., PŁONKA T., POŁTOWICZ-BOBAK M., WIŚNIEWSKI A., 2013: New chronological data for Weichselian sites from Poland and their implications for Palaeolithic. *Quatuernary International* 296: 23–36.

BOCHEŃSKI A., GINTER B., KOZŁOWSKI J. K., MOOK W. G., MUSZYŃSKI M., NADACHOWSKI A., STWORZEWICZ E., SZYNDLAR Z., 1985: Badania osadów schronisk podskalnych w Zalasie koło Krakowa. In: Studia nad czwartorzędem Polski południowej. *Folia Quaternaria* 56: 3–56.

BOUSMAN C. B., 1993: Hunter-gatherer adaptations, economic risk and tool design. *Lithic Technology* 18: 59–86.

CYREK K., NADACHOWSKI A., MADEYSKA T., BOCHENSKI Z., TOMEK T., WOJTAL P., MIEKINIA B., LIPECKI G., GARAPICH A., RZEBIK-KOWALSKA B., STWORZEWICZ E., WOLSAN M., GODAWA J., KOSCIÓW R., FOSTOWICZ-FRELIK L., SZYNDLAR Z., 2000: Excavation in the Deszczowa Cave (Kroczyckie Rocks, Częstochowa Upland, Central Poland). *Folia Quaternaria* 71: 56–75.

FIEDORCZUK J., SCHILD R., 2002: Wilczyce – a new Late Magdalenian site In Poland. In: B. V. Eriksen, B. Bratlund (Eds.): *Recent studies in the final Palaeolithic of the European Plain.* Pp. 91–100. Jutland Archaeological Society, Aarhus.

FURMANEK M., MOLENDA G., RAPIŃSKI A., 2001: Wstępne wyniki badań na stanowisku schyłkowopaleolitycznym w Sowinie, pow. Niemodlin w roku 2000. *Śląskie Sprawozdania Archeologiczne* 43: 485–490.

FURMANEK M., WIŚNIEWSKI A., GEDIGA K., JARY Z., LISA L., PISZCZ U., SKRZYPEK G., 2011: "Odkryć niewidoczne". Wybrane zagadnienia z geoarcheologii Śląska. In: A. Żelaźniewicz, J. Wojewoda, W. Ciężkowski (Eds.): *Mezozoik i kenozoik Dolnego Śląska*. Pp. 159–168. Wrocław, WIND.

GINTER B., 1974: Spätpaläolithikum in Oberschlesien und im Flussgebiet der oberen Warta. In: *Prace Archeologiczne* 17. Uniwersytet Jagielloński, Kraków.

GINTER B., POŁTOWICZ M., 2010: Magdalenian with triangles in Central Europe. In: M. Połtowicz-Bobak, D. Bobak (Eds.): *The Magdalenian in Central Europe. New Finds and*

Concepts. Pp. 23–34. Fundacja Rzeszowskiego Ośrodka Archeologicznego, Instytut Archeologii Uniwersytetu Rzeszowskiego, SKAM – Flintreaders Society, Rzeszów.

GINTER B., POŁTOWICZ M., PAWLIKOWSKI M., SKIBA S., TRĄBSKA J., WACNIK A., WINIARSKA-KABACIŃSKA M., WOJTAL P., 2002: Dzierżysław 35, stanowisko magdaleńskie na przedpolu Bramy Morawskiej. In: J. Gancarski (Ed.): *Starsza i środkowa epoka kamienia w Karpatach polskich*. Pp. 111–145. Muzeum Podkarpackie w Krośnie, Krosno.

GINTER B., POŁTOWICZ M., PAWLIKOWSKI M., SKIBA S., TRĄBSKA J., WACNIK A., WINIARSKA-KABACIŃSKA M., WOJTAL P., 2005: Dzierżysław (Dirschel) 35 ein neuer Fundplatz des Magdalénien in Oberschlesien. *Archäologisches Korrespondenzblatt* 35: 431–446.

GRAF K. E., 2010: Hunter–gatherer dispersals in the mammoth-steppe: technological provisioning and land-use in the Enisei River valley, south-central Siberia. *Journal of Archaeological Science* 37: 210–223.

INIZAN M. L., REDURON-BALLINGER M., ROCHE H., TIXIER J., 1999: *Technology and terminology of knapped stone*. CREP, Nanterre.

IRISH J. D., BRATLUND B., SCHILD R., KOLSTRUP E., KRÓLIK H., MAŃKA D., BOROŃ T., 2008: A late Magdalenian perinatal skeleton from Wilczyce, Poland. *Journal of Human Evolution* 55, 4: 736–740.

JARY Z., 2009: Periglacial markers within the Late Pleistocene loess–palaeosol sequences in Poland and Western Ukraine. *Quaternary International* 198: 124–135.

JASTRZĘBSKI S., LIBERA J., 1987: Stanowisko późno-magdaleńskie w Klementowicach-Kolonii w świetle badań 1981–1982 r. *Sprawozdania Archeologiczne* 39: 9–52.

KELLY R. L., 1983: Hunter-gatherer mobility strategies. *Journal of Antropological Research* 39, 3: 277–306.

KELLY R. L., 1995: *The foraging spectrum. Diversity in hunter-gatherer lifeways*. Smithsonian Institution Press, Washington and London.

KOZŁOWSKI J. K., 1964: *Paleolit na Górnym Śląsku. Prace Komisji Archeologicznej 5.* Ossolineum, Wrocław–Warszawa.

KOZŁOWSKI J. K., 1990: Northern Central Europe c. 18,000 B.P. In : O. Soffer, C. Gamble (Eds.) : *The world at 18 000 BP, vol. 1, High Latitudes*. Pp. 204–227. Univ. Hyman, London.

KOZŁOWSKI J. K., 1992 : Le Paléolithique des Carpates occidentale. *Prehistoria Alpina* 28: 113–126.

KOZŁOWSKI J. K., 1999: Les origines de la récolonisation de la partie septentrionale de l'Europe Centrale après le pléniglaciaire. In : M. Kobusiewicz, J. K. Kozłowski (Eds.): Post-pleniglacial re-colonisation of the Great European Lowland. *Folia Quaternaria* 70: 317–331.

KOZŁOWSKI J. K., 2007: Le Gravettien du nord des Carpathes et des Sudètes. *Paleo* 19/2007: 221–241.

KOZŁOWSKI S. K., POŁTOWICZ-BOBAK M., BOBAK D., TERBERGER T., 2012: New information from Maszycka Cave and the Late Glacial recolonisation of Central Europe. *Quaternary International* 272–273: 288–296.

KOZŁOWSKI S. K., SACHSE-KOZŁOWSKA E., MARSHACK A., MADEYSKA T., KIERDORF H., LASOTA-MOSKALEW-SKA A., JAKUBOWSKI G., WINIARSKA- KABACIŃSKA M., KAPICA, Z., WIERCIŃSKI, A., 1993: Maszycka Cave. A Magdalenian Site in Southern Poland. *Jahrbuch des Römisch-Germanischen Zentralmuseums* 40: 115–252.

KOZŁOWSKI J. K., SOBCZYK K., 1987: The Upper Palaeolithic site Krakow-Spadzista street C2. Excavations 1980. *Prace Archeologiczne* 42: 1–84.

KREBS J. R., DAVIES N. B., 2001: *An introduction to behavioral ecology*. (in Polish). PWN, Warszawa.

KUHN S. L., 1995: *Mousterian lithic technology. An ecological perspective*. Princeton University Press, Princeton, New York.

KURTZ H., 1930: Die Funde der älteren und mittleren Steinzeit aus dem Falkenberger Kreise. In: S. L. Heege (Ed.): *Heimatkalender des Kreises Falkenberg*. Pp. 57–71. Schweidnitz.

LEWANDOWSKI J., 1988: Plejstocen środkowy w strefie doliny górnej Odry: Brama Morawska – Kotlina Raciborska (próba syntezy). *Przegląd Geologiczny* 424, 8: 465–472.

PASDA C., 1996: Silexverbreitung am Rohamaterialvorkommen im Mittelpleistozän. Ergebnisse einer Rettungsgrabung in Zwochau (Ldkr. Delitzsch). *Arbeits-und Forschungsberichte zur Sächsischen Bodendenkmalpflege* 38: 13–55.

PŁONKA T., WIŚNIEWSKI A., 2004: A new Gravettian site in Lower Silesia. In: J. A. Svoboda, L. Sedláčková (Eds.): *The Gravettian along the Danube, Proceedings of the Mikulov Conference, November 2002*. Pp. 164–179. Archeologický ústav Akademie věd ČR, Brno.

POŁTOWICZ-BOBAK M., 2009: Magdalenian settlement in Poland in the light of recent research. In: M. Street, N. Barton, T. Terberger (Eds.): *Humans, environment and chronology of the late glacial of the North European Plain, Proceedings of Workshop 14 (Commission XXXII: The Final Palaeolithic of the Great European Plain / Le Paléolithique Final de la Grande Plaine Européenne) of the 15th U.I.S.P.P. Congress, Lisbon, September 2006*. Pp. 55–66. Verlag des Römisch-Germanischen Zentralmuseums, Mainz.

POŁTOWICZ-BOBAK M., 2012: Observations on the late Magdalenian in Poland. *Quaternary International* 272–273: 297–307.

PRZEŹDZIECKI M., MIGAL W., KRAJCARZ M., PYŻEWICZ K., 2011a: Ćmielów, St. 95 ("Mały Gawroniec"), woj. świętokrzyskie. Badania w roku 2009. *Światowid.* VIII/XLIX/B, 2009–2010: 191–192.

PRZEŹDZIECKI M., MIGAL W., PYŻEWICZ K., 2011b: Badania nad osadnictwem paleolitycznym północnego obrzeżenia Wyżyny Sandomierskiej. *Światowid* VIII/XLIX/B, 2009–2010: 27–34.

SALAMON T., 2012: Rekonstrukcja kierunków ruchu lodu w obrębie lobu górnej Odry. *Przegląd Geologiczny* 60, 10: 539–545.

SCHILD R., 1965: Nowy przemysł cyklu madleńskiego w Polsce. *Archeologia Polski* 10, 1: 115–150.

SHOTT M., 1986: Technological organization and settlement mobility: an ethnographic examination. *Journal of Antropological Research* 42, 1: 15–51.

SOBCZYK K., 1993: *The Late Palaeolithic Flint Workshops at Brzoskwinia-Krzemionki near Kraków. Prace Archeologiczne 55*. Uniwersytet Jagielloński, Kraków.

SOBCZYK K., 1995: Osadnictwo wschodniograweckie w dolinie Wisły pod Krakowem. *Rozprawy Habilitacyjne* 303: 61–62, 119–120.

SURMELY F., ALIX P., 2005: Note sur les talons en éperon du Protomagdalénien. *Paleo* 17: 2–22.

SVOBODA J. A., 2007: The Gravettian on the Middle Danube. *PALEO* 19: 203–220.

SVOBODA J. A., NOVÁK M., 2004: Eastern Central Europe after the Upper Pleniglacial: changing points of observation. *Archäologisches Korrespondenzblatt* 34: 463–477.

TERBERGER T., STREET M., 2002: Hiatus or continuity? New results for the questions of pleniglacial settlement in Central Europe. *Antiquity* 76: 691–698.

TORRENCE R., 1989: Tools as optimal solutions. In: R. Torrence (Ed.): *Time, energy and stone tools.* Pp. 1–6. New directions in archaeology. Cambridge University Press, Cambridge.

VALENTIN B., 2008: Magdalenian and Azilian lithic productions in the Paris Basin: disappearance of a programmed economy. *The Arkeotek Journal* 2, 3: 1–54.

VALDE-NOWAK P., 1998: Z badań najstarszego osadnictwa w Karpatach Polskich. In: J. Gancarski (Ed.): *Dzieje Podkarpacia* 2. Pp. 39–54. Krosno.

VALDE-NOWAK P., MUZYCZUK A., 2000: Magdalenien Settlement at Hłomcza (Polish Carpathians). *Acta Archaeologica Carpathica* 35: 5–32.

VALOCH K., 2001: Das Magdalénien in Mähren. *Jarhbuch des Römisch-Germanischen Zentralmuseums* 48: 103–159.

WILCZYŃSKI J., 2007: The Gravettian and Epigravettian assemblages from Kraków-Spadzista B + B1: dynamic approach to the technology. Man/mammoth interactions: bone beds and late Gravettian occupations at Kraków-Spadzista. *Folia Quaternaria* 77: 37–96.

WILCZYŃSKI J., 2006: The Upper Paleolithic workshop at the site Piekary IIa , sector XXII layer 5. *Sprawozdania Archeologiczne* 58: 175–203.

WILCZYŃSKI J., 2009: Targowisko: a new Late Glacial site in southern Poland. *Eurasian Prahistory* 6: 1–23.

WIŚNIEWSKI A., BADURA J., FURMANEK M., HNAT M., PRZYBYLSKI B., RAPIŃSKI A., 2010: Prace wykopaliskowe na stanowisku 9 w Sowinie, województwo opolskie. *Badania Archeologiczne na Górnym Śląsku i Ziemiach Pogranicznych w latach 2007–2008:* 15–24.

WIŚNIEWSKI T., MROCZEK P., RODZIK J., ZAGÓRSKI P., WILCZYŃSKI J., NÝVLTOVÁ FIŠÁKOVÁ M., 2012: On the periphery of the Magdalenian World: An open-air site in Klementowice (Lublin Upland, Eastern Poland). *Quaternary International* 272–273: 308–321.

ŻARSKI M., NADACHOWSKI A., 2009: Sediments and stratigraphy. In: A. Nadachowski (Ed.): *Late Pleistocene environment of the Częstochowa Upland (Poland) reconstructed on the basis of faunistic evidence from archaeological cave site*. Pp. 69–72. Institute of Systematics and Evolution of Animals Polish Academy of Sciences, Kraków.

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