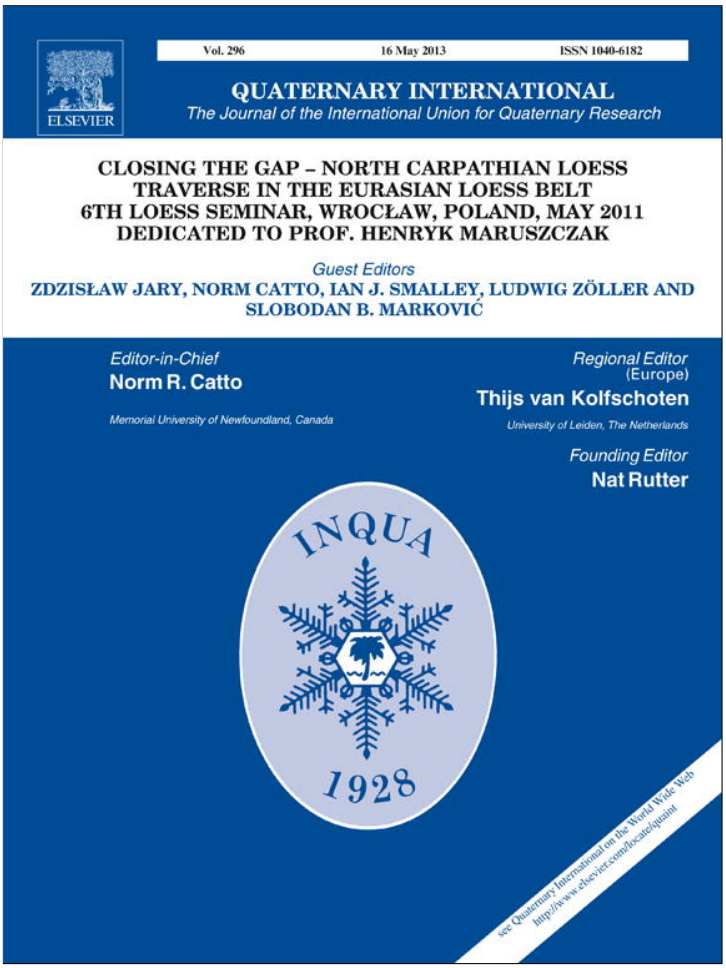

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New chronological data for Weichselian sites from Poland and their implications for Palaeolithic

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ABSTRACT

The goal of this paper is to present the new records on chronology and settlement dynamics in the area situated north of the Carpathians and Sudeten between MIS-3 and GI-1. The focus is on records representing Middle Palaeolithic and so-called transitional industries (Early Upper Palaeolithic), as well late Upper Palaeolithic. Studies are based on longer series of numerical data obtained during recent field work and an examination of old museum collections. These attempts differ from the previous approaches in which the main attention was put on the comparison of stratigraphical and archaeological data, rarely relating to the chronometric records. In the beginning of MIS-3, no settlement hiatus took place in this area. It appears that the classic late Middle Palaeolithic industries had no direct influence on the appearance of the transitional industries and that in the same period different industries could co-exist. There are no convincing arguments indicating a connection between the youngest transitional units and the Upper Palaeolithic industries. Studies on settlement dynamics during the last glaciation maximum (ca. 19,000–17,000 BP) have led to the acceptance of the previous concept emphasizing its unstable character. The sites with more numerous artefacts connected with the Magdalenian tradition and the Epigravettian come from the end of that period. The beginning of Magdalenian settlement on Polish territory took place at the turn of GS-2c and GS-2b, ca. 18,500–17,500 BP. More numerous Magdalenian camps started to appear in GS-2a, ca. 16,500–14,500 BP. The late dates of Magdalenian camps (GI-1c-1a) may be caused by the contamination of the samples, but it cannot be also excluded that the Magdalenian style of life survived in some southern regions of Poland until the Allerød.

1. Introduction

It is believed that Central Europe, in particular its part situated north of the Carpathians and the Sudeten within the Polish territory, was periodically inhabited by human groups in the cold periods of the Upper Pleistocene, and that this colonisation had an unstable character. The climatic and environmental conditions as well as less abundant and more dispersed sources of food, together with the differences in the geological structure and terrain topography, resulted in a very complicated pattern of settlement patches. The reconstruction of this complex process of colonisation based on the small series of chronometric data was in contrast to the records from the regions bordering Poland to the south, east and west (Jochim et al., 1999; Blockley et al., 2000; Richter, 2002; Fort et al., 2004; Svoboda, 2005; Monigal, 2006). The significant increase of chronological data in recent years encouraged completion of the earlier approaches and proposal of entirely new solutions.

The new data extend the period of existence of the Middle Palaeolithic industries in Poland to the beginning of MIS 3. The previous synthetic works emphasised a settlement break from the beginning of the MIS 4 to the middle phase of MIS 3 in this area (Kozłowski, 2000). The lack of settlement hiatus indicates that the colonisation of this area by the groups of archaic humans proceeded gradually in harmony with the potential cultural, climate, and environmental conditions, as in neighbouring areas (Germany, Moravia, and Ukraine). As a result of new field work, the appearance of the so-called transitional industries can be moved to at least ca. 47,000 cal BP, to GS-13–GI-12 (MIS-3). Moreover, these data raise doubt whether the simple evolution of Middle Palaeolithic complexes such as the Micoquian into the Szeletian complexes could have taken place. In the light of new dataset, the direct contacts of the transitional industries with the Aurignacian complex remain an open question.

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The constantly increasing number of data for late glacial (MIS-2, MIS-1) changed knowledge of the frequency and settlement dynamics of this period. New radiocarbon dates confirm the presence of the human groups in the territory of Southern Poland in the second pleniglacial as well as in the following interstadial. Finally, the rich dataset referring to the Magdalenian complex places the colonisation process between the end of GS-2c and the end of GI-1 (the end of MIS-2 and MIS-1). These records shed new light on the previously designed models of the Magdalenian expansion to Central Europe.

The present paper is based on the new numerical dates obtained by TL, OSL and radiocarbon methods for sites located in the southern part of Poland. Thus, it does not discuss records from lowland areas which were domains of the Hamburgian, Federmesser, Ahrensburgian or Świderian cultures. This scope of data recently has been discussed in separate paper (Burdukiewicz, 2011). The sites with the series of dates come from the last cold period, the Weichselian. The traces described in this paper represent the Middle Palaeolithic, "transitional" industries that are classified by some scholars as belonging to the Early Upper Palaeolithic (EUP) and the late Upper Palaeolithic including the Magdalenian complex.

2. Regional setting

The archaeological sites presented in this paper are located in the southern part of Poland. The area lies within the Baltic Sea drainage basin and includes the watersheds of the Oder River in the west and the Vistula River in the east. In the regional division of Europe, that area covers the northern part of the Bohemian Massif, the southern part of Central European Lowland, the Uplands, and the Western Carpathians. The zone covers mainly uplands and mountains. The northernmost site, Wilczyce 10, lies at 51°5′ N. The altitude of the territory ranges from approx. 100 m a.s.l. in the north to almost 2500 m a.s.l. in the south. In a meridianal pattern, the highs are approx. 100 m above sea level in the west and approx. 200 m a.s.l. in the east. The site with the lowest elevation lies at 125 m a.s.l., and the highest at 550 m a.s.l.

The area borders the Central European Lowland to the north and the highest parts of the Carpathians and the Sudeten to the south. It consists of alluvial and denudation plains formed on the old platform (eastern part of Poland), alluvial and denudation plains and plates as well as the mountains on the post-Hercynian platform (western Poland) (Mojski, 1993). The Krakow-Czestochowa Upland, situated in the centre of the area, is the karst region within which most cave sites are located. The western part and some eastern regions are underlain with deposits of glacial origin. The last glacial transgression in the southern territories took place during MIS 6 (Ehlers et al., 2004; Lindner, 2005; Litt et al., 2007). A considerable part of that region is covered by loess (Jary, 2009), and many open-air sites lie within aeolian and slope deposits (e.g. Bluszcz et al., 1994; Wiśniewski, 2006; Sitlivy et al., 2008, 2009; Bobak and Połtowicz-Bobak, in press).

3. Methods

The recent progress regarding the geochronology of the Quaternary period and in the calibration of radiocarbon dates allows placement of archaeological phenomena into the timescale of the Weichselian much more precisely than one or two decades before. Ice core data include a detailed continuous stratigraphic record to ca. 1000 y precision for the period from 50,000 cal BP (Svensson et al., 2008) and to several dozen years for the final glaciation period (Rasmussen et al., 2006). The records obtained from the Greenland core NGRIP allowed creation of the GICC05 timescale that covers the period extending to 60,000 cal BP (Rasmussen et al., 2006; Svensson et al., 2006, 2008). At the same time, the integration of marine data and terrestrial climatic proxy (e.g. Hoek et al., 2008) enabled the inclusion of the archaeological numerical records into this scheme.

Moreover, it is possible to calibrate radiocarbon dates to 50,000 cal BP using curve IntCal09 (Reimer et al., 2009). This is necessary because of the changeable ^{14}C isotope content value in the atmosphere and its non-linear changeability (see Reimer et al., 2009; Scott, 2009). However, the uncertainty of uncalibrated ^{14}C dates has a normal distribution and their calibration often results in irregular multi-peaked distributions of calendar age uncertainties (e.g. Blaauw, 2010). This usually results in wider and less regular distribution of uncertainties of the obtained results.

The purity of samples affects the precision of radiocarbon dating. Younger contamination equalling approx. 1% of a sample from 40,000 BP may make the determined date younger by 7000 years (Bronk Ramsey, 2008). In these cases, new methods of preparation, such as the ABOX for charcoal (Bird et al., 2006) or the ultrafiltration method for collagen obtained from bones (Higham et al., 2008) are of great importance. Samples prepared in this way allow greater accuracy of dating and broaden the chronological range of the method to reach ca. 50,000–55,000 years (Bronk Ramsey et al., 2007; Higham et al., 2008).

In this paper, radiocarbon dates were calibrated with the IntCal09 curve. Values are presented to significance level 95.4% (2σ). For TL and OSL dates, 68.2% significance (1σ) is considered to be sufficient, as their uncertainty distribution has a shape of a bell curve. The chronological data are correlated with the chronology of the last glaciation based on the GICC05 scale (Rasmussen et al., 2006; Svensson et al., 2008). However, ages are not expressed in "years before the year 2000" (b2k, see Rasmussen et al., 2006) in order to compare the results with other records. Therefore, all dates are expressed in calendar years before the year 1950 (BP).

4. Results

The oldest dataset refers to the sites from the Middle Palaeolithic and so-called transitional industries. One of these sites, Hallera Ave. in Wrocław, is located in the Silesian Lowland bordered to the north by the Silesian Rampart (Fig. 1). The site is situated within an edge of the Oder River valley, in terrace sediments dated to the older and middle phase of the Weichselian. During the excavations covering 800 m^2, two horizons with stone artefacts (Fig. 2a–d) and faunal remains were recognised in the middle sector (Wiśniewski et al., 2013). The finds of the lower horizon (2060 artefacts) were slightly displaced due to fluvial processes (complexes A/B). Within the upper horizon (827 artefacts) found in low energy sediments (complexes C and D), some flint artefact clusters are preserved. Both horizons contained numerous flint refittings. According to the initial interpretation, the lower horizon represented the end of the Middle Pleistocene. However, no taxa of Middle Pleistocene fauna have been found, and the OSL dating carried out in 2006 shows the affinity of both horizons to the last glaciation (Skrzypek et al., 2011; Wiśniewski et al., 2013). Although the sediments from complex of A/B can be synchronised with the beginning of MIS-4, the remains found in the base of that series must have developed earlier: MIS-5a–MIS-5d (Table 1, Fig. 3). At present, this range cannot be determined more accurately. The younger horizon was buried with deposits of MIS 3. Therefore, it can be concluded that they are connected with the beginning of the stage (Table 1, Fig. 3). Taxonomically, the lower horizon could be assigned to the Mousterian, whereas the upper may be located in the widely understood Micoquian. From faunal remains, it seems that steppe and tundra conditions prevailed, with relatively

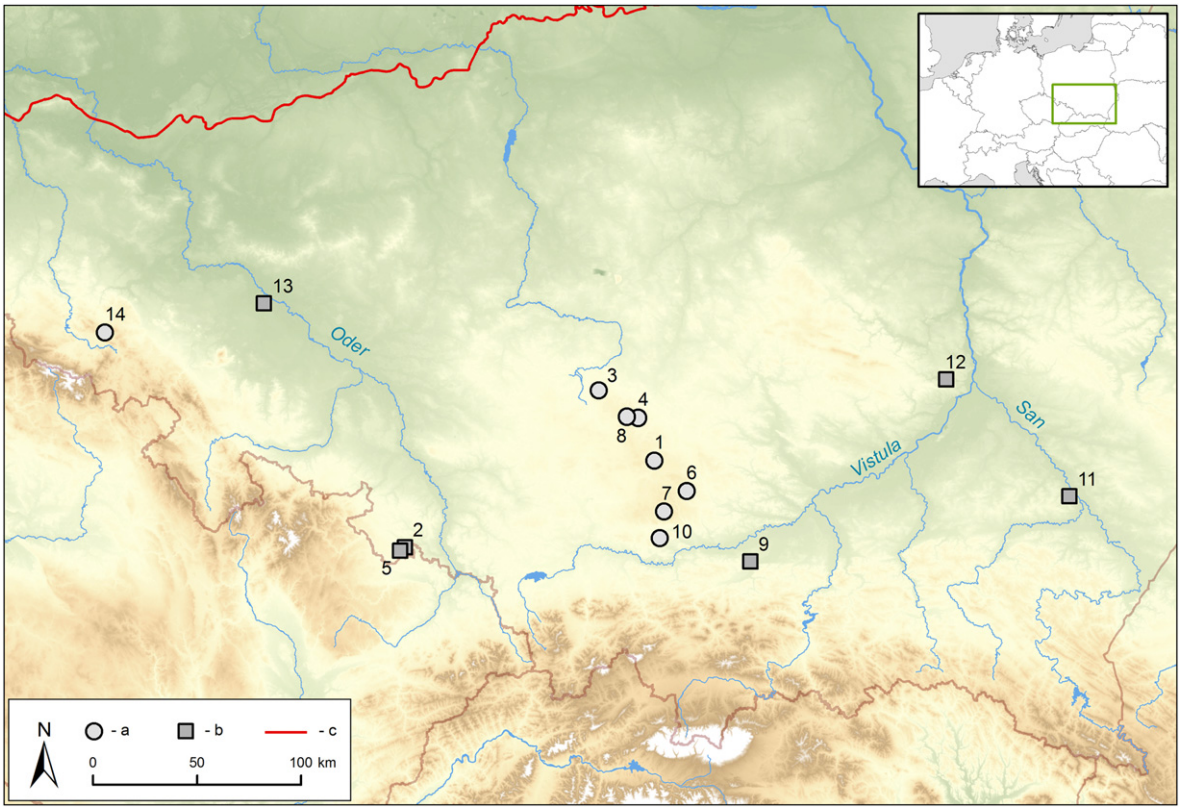

Fig. 1. Location of key Palaeolithic sites. a – cave sites, b – open-air sites, c – extent of Last Glacial Maximum (Leszno phase, after Marks, 2011). 1 – Biśnik Cave, 2 – Dzierżysław 35, 3 – Komarowa Cave, 4 – Krucza Skała Cave, 5 – Lubotyń 11, 6 – Maszycka Cave, 7 – Nietoperzowa Cave, 8 – Stajnia Cave, 9 – Targowisko 10, 10 – W Zalasie Cave, 11 – Wierzawice 31, 12 – Wilczyce 10, 13 – Wrocław-Hallera 1, 14 – Wschodnia Cave.

favourable climatic conditions suggested by the results of isotope studies ($\delta^{18}O$ of phosphates) on palaeotemperatures (Skrzypek et al., 2011). Both levels may be linked with hunter activities, possibly focused on hunting *Bovidae*.

The Middle Palaeolithic site of Stajnia Cave, situated in the northern part of the Czestochowa Upland (Fig. 1) (Urbanowski et al., 2010), provided approx. 15,000 stone items (as per 2011) representing the Middle Palaeolithic, and thousands of bone remains.

Table 1
TL and radiocarbon dates of Middle Palaeolithic and "transitional" (Early Upper Palaeolithic) sites.

Site	Method	Lab no.	^{14}C determination (BP)	Calendar age (BP)	Material dated	Source
Biśnik Cave	U–Th	–	–	79,000–39,000	Bones	Cyrek et al., 2010
Biśnik Cave	TL	–	–	69,000–47,000	Sediment	Cyrek et al., 2010
Biśnik Cave	TL	–	–	64,000–44,000	Sediment	Cyrek et al., 2010
Lubotyń 11	14C-AMS	Poz-25208	35,100 ± 800	41,774–38,649	Charcoal	Bobak and Połtowicz-Bobak, in press
Lubotyń 11	14C-AMS	Poz-25209	44,000 ± 3000	>50,000–44,351	Charcoal	Bobak and Połtowicz-Bobak, in press
Lubotyń 11	14C-AMS	Poz-25207	38,100 ± 1800	46,755–39,656	Charcoal	Bobak and Połtowicz-Bobak, in press
Lubotyń 11	14C-AMS	Poz-36903	43,000 ± 1000	48,944–44,768	Charcoal	This paper
Lubotyń 11	14C-AMS	Poz-36904	39,500 ± 700	44,749–42,615	Charcoal	This paper
Lubotyń 11	14C-AMS	Poz-36905	44,000 ± 1100	49,700–45,540	Charcoal	This paper
Nietoperzowa Cave	14C-AMS	Poz-23628	32,500 ± 400	38,467–36,421	Mammoth bone	Nadachowski et al., 2011
Stajnia Cave	14C-AMS	Poz-28892	>49,000	Beyond IntCal09 range	Bone	Urbanowski et al., 2010
Stajnia Cave	U–Th	–		~52,900		Żarski et al., 2012
Wrocław Hallera 1	OSL	GdTL-859	–	60,900–54,100	Sediment	Skrzypek et al., 2011
Wrocław Hallera 1	OSL	GdTL-862	–	83,700–77,100	Sediment	Skrzypek et al., 2011
Wrocław Hallera 1	OSL	GdTL-858	–	71,400–66,400	Sediment	Skrzypek et al., 2011
Wrocław Hallera 1	OSL	GdTL-860	–	55,800–52,000	Sediment	Skrzypek et al., 2011
Wrocław Hallera 1	OSL	GdTL-861	–	40,900–21,100	Sediment	Skrzypek et al., 2011
Wrocław Hallera 1	OSL	GdTL-854	–	62,900–58,500	Sediment	Skrzypek et al., 2011
Wrocław Hallera 1	OSL	GdTL-856	–	53,900–49,900	Sediment	Skrzypek et al., 2011
Wrocław Hallera 1	OSL	GdTL-857	–	61,400–56,800	Sediment	Skrzypek et al., 2011
Wrocław Hallera 1	OSL	GdTL-855	–	57,700–49,900	Sediment	Skrzypek et al., 2011

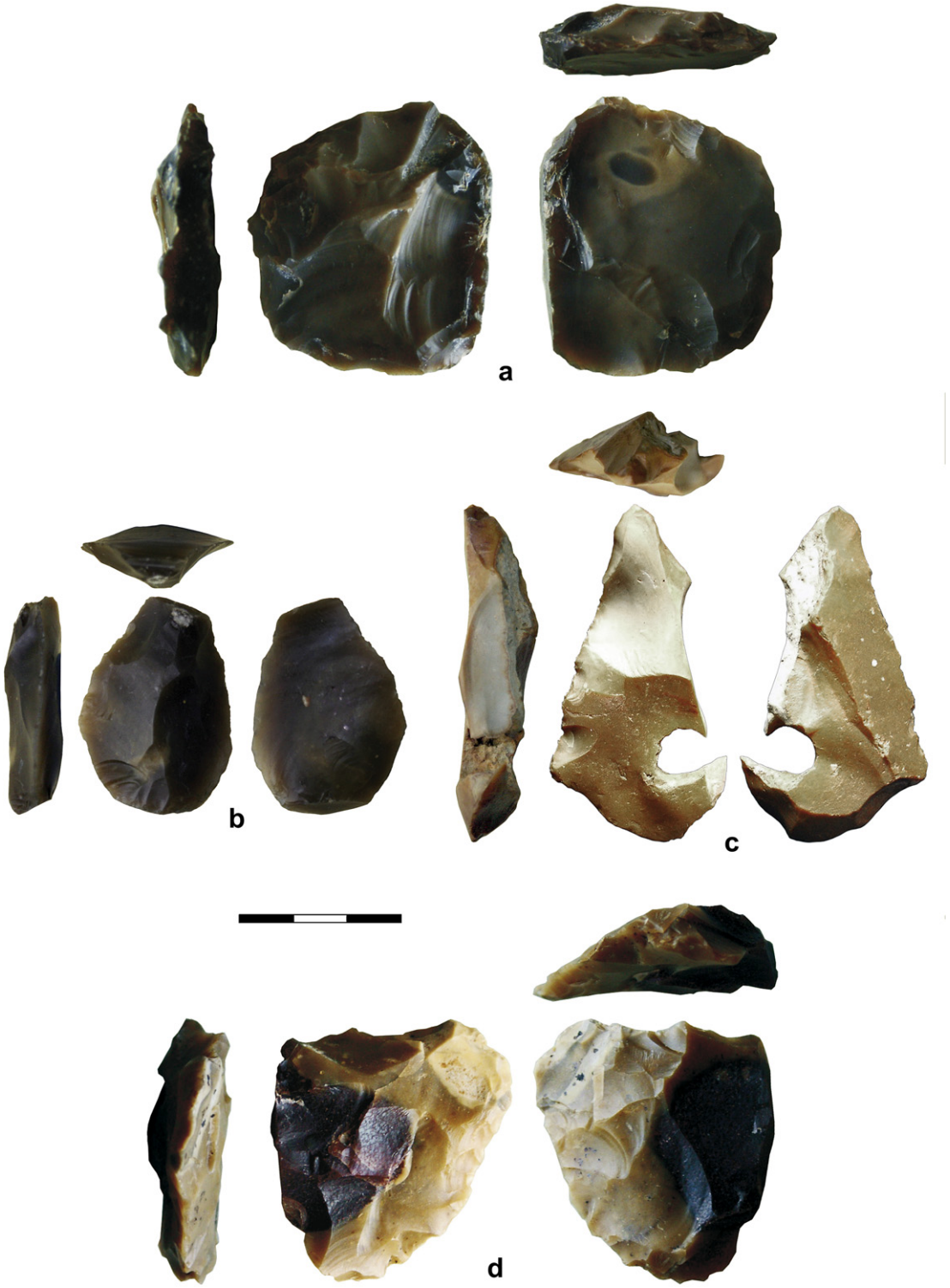

Fig. 2. A selection of flint tools from the site 1 at Hallera Avenue, Wrocław (upper horizon with Micoquian industry), SW Poland: a, d – bifacial knives; b – side-scraper; c – unifacial knife-like tool. Photo by A. Wiśniewski.

The finds lie in cave clay D1–C8 horizons. Layer D1, documented in primary and secondary positions (D1a; D1b) contained a lens of different sediment (C8). In these deposits, teeth of *Homo neanderthalensis,* unique in Poland, were found. Initially, the dating of the level to the beginning of the last glaciation was suggested, based on the results of the pilot radiocarbon dating of cave bear bones (uncalibrated age older than 49,000 BP; Table 1) (Urbanowski et al., 2010). Preliminary results of AMS dating of a bone from layer D1 indicate an analogous period (Urbanowski 2012, personal communication). The age of the lower layer D2, 52,900 (W1400-1417), was determined by U–Th (Żarski et al., 2012). The results show that the layer was formed in MIS 3. Steppe and tundra were the vegetation types during occupation. The numerous stone finds and bone remains indicate that this place could have been a base camp several times. In M. Urbanowski's opinion, these artefacts belong to the Central European Micoquian

assemblages (e.g. Richter, 1997; Jöris, 2006). Studies of bone remains revealed cut marks on the reindeer and other species bones.

The chronological data regarding the sites of the so-called transitional industries or early phase of the Upper Palaeolithic (EUP) come from the middle phase of MIS 3. One of the key sites is Lubotyń 11, situated in the southern part of the Głubczyce Upland (Fig. 1) (Bobak and Połtowicz-Bobak, in press). The site is located on a hill only 1.5 km south of Dzierżysław 1, a well-known site with leaf points. Lubotyń 11 site provided almost 10,000 stone artefacts (Fig. 4a–c) lying in the residues of the Komorniki (Bryansk or Lohne) soil. The post-depositional processes slightly affected the position of stone artefacts. No bone remains were preserved. However, unique remnants of hearths were recorded (Fig. 5a, b). In the hearths, charcoal was found, including remains of pine. The dates of charcoal samples indicate a time range from older than 50,000 BP to 38,649 BP (Table 1, Fig. 3). On the basis of palynological study, 12 taxa were identified that formed a forest tundra assemblage. Numerous stone artefacts suggest that this place was frequently visited. This inventory represents the Szeletian complex (Bobak and Połtowicz-Bobak, in press).

Recently, large-scale projects concerning the extinction of Upper Pleistocene fauna species provided new data from the classical sites of the so-called transitional complexes as well as the late Palaeolithic (Lorenc, 2006; Nadachowski et al., 2009, 2011; Wiśniewski et al., 2009). New data from the bone remains of the well-known Palaeolithic Nietoperzowa Cave (Jerzmanowice) site (Fig. 1) were obtained. This site is famous mainly for layers 6, 5a and 4, representative of the Lincombian–Ranisian–Jerzmanowician complex (L–R–J) (Chmielewski, 1961; Jacobi, 2007; Flas, 2011). Until recently, only two dates for the oldest layer 6 were available (44,940–41,105 BP, GrN-2181, Chmielewski, 1961, p. 68; 44,770–40,405 BP; Kozłowski, 2002, p. 57) and a single date for layer 5a and 4 (with range 38,392–32,892 BP, Gd-10023, Kozłowski and Kozłowski, 1996, p. 106). However, the current attempts are not completely satisfactory. For example, mammoth remains (*Mammuthus primigenius*) from layer 5b are younger by ca. 3000 years (Table 1) than the age of layer 6 (Nadachowski et al., 2011, Table 1). The other new radiocarbon dates of bone remains from layers 4, 5, and 6 indicate significant dispersion (A. Nadachowski 2012, personal communication). The new paleontological examination of the layers indicates steppe and tundra conditions (Wojtal, 2007, Table VII.1). Traces of using fire and cut marks on bones come from layers 6 and 4 (Wojtal, 2007, p. 115).

New dates have been obtained from Biśnik Cave situated in the Czestochowa Upland (Fig. 1). The TL age evaluation based on burnt flints gained from G complex, which is compared to the L–R–J complexes, indicates ranges of 64,000–44,000 and 69,000–47,000 a (Cyrek et al., 2010). U–Th dating on bones was also carried out but the accuracy is low: 79,000–32,000 a (min-Eu, max-LU) (Cyrek et al., 2010) (Table 1, Fig. 3).

The other significant records come from sites dated to GS-2 and GI-1, sites of the so-called Epigravettian (Kasovien/Grubgrabien), Magdalenian and Arched Backed Point complex. A few years ago, a puzzling site in Targowisko (Fig. 1) was uncovered. The site lies on the border of the Sandomierz Basin and the Carpathian Foreland (Wilczyński, 2009). Over 4000 stone artefacts were found over approx. 400 m^2 in a laminated loess layer. They were dispersed around five hearths, where some fragments of reindeer and horse teeth were also found. The well-preserved remnants allowed reconstruction of the cultural clusters and provided relatively rich refittings. Hematite and ochre lumps were also found. More than 250 artefacts were made of obsidian imported from Slovakia. Charcoal samples from the hearths dated the occupation to ca. 18,510–16,665 BP (Table 2, Fig. 6), and flint artefacts are linked with the Epigravettian.

Table 2
Radiocarbon dates of Late Glacial sites.

Site	Method	Lab no.	^{14}C determination (BP)	Calendar age (BP)	Material dated	Source
Dzierżysław 35	14C	GdA-193	13,370 ± 80	16,857–15,665	Bone	Ginter et al., 2005
Dzierżysław 35	14C	GdA-70	13,220 ± 70	16,687–15,420	Bone	Ginter et al., 2005
Dzierżysław 35	14C-AMS	Poz-10136	14,150 ± 70	17,550–16,923	Mammoth	Ginter et al., 2005
Dzierżysław 35	14C	GdA-69	13,500 ± 80	16,919–16,299	Bone	Ginter et al., 2005
Dzierżysław 35	14C-AMS	Poz-7318	12,150 ± 70	14,201–13,795		Ginter et al., 2005
Dzierżysław 35	14C	Ki-8851	12,300 ± 400	16,094–13,379		Ginter et al., 2005
Dzierżysław 35	14C-AMS	Poz-10135	13,180 ± 60	16,604–15,320	Mammoth	Ginter et al., 2005
Komarowa Cave	14C-AMS	Poz-6621	12,260 ± 60	14,838–13,899	Bear bone	Wojtal, 2007
Krucza Skała	14C	Lod-407	11,450 ± 200	13,763–12,903	Bone	Cyrek, 1994; Nadachowski et al., 2009
Krucza Skała	14C-AMS	Poz-27261	12,480 ± 60	15,044–14,178	Bone	Nadachowski et al., 2009
Krucza Skała	14C-AMS	Poz-27245	12,970 ± 60	16,247–15,094	Willow ptarmigan bone	Nadachowski et al., 2009
Krucza Skała	14C-AMS	Poz-1139	11,980 ± 70	14,021–13,665	Bone	Cyrek, 1994; Nadachowski et al., 2009
Krucza Skała	14C-AMS	Poz-1141	11,210 ± 80	13,296–12,870	Bone	Cyrek, 1994; Nadachowski et al., 2009
Krucza Skała	14C-AMS	Poz-1138	12,520 ± 70	15,096–14,206	Bone	Cyrek, 1994; Nadachowski et al., 2009
Maszycka Cave	14C-AMS	KIA-39228	15,155 ± 60	18,622–18,035	Human mandible	Kozłowski et al., 2012
Maszycka Cave	14C-AMS	KIA-39227	15,015 ± 50	18,541–18,013	Human skull	Kozłowski et al., 2012
Maszycka Cave	14C-AMS	KIA-39226	15,025 ± 50	18,544–18,017	Antler, point	Kozłowski et al., 2012
Maszycka Cave	14C-AMS	KIA-39225	14,855 ± 60	18,518–17,780	Antler, navette	Kozłowski et al., 2012
Targowisko	14C-AMS	Poz-14693	13,720 ± 70	17,040–16,665	Charcoal	Wilczyński, 2009
Targowisko	14C-AMS	Poz-14692	14,790 ± 80	18,504–17,657	Charcoal	Wilczyński, 2009
Targowisko	14C-AMS	Poz-14695	14,720 ± 70	18,461–17,610	Charcoal	Wilczyński, 2009
Targowisko	14C-AMS	Poz-14694	14,520 ± 70	17,942–17,255	Charcoal	Wilczyński, 2009
Targowisko	14C-AMS	Poz-14691	14,820 ± 70	18,510–17,697	Charcoal	Wilczyński, 2009
W Zalasie Cave	14C-AMS	OxA-6625	12,820 ± 80	15,931–14,888	Mountain hare bone	Kozłowski and Pettitt, 2001
W Zalasie Cave	14C-AMS	OxA-6591	12,530 ± 110	15,137–14,166	Red fox bone	Kozłowski and Pettitt, 2001
Wierzawice 31	14C-AMS	Poz-36901	11,560 ± 40	13,539–13,275	Charcoal	Bobak et al., 2010
Wilczyce 10	14C-AMS	Poz-14892	12,770 ± 120	16,065–14,560	Charcoal	Fiedorczuk et al., 2007
Wilczyce 10	14C-AMS	OxA-16729	12,870 ± 60	15,935–14,970	Infant bone	Irish et al., 2008
Wilczyce 10	14C-AMS	OxA-16728	13,180 ± 60	16,604–15,320	Perforated arctic fox tooth	Irish et al., 2008
Wilczyce 10	14C-AMS	Poz-3914	12,960 ± 60	16,221–15,081	Charcoal	Fiedorczuk et al., 2007
Wilczyce 10	14C-AMS	Poz-14891	13,020 ± 60	16,350–15,155	Charcoal	Fiedorczuk et al., 2007
Wschodnia Cave	14C-AMS	Poz-25328	12,170 ± 70	14,466–13,788	Perforated bear rib	Wiśniewski et al., 2009
Zawalona Cave	14C	GrN-8519	11,500 ± 400	14,565–12,585	Charcoal	Kozłowski, 1996

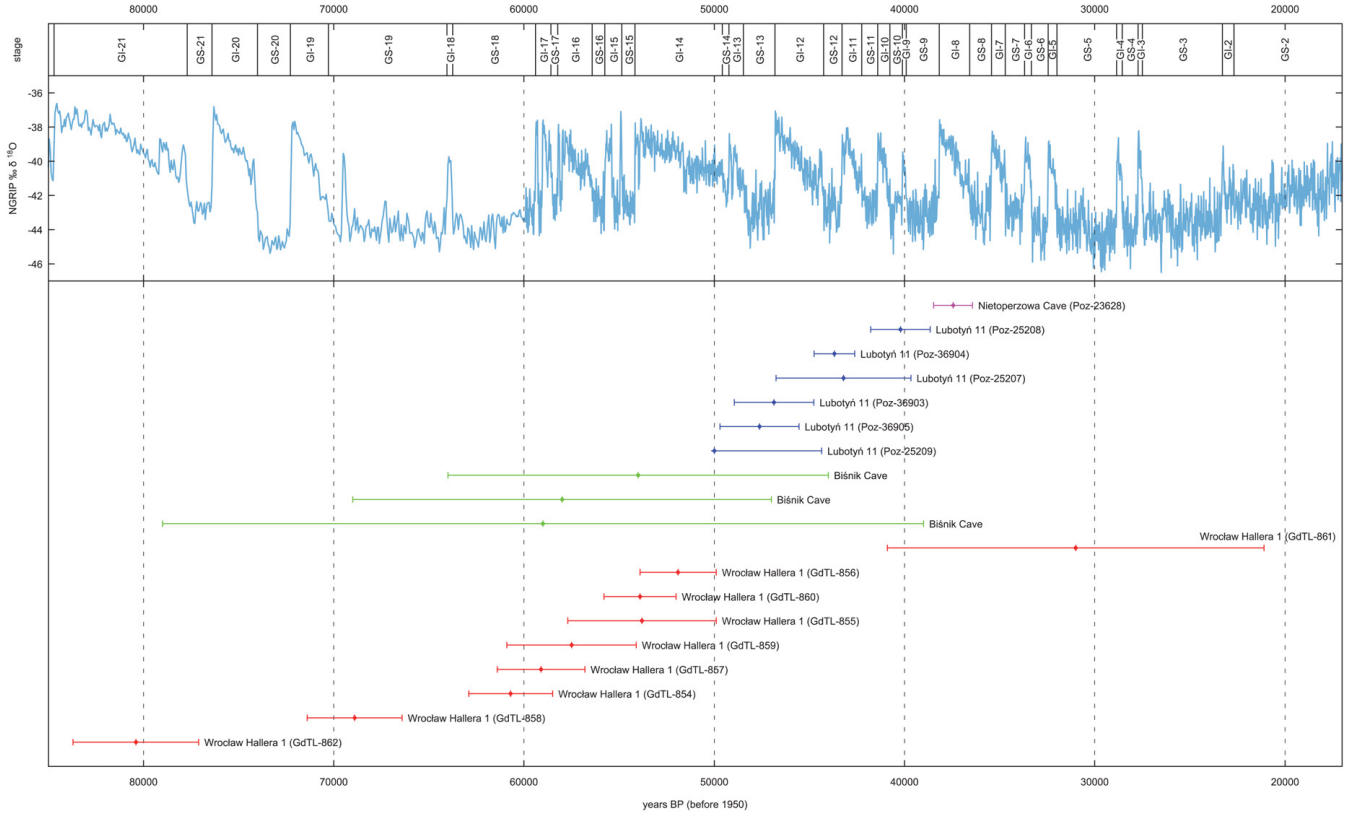

Fig. 3. TL, U–Th and radiocarbon dates for Middle Palaeolithic and "transitional" (Early Upper Palaeolithic) sites shown against the record of climate change on the GICC05 timescale.

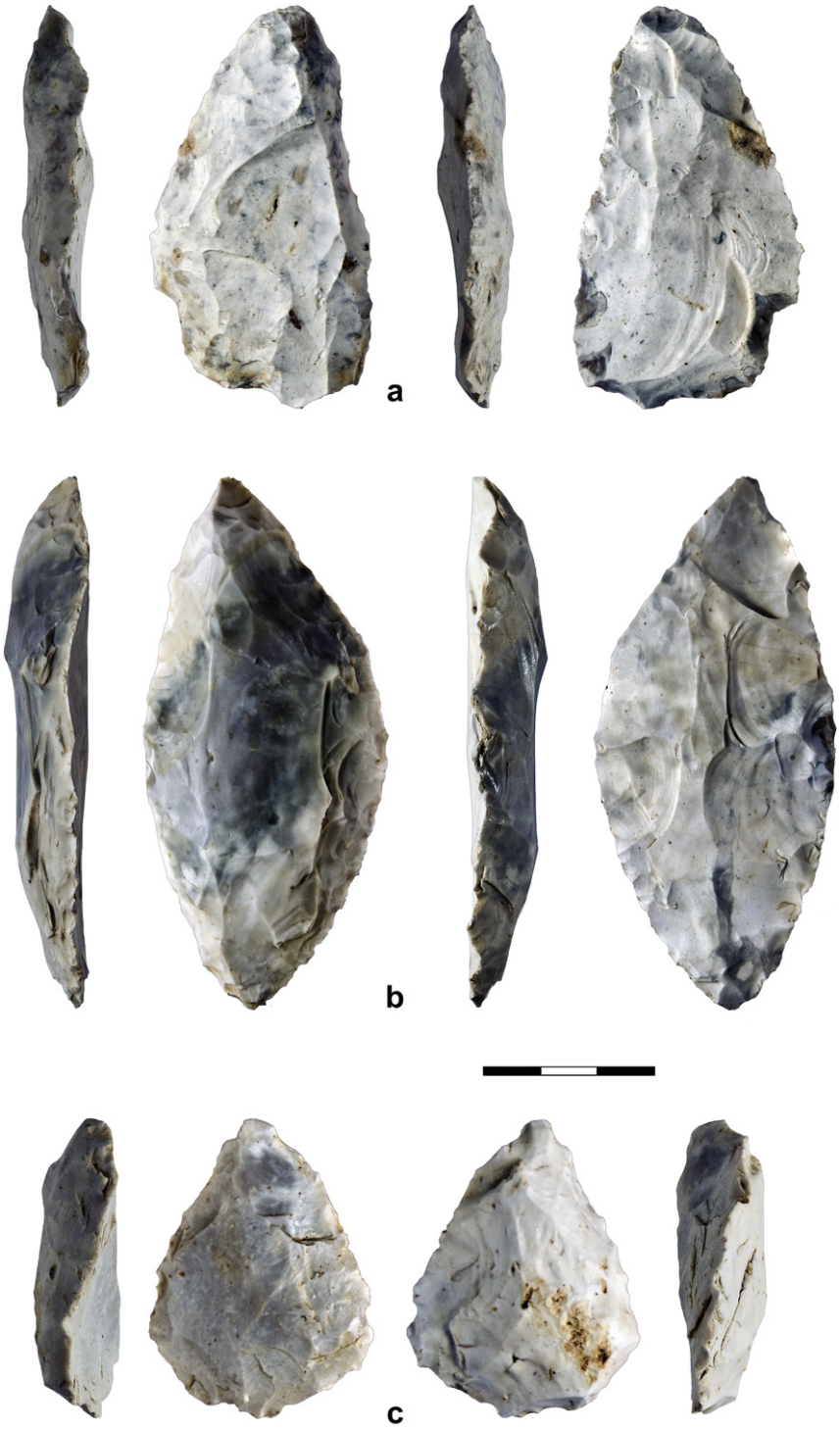

Fig. 4. A selection of flint tools from the site 11 at Lubotyń, SW Poland: a–c – leaf points. Photo by D. Bobak.

Maszycka Cave (Fig. 1), excavated for the first time in the 2nd half of the 19th century by G. Ossowski, and later, in the 1960s by S.K. Kozłowski, undoubtedly is one of the most significant sites from that period. The site provided a unique inventory and human remains (Kozłowski and Sachse-Kozłowska, 1995). The assemblage consists of 292 flint artefacts and 98 bone objects, mainly *sagaies* of different types, as well as many others, such as *bâton percée, baguette demi-ronde,* and awls. In this context, a small series of eight *navettes,* unusual and very rare tools, deserves special attention. On the basis of characteristic features, mainly the presence of *navettes* and decorative motifs, the inventory can be synchronised with the *Magdalénien à navettes* – the facies known, in addition to Poland, from the territory of France and placed in the Middle Magdalenian (Allain et al., 1985). The affinity with the Middle Magdalenian is also confirmed by radiocarbon dates (Table 2, Fig. 6), ranging between 18,622 and 17,780 BP (Kozłowski et al., 2012). These dates were obtained from the human remains and bone tools, consequently confirming their contemporaneity.

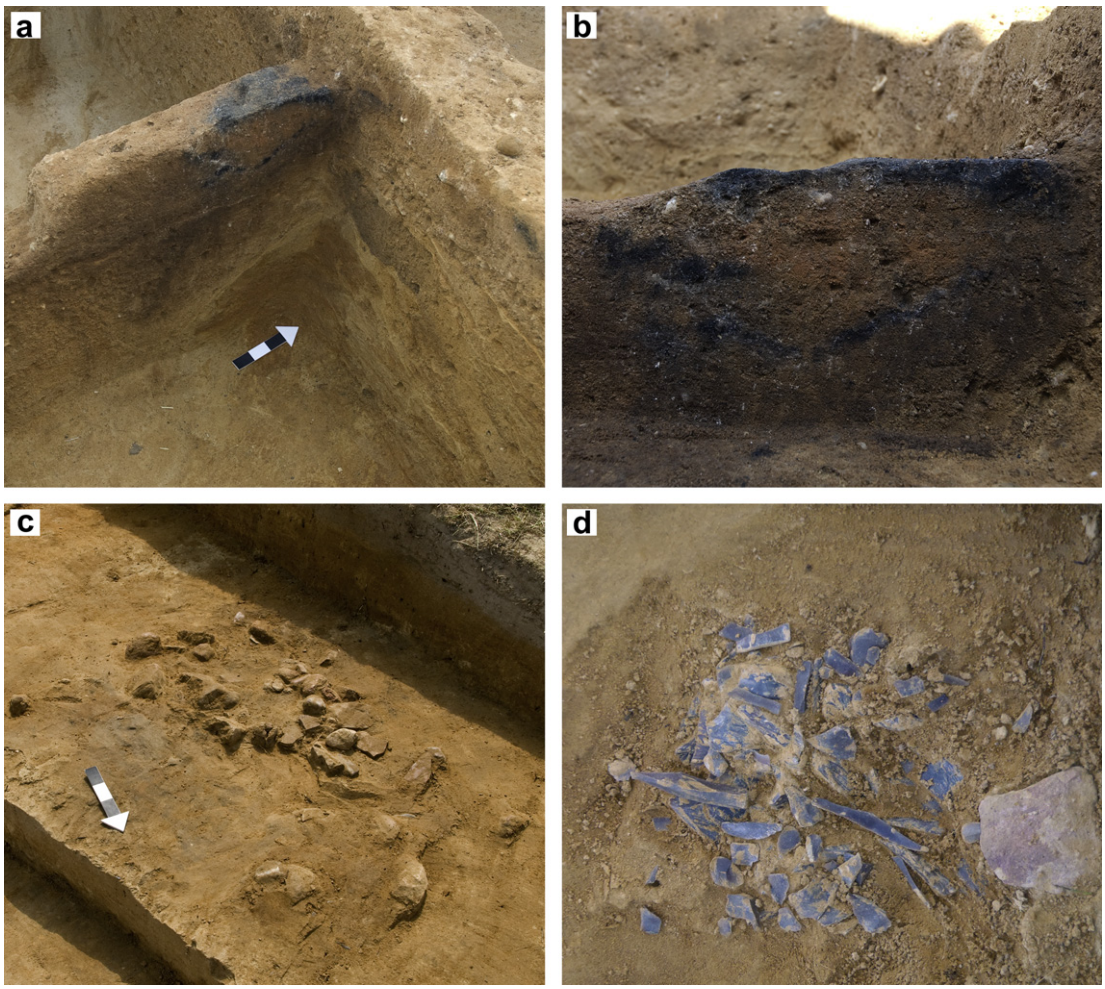

Fig. 5. Selected site features: a, b – cross-section of the hearth at the Lubotyń 11 site; c – plan view of the hearth with stone cluster at the Wierzawice 31 site; d – flint cluster close to the hearth at the Wierzawice 31 site.

Site Dzierżysław 35 is known from the remains of Magdalenian camps. The excavation, carried out between 1997 and 2005, covered 226 m^2 (Ginter et al., 2002, 2005; Ginter and Połtowicz, 2010). The site lies in the Głubczyce Upland, at the foot of the Eastern Sudeten, in the Moravka River valley (Fig. 1). The finds were buried mainly in the humic layer of soil (1a) and in the top of the sandy loess layer (2). The assemblage consists of over 43,000 flint artefacts, many hematite pieces, including an original figurine as well as pendants, stone items, a few bone artefacts, and single mammoth, horse and reindeer bone remains (Wojtal, 2007; Ginter and Połtowicz, 2010). The finds come from approx. 20 concentrations, probably constituting the traces of several settlement episodes. The excavations yielded also remains of hearths, hollows and pits connected possibly with tent structure. The site at Dzierżysław is interpreted as a base camp. The dates on bone materials belong mainly to the period ca. 16,700–15,400 BP (Table 2, Fig. 6).

Other data come from the Magdalenian site Wilczyce 10 situated in the Sandomierz Basin, in the Opatówka River valley (Fig. 1). Ongoing excavations were initiated in 1998 (Fiedorczuk et al., 2007; Irish et al., 2008). The remnants were moved by slope processes within a periglacial zone, and deposited secondarily to the ice wedge fill. The rich finds include over 50,000 flint and quartzite artefacts, implements made of bone, antler and ivory, over 30 female figurines, mostly made of flint, and rich remnants of ochre. Numerous sandstone plates might have covered the surface as a kind of pavement. Among a large number of finds, a perinatal human skeleton was found, preserved to ~60%. Nearby, 80 drilled arctic fox teeth were found, originally constituting a necklace. The site of Wilczyce is interpreted as a seasonal hunting camp, visited frequently and occupied mainly in late autumn and/or in winter (Bratlund, 2002). The previous radiocarbon dates suggesting the Allerød origin of the site (Fiedorczuk and Schild, 2002) are considered to be incorrect as the samples were taken too close to the surface (R. Schild, personal communication). At present, the chronology of the site is determined by the series of ^{14}C dates (16,604–14,560 BP) on charcoal samples, skeleton bones and a drilled arctic fox tooth (Table 2, Fig. 6).

The open-air site Wierzawice 31 is situated in the foreland of the Sandomierz Basin, in the San River Valley (Fig. 1; Bobak et al., 2010). The rescue excavation, carried out in 2009–2010, covered 26 m^2 and revealed 8 or 9 small concentrations (Fig. 5d) in which over 2600 flint artefacts were found. The remains of the hearth sheathed stones (Fig. 5c) as well as stains and lumps of ochre were also uncovered. The remains were deposited in the illuvium of loessive soil formed on laminated sand and silt. The excavated area covered a part of the Wierzawice site which is interpreted as a short term camp. The ^{14}C dates suggest that the site was occupied in the younger phase of GI-1 (Allerød) (Table 2, Fig. 6). Lately, the date was confirmed by TL dating (J. Kusiak, M. Łanczont, personal communication) and additional radiocarbon records.

The data are supplemented by the records from cave sites which, unlike open-air sites, provided much more modest settlement

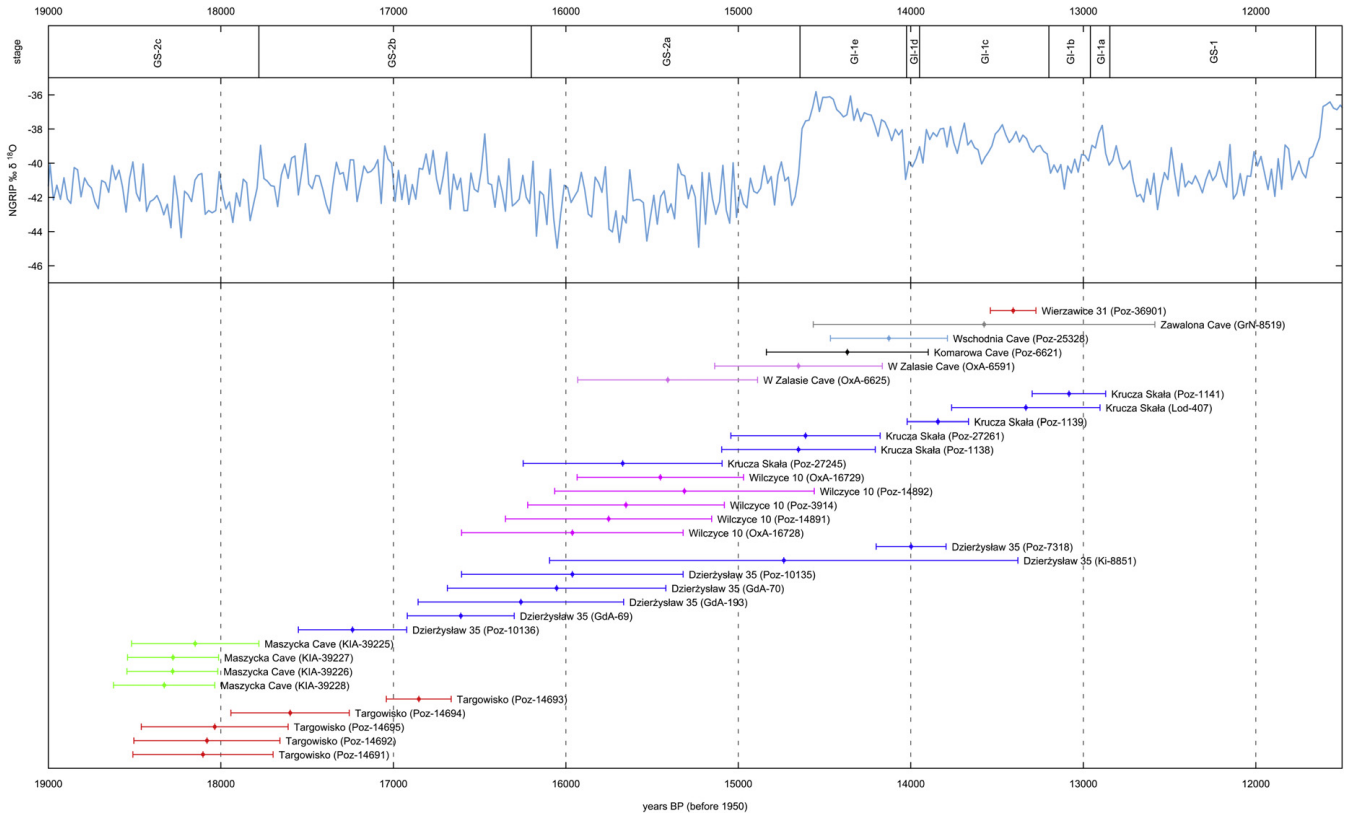

Fig. 6. Radiocarbon dates for Late Glacial sites shown against the record of climate change on the GICC05 timescale.

remains. Most of the sites are located within the Krakow-Czestochowa Upland, northwest of Krakow, and only one lies in the Western Sudeten. The largest settlement sequence was observed in the Krucza Skała Cave near Kostkowice (Fig. 1) (Cyrek, 1994, 1999). In the oldest layer of cave clay with sand and limestone debris (layer I/1), only charcoal and remains of bones with traces of processing were found. In the upper layer, consisting of grey and yellow sandy sediments, single flint and bone artefacts, a pendant, and many bones of birds and reindeer were uncovered. Above this, in the contemporary layer 6 (cave entrance) and IV (shelter), over 50 flint items were found together with remains of hearths and possibly an artificial limestone plate pavement. These occupational remains correspond to the Magdalenian complex. The chronology was established on the base of bone samples. These dates cover the period between 16,247 and 12,870 BP and they appear to constitute a clear sequence except for the two lower layers (Table 2, Fig. 6). The last two come from the younger part of GI-1 (Allerød).

Over thirty years ago, the excavation of 20 m^2 in Zalas Cave (Fig. 1) provided evidence of late Upper Palaeolithic settlement (Bocheński et al., 1985; Kozłowski and Pettitt, 2001). The artefacts were recovered from sandy layers 7–9 and clayey sand (layer 11). In layers 7–9, a concentration of 554 flint artefacts on the small surface (3 m × 4 m) was recorded that could be connected with a blade workshop. Remains of another workshop, constituting 107 artefacts, were found in layer 11. In layers 7–11, species of fauna typical of steppe and an open landscape with clusters of bushes and thicket were identified. In the upper layer 4 with another hearth, single items, probably linked with the tradition of the Arched Backed Point complex (Federmesser), were found. They were assigned to the earlier part of GI-1 (Allerød). The dates on bones from the Magdalenian layers are ca. 16,000 BP (Table 2, Fig. 6).

Two other cave sites provided single traces. In Komarowa Cave, several artefacts were found on a terrace in front of the cave (Fig. 1) (Wojtal, 2007; Nadachowski et al., 2009). They were discovered in the complex of layer B, composed of sand with layers of clay and silt sediment (loam). Among the few artefacts, a double perforator and a backed blade were present. Remains of vertebrates from tundra and steppe were identified; the only birds are represented by species inhabiting the area covered by forest and thicket. The chronology of these traces was determined on the base of the date obtained from a brown bear rib and indicating ca. 14,800–13,900 BP (Table 2, Fig. 6).

Other dates come from the Wojcieszów area (Western Sudeten; Fig. 1), where a few cave sites were discovered and partly examined in the 1930s. On the pile where the damaged Wschodnia Cave used to be, a brown bear rib with a hole and traces of processing was found (Zotz, 1939) The radiocarbon date of the bone (14,466–13,788 BP, Table 2, Fig. 6) is from the GI-1e–GI-1d period (Wiśniewski et al., 2009).

5. Discussion

The presented data provoke discussion on a few key issues regarding the last glacial Palaeolithic in Poland. These issues focus on the chronological range of the respective cultural complexes. Thus, they also provide a chance to discuss recent concepts of the origin and relationship between specific taxonomical units, as well as demographic processes.

The first issue concerns the “continuity” of the Middle Palaeolithic industries in MIS-3 stage and their relationship to the so-called transitional complexes of the Szeletian and the L–R–J types as well as chronological frontier of this period. As far as the problem of the so-called continuity or, strictly speaking, frequency of settlement within the areas situated north of the Carpathians and the Sudetes is concerned, the Polish territory was not an exception in this respect, as was previously suggested. The dates of the upper horizon at the Hallera Ave. site in Wrocław, as well as the evidence from the Stajnia Cave, clearly indicate (Fig. 3) that after MIS-4 no settlement hiatus took place in the southern part of Poland that lasted to the appearance of the so-called transitional complexes (cf. Kozłowski, 2000). The new records correspond with other regions of Central Europe (Valoch, 1988; Rink et al., 1996; Richter, 2002; Neruda, 2006). The presence of the late Mousterian industries with blades is known from the Krakow area. The dates from the youngest layer 7a in Piekary IIa suggest an age between 40,000 and 35,000 BP (Sitlivy et al., 2008). In turn, the youngest layer with Middle Palaeolithic artefacts from the site at Księcia Józefa Str. (series IV) is dated to ca. 45,000 BP (Sitlivy et al., 2009). Nevertheless, the upper extent of chronological records corresponding to a relatively late period should be emphasised. To sum up, the situation is very similar to the south-western part of Germany and Moravia, as well as in Crimea (Richter, 2002; Monigal, 2006; Neruda and Nerudová, 2011).

The next question is the chronological range and the origin of the Polish transitional industries. The new data specify the period of appearance of the Szeletian type and encourage discussion regarding the low and upper time limits of the L–R–J type.

Presently, the lower time limit may be placed at ca. 48,000–45,000 BP. Previously, it was based on imprecise TL examination of mineral sediments at Dzierżysław 1 site, 36,500 ± 5500 a (GdTl-349) (Bluszcz et al., 1994). The new chronological records from Lubotyń correspond to the so-called lower Szeletian of Moravia (Neruda and Nerudová, 2009). They are slightly younger than the dates from Biśnik Cave where the transitional complex was also documented (Cyrek et al., 2010). However, it seems that at Biśnik Cave, the dating carried out by J. Kusiak was not very precise. The standard deviation for samples of burnt flints equals 10,000 and 11,000 years. Thus, they cannot be treated as the basis for further discussions.

The upper time range of the so-called transitional complexes (ca. 37,500 BP, Fig. 3) is based on dates carried out for animal bones from the L–R–J assemblages of the Nietoperzowa Cave (Nadachowski et al., 2011). It appears that the age of that sample, as well as the other published samples from layers 4–5, are not accurate and may result from the contamination that caused the deviations of dates by up to 7000 years (Bronk Ramsey, 2008). An example of similar discrepancies is Spy Cave, where the dates on animal bones differ from the dates on the remains of Neanderthals, a maker of the local transitional industry (Semal et al., 2009). The dates of the so-called transitional industries should be at least 3000 years older than those from the Nietoperzowa Cave.

The records and their interpretation lead to consideration of the relationship between the Middle Palaeolithic industries and the so-called transitional complexes. For a long time, it has been believed that the Szeletian evolved from the Micoquian (Valoch, 1966; Kozłowski, 1988, p. 351; Svoboda and Simán, 1989, and others). It is also accepted that the Szeletian, similarly to the Micoquian, was created by the Neanderthals. It is supposed that process took place between 50 and 40 ka (Kozłowski, 1996, p. 208). Considering the typo-technological features of the Szeletian, especially the lack of the Levallois technology and the presence of bifacial tools, this idea seems very likely. However, taking into account that both complexes could have overlapped in time, the hypothesis about the transition from Micoquian to Szeletian does not appear as well-grounded. The most recent dates from the Stajnia Cave (M. Urbanowski, personal communication) do not exclude the co-existence of these industries. Examples of chronological overlap between the Micoquian and Szeletian in Moravia are well-known (Šipka Cave, layer III – Moravský Krumlov IV, layer 0; Neruda and Nerudová, 2011, also further reading). The Polish Szeletian

chronologically corresponds also to the Mousterian sites with blades (Sitlivy et al., 2008, 2009). It seems that the new records challenge the concept of a simple evolution. Thus, the present authors are inclined to accept the multi-cultural model similar to the Crimean option (Monigal, 2006), and fully agree with the idea (Flas, 2011) that the late Middle Palaeolithic industries and the so-called transitional industries could have developed independently. The Buhunician is not considered here, because no typical examples of this industry have been found in Poland (see Allsworth-Jones, 2004, p. 290; Wiśniewski, 2006, p. 100, vs. Bluszcz et al., 1994).

The next question concerns the possible relationship between the so-called transitional complexes and the Upper Palaeolithic groups. Rejecting the uncertain dates from the Nietoperzowa Cave layers, there is no sound evidence for chronological overlap between the transitional and Aurignacian industries in Poland (Flas, 2011). The earliest Aurignacian sites in Moravia are dated to 40,000–35,000 BP (Svoboda et al., 2002; Svoboda, 2005). Thus, the hypothesis regarding the different contacts between two populations (e.g. the direct interaction model or the acculturation of the Middle Palaeolithic inhabitants by the Upper Palaeolithic populations) within the territory of Poland may be difficult to accept (see Allsworth-Jones, 2004; Mellars, 2005, 2006).

The next set of new records refers to the period from GS-2 to the beginning of GS-1 (LGM – Allerød). In the southern regions of Poland, the industries from the middle phase of the Upper Palaeolithic became to disappear, and the colonisation and local evolution of the groups identified with the Magdalenian complex took place. It has been known for a long time that as a consequence of the dramatic deterioration of climatic conditions during GS-2, Central Europe was almost completely depopulated (Kozłowski, 1999; Terberger and Street, 2002; Verpoorte, 2004). However, throughout the region single sites are recognized, and their radiocarbon dates may suggest episodic visits of human groups linked with the Epigravettian or Kasovian/Grubgrabien (Kozłowski, 1999; Street and Terberger, 1999; Terberger and Street, 2002; Terberger, 2003; Svoboda and Novák, 2004; Svoboda, 2007). Additionally, in the area north of the Carpathians some sites dated to 15,000–20,000 BP were discovered.

However, the problem of precise dates for Epigravettian sites in Poland is more complex. Layer VIII from Deszczowa Cave is an example of such uncertainty about the time range. Its previous radiocarbon dates indicated that the settlement came from the period ca. 20,000–19,000 BP (Cyrek, 1999; Kozłowski, 1999; Cyrek et al., 2000). The latest dates belong to the period from 33,500 to 22,500 BP (Nadachowski et al., 2009). Although many of bones from this layer bear traces of modification by human activity, none of them were dated (Wojtal, 2007, pp. 30–47; Nadachowski et al., 2009). From among 26 dates on bird bones from the Krakow-Czestochowa Upland caves, most differ from the age established on the basis of the sedimentary sequence (Lorenc, 2006). The cause is due to contamination, and relocations of the materials between the layers: redeposition of the younger materials to older layers and vice versa. Therefore, the age of single artefacts from other caves, in particular unprocessed animal bones from Żytnia Skała, Zawalona Cave (Alexandrowicz et al., 1992), should be interpreted very carefully. The reasons of the Epigravettian penetration are difficult to determine. It cannot be excluded that some migrations were connected with searching for new sources of food. At the sites in Hungary situated in the Danube River Valley, Baltic and Jurassic raw materials are found, as well as Slovakian obsidian (Féblot-Augustins, 1997). Rather than systematic exchange, this indicates provisions of groups during migration, also suggested by the lack of stable settlement structures. The other patterns were observed in case of the colonisation of these areas by the Gravettian hunters and, in the later period, by the Magdalenians (Kozłowski, 1994, p. 130). Similar flint materials considering their technological and stylistic character are known from a few other sites, mainly from the Krakow-Czestochowa Upland, but they have imprecise dates (see Wilczyński, 2007, p. 95; 2009, pp. 115–117). The complex from Targowisko 10 may refer to that tradition, although its dates place it in the end of GS-2c (Wilczyński, 2009) (Fig. 6). These dates are very similar to the oldest Magdalenian ones from Poland (Maszycka Cave). They also correspond with the youngest dates for the Epigravettian at Moravian sites: Brno-Vídeňská (18,514–17,690 BP, GrA-20002; 17,905–17,192 BP, GrN-9350) and Velké Pavlovice (18,458–16,975 BP, GrN-16139). However, the stone artefacts found at these sites are not characteristic. They were classified mainly on the basis of early dates and absence of backed blades (Brno) but their links with the Magdalenian cannot be completely excluded (Valoch, 2010, p. 20). According to Neruda and Nerudová (2011), two concentrations were found at this site: the first, corresponding to the one known from K. Valoch's excavations, is hypothetically linked with the Magdalenian, and the second with the Epigravettian.

The increasing number of archaeological sites in the upland belt of Southern Poland is commonly linked with the Magdalenian colonisation of Central Europe, although their age, rate and the role of local factors are still under discussion (Housley et al., 1997; Jochim et al., 1999; Blockley et al., 2000; Fort et al., 2004; Valoch, 2010). The oldest evidence of the Magdalenian settlement comes from the Maszycka Cave (18,622–17,780 BP), the oldest in the eastern part of Central Europe. The early Magdalenian presence in the western part of Central Europe (19,000–18,000 BP) is well confirmed by the oldest dates from Kesslerloch, Munzingen and Hohle Fels IIa (Housley et al., 1997; Pasda, 1998; Napierala and Uerpmann, 2012). Bearing in mind the finds from Targowisko, linked technologically with the different tradition, between GS-2c and GS-2b, the Magdalenian group (or groups) could have occupied territories controlled temporarily by other groups. This initial Magdalenian settlement is from the period before ca. 18,000 cal. BP, whereas the actual colonisation in southern Poland began ca. 1000–1500 years later (Fig. 6).

The other dates from southern Poland show the beginning of the more intense Magdalenian occupation from ca. 16,500–16,000 BP. The beginning of the Magdalenian colonisation in the neighbouring areas of Moravia, Bohemia and Thuringia has a similar age (Höck, 2000; Verpoorte and Šída, 2009; Küssner, 2010, Fig. 7; Valoch, 2010). The older date from Dzierżysław (>17,000 BP, Table 2, Fig. 6) on a mammoth bone, may be connected with the phenomena of fossil collecting (Wiśniewski et al., 2009) because mammoth was rare in this area at that time (Nadachowski et al., 2011). Such practices were recorded at other Magdalenian sites in Central Europe, e.g. from Oelknitz or Gönnersdorf (Bosinski, 1989; Stuart et al., 2002). The archaeological data from the Magdalenian camps Wilczyce 10 and Dzierżysław 35 are inconsistent with the concept of two settlement phases: pioneer and residential (see Housley et al., 1997). From the very beginning, the colonizers represented the advanced settlement model with recognition of stone and pigment resources, with large camps containing expanded living structures and with objects of art. The evidence indicates the presence of a more logistical system rather than refugial *sensu* Binford (1980). Different archaeological data suggest that such a developed system existed also in Moravia and Thuringia. Even if the initial phase existed, it must have been very short-lived, although its determination on the base of radiocarbon dates seems doubtful, in particular considering dates exact to 2σ (Blockley et al., 2000).

The almost simultaneous colonisation of different regions in Central Europe: the Rhineland, Thuringia, Bohemia, Moravia and Southern Poland, provokes discussion on the validity of the way-of-

advance model of the Magdalenian migration (Housley et al., 1997). Jochim et al. (1999, p. 132) noticed that in case of the Magdalenians, it is difficult to specify the demographic reasons of migration that created the base for the way-of-advance model. The migrations not only could be brought about by demographic and environmental reasons, but also social ones (Jochim et al., 1999, p. 132). Mobility was a method of resolving group problems known by hunter–gatherer people; it may also result from a fight for the position in the group (Woodburn, 1982; Kelly, 1995). The expansion of the Magdalenian societies is much better explained by the stream model of migration (Anthony, 1990; Jochim et al., 1999), in which migrating groups move to the territory characterised by specific and expected geographic conditions, disregarding the areas lying between them. Such a model corresponds to the picture of the Magdalenian settlement that focused in the specific regions of Europe (Weniger, 1989).

Most dates for the Magdalenian settlement from the southern part of Poland belong to the period 16,500–14,500 BP (Fig. 6). These records suggest the permanent presence of the Magdalenian hunters in Little Poland, Upper Silesia and most probably in the mountainous regions: in the Sudetes and the Carpathians (Valde-Nowak et al., 2003; Lorenc, 2006). The youngest dates connected with the Magdalenian refer to the younger part of the last Greenland interglacial, GI-1c-a (Allerød). Similar dates come from some Magdalenian sites from different regions of Central Europe (Bobak et al., 2010). Usually, they are deemed to be incorrect, that is too young, perhaps caused by contamination of the samples (Verpoorte, 2004). This factor may be responsible for incoherent dates of the grave from Bonn-Oberkassel, in particular dog remains, ca. 14,500–13,300 BP (Street et al., 2006). These records are not consistent with the model of the Late Palaeolithic settlement in the Rhineland in which the end of the Magdalenian settlement and the beginning of the backed blade complex (Federmesser) is dated around 14,000 BP. Late radiocarbon dates have been obtained from a sequence of layers at the Krucza Skała, although the Magdalenian remains are very enigmatic. Sound arguments in the discussion concerning the end of the Magdalenian are provided by the new chronological records of Wierzawice site.

6. Conclusions

In recent years, the different methods of numerical dating have become significantly more commonly used. This has resulted in longer series of dates coming from a single site. Therefore, there is a possibility to compare reliably the results of dating carried out with the use of different techniques. This significant advantage in testing the chronology of hunter and gatherer activity enabled presentation of this new interpretation concerning dynamics and time range of the settlement in Poland in the Upper Pleistocene, especially in the beginning of MIS-3 and at the end of MIS-2 and during MIS-1 (GS-2b–GI-1).

The area, similarly to other regions of Central Europe, was occupied synchronously by groups of the late Neanderthals that produced the Micoquian and Mousterian industries. Additionally, the new data challenge the former concept of the transitional industries, by indicating the importance of chronological overlap of Middle Palaeolithic and transitional industries. This phenomenon supports the model of co-existence of two complexes at the same period. Additionally, the recent data allow rejection of the hypothesis of the development of transitional complexes in the Polish territory with the direct participation of the Upper Palaeolithic impulses. The idea of acculturation is ungrounded due to the time gap between the transitional industries and the first Aurignacian colonists.

The situation during the last glacial (MIS-2 and MIS-1) was also complex. For a considerable part of the last glacial maximum (ca. 19,000–17,000 BP), the southern regions of Poland were settled occasionally. The dynamics and character of the settlement are difficult to determine precisely, due to the problems with specifying the age of cave deposits from which the traces come from. The dataset coming from the same layers of caves show large discrepancies, sometimes as much as 12,000 years. From the period of GS-2c/2b, the sites of the Magdalenian tradition (Maszycka Cave) and the so-called Epigravettian/Kosovien (Targowisko 10) are known. The beginning of a proper Magdalenian colonisation of the Polish territory took place between GS-2b and GS-2a, ca. 16,500–16,000 BP. The camps from that early period show the distinct remnants of residential structures and organisation of site space, many art items and use of pigments, similar to the oldest sites from Thuringia (Kniegrotte). Therefore, they have no “pioneer” features *sensu* Housley et al. (1997). They rather suggest that from the beginning of the colonisation, a stable network of territorial exploitation was created that was similar to a logistic system. Most radiocarbon data from the Magdalenian camps indicate that the development of that settlement took place in GS-2a and GI-1e, mainly in Little Poland and Upper Silesia. The different single records coming from the end of the interstadial (GI-1c–a) may be the result of contamination of samples, but it is not excluded that the Magdalenian style of life survived in some regions in southern Poland until the Allerød.

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.

Allain, J., Desbrosse, R., Kozłowski, J.K., Rigaud, A., Jeannet, M., Leroi-Gourhan, A., 1985. Le Magdalénien à navettes. Gallia Préhistoire 28, 37–124.

Allsworth-Jones, P., 2004. The Szeletian revisited. Anthropologie (Brno) 42 (3), 281–296.

Anthony, D., 1990. Migration in archaeology: the baby and the bathwater. American Anthropologist 92, 895–914.

Binford, L.R., 1980. Willow smoke and dog's tails: hunter–gatherer settlement systems and archaeological site formation. American Antiquity 45 (1), 4–20.

Bird, M.I., Ayliffe, L.K., Fifield, L.K., Turney, C.M., Cresswell, R.G., Barrows, T.T., David, B., 2006. Radiocarbon dating of “old” charcoal using a wet oxidation, stepped-combustion procedure. Radiocarbon 41 (2), 127–140.

Blaauw, M., 2010. Methods and code for “classical” age-modelling of radiocarbon sequences. Quaternary Geochronology 5, 512–518.

Blockley, S.P.E., Donahue, R.E., Pollard, A.M., 2000. Radiocarbon calibration and Late Glacial occupation in northwest Europe. Antiquity 74, 112–119.

Bluszcz, A., Kozłowski, J.K., Foltyn, E., 1994. New sequence of EUP leaf point industries in southern Poland. Préhistoire Européenne 6, 197–223.

Bobak, D., Połtowicz-Bobak, M. Les nouvelles données sur le Szélétien en Pologne. In: Bodu, P. (Ed.), Le Paléolithique supérieur ancien de l'Europe du Nord-Ouest. Mémoire de la Société Préhistorique Française, Paris, in press.

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.

Bocheński, Z., 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. Folia Quaternaria 56, 3–56.

Bosinski, G., 1989. Die große Zeit der Eiszeitjäger. Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz 34 (1), 3–139.

Bratlund, B., 2002. The faunal remains from Wilczyce. In: Eriksen, B.V., Bratlund, B. (Eds.), Recent Studies in the Final Palaeolithic of the European Plain. Proceedings of a U.I.S.P.P. Symposium, Stockholm, 14.–17. October 1999, vol. 39. Jutland Archaeological Society Publications, Højbjerg, pp. 101–107.

Bronk Ramsey, C., 2008. Radiocarbon dating: revolutions in understanding. Archaeometry 50 (2), 249–275.

Bronk Ramsey, C., Higham, T., Bowles, A., Hedges, R., 2007. Improvements to the pretreatment of bone at Oxford. Radiocarbon 46, 155–163.

Burdukiewicz, J.M., 2011. Late Glacial hunter-gatherer reactions to the Younger Dryas cooling event in the southern and eastern Baltic regions of Europe. Quaternary International 242, 302–312.

Chmielewski, W., 1961. La civilisation de Jerzmanowice. Instytut Historii Kultury Materialnej Polskej Akademii Nauk, Wrocław.

Cyrek, K., 1994. Die jungpaläolitische Höhlenfundplatz Krucza Skała in Mittelpolen. Archäologisches Korrespondenzblatt 24 (4), 367–374.

Cyrek, K., 1999. Menschliche Penetration der Höhlen im mittleren Teil der Krakowsko-Częstochowska – Hochebene zwischen dem 18. und 11. Jahrtausend (vom Interstadial Lascaux bis zum Interstadial Alleröd). Folia Quaternaria 70, 269–288.

Cyrek, K., Nadachowski, A., Madeyska, T., Bocheński, Z., Tomek, T., Wojtal, P., Miękina, B., Lipecki, G., Garapich, A., Rzebik-Kowalska, B., Stworzewicz, E., Wolsan, M., Godawa, J., Kościów, R., Fostowicz-Frelik, Ł., Szyndlar, Z., 2000. Excavation in the Deszczowa Cave (Kroczyckie Rocks, Częstochowa Upland, Central Poland). Folia Quaternaria 71, 5–84.

Cyrek, K., Socha, P., Stefaniak, K., Madeyska, T., Mirosław-Grabowska, J., Sudoł, M., Czyżewski, Ł., 2010. Palaeolithic of Biśnik Cave (Southern Poland) within the environmental background. Quaternary International 220, 5–30.

Ehlers, J., Eissmann, L., Lippstreu, L., Stephan, H.-J., Wansa, S., 2004. Pleistocene glaciations of North Germany. In: Ehlers, J., Gibbard, P.L. (Eds.), Quaternary Glaciations – Extent and Chronology, Part I: Europe. Elsevier, Amsterdam, Boston, pp. 135–146.

Féblot-Augustins, J., 1997. La circulation des matières premières au Paléolithique. Synthèse des données perspectives comportementales. ERAUL 75. Liège.

Fiedorczuk, J., Schild, R., 2002. Wilczyce B: a new late Magdalenian site in Poland. In: Eriksen, B.V., Bratlund, B. (Eds.), Recent Studies in the Final Palaeolithic of the European Plain. Jutland Archaeological Society, Åarhus, pp. 91–100.

Fiedorczuk, J., Bratlund, B., Kolstrup, E., Schild, R., 2007. Late Magdalenian feminine flint plaquettes from Poland. Antiquity 81, 97–105.

Flas, D., 2011. The Middle to Upper Paleolithic transition in Northern Europe: the Lincombian–Ranisian–Jerzmanowician and the issue of acculturation of the last Neanderthals. World Archaeology 43 (4), 605–627.

Fort, J., Pujol, T., Cavalli-Sforza, L., 2004. Palaeolithic populations and waves of advance. Cambridge Archaeological Journal 14 (1), 53–61.

Ginter, B., Połtowicz, M., 2010. Magdalenian with triangles in Central Europe. In: Połtowicz-Bobak, M., Bobak, D. (Eds.), The Magdalenian in Central Europe. New Finds and Concepts. Fundacja Rzeszowskiego Ośrodka Archeologicznego, Instytut Archeologii Uniwersytetu Rzeszowskiego, SKAM – Flintreaders Society, Rzeszów, pp. 23–34.

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: Gancarski, J. (Ed.), Starsza i środkowa epoka kamienia w Karpatach polskich. Muzeum Podkarpackie w Krośnie, Krosno, pp. 111–145.

Ginter, B., Połtowicz, M., Pawlikowski, M., Skiba, S., Trąbska, J., Wacnik, A., Winiarska-Kabacińska, M., Wojtal, P., 2005. Dzierżysław 35 ein neuer Fundplatz des Maddalénien in Oberschlesien. Archäologisches Korrespondenzblatt 35 (4), 431–446.

Higham, T.G., Jacobi, R.M., Ramsey, C.B., 2008. AMS radiocarbon dating of ancient bone using ultrafiltration. Radiocarbon 48, 179–195.

Höck, Ch, 2000. Das Magdalénien der Kniegrotte. Ein Höhlenfundplatz bei Döbritz, Saale-Orla-Kreis. In: Weimerer Monographien zur Ur- und Frühgeschichte, vol. 35. Stuttgart.

Hoek, W.Z., Yu, Z.C., Lowe, J.J., 2008. INTegration of Ice-core, MArine, and TErrestrial records (INTIMATE): refining the record of the Last Glacial–Interglacial Transition. Quaternary Science Reviews 27, 1–5.

Housley, R.A., Gamble, C., Street, M., Pettitt, P., 1997. Radiocarbon evidence for the late glacial human recolonisation of Northern Europe. Proceedings of Prehistoric Society 63, 25–54.

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.

Jacobi, R., 2007. A collection of Early Upper Palaeolithic artefacts from Beedings, near Pulborough, West Sussex and the context of similar finds from British Isles. Proceedings of the Prehistoric Society 73, 229–325.

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

Jochim, M., Herhahn, C., Starr, H., 1999. The Magdalenian colonization of southern Germany. American Anthropologist 101 (1), 129–142.

Jöris, O., 2006. Bifacially backed knives (Keilmesser) in the Central European Middle Palaeolithic. In: Goren-Inbar, N., Sharon, G. (Eds.), Axe Age. Acheulian Toolmaking from Quarry to Discard. Equinox Publishing Ltd, London, pp. 287–310.

Kelly, R., 1995. The Foraging Spectrum: Diversity in Hunter–Gatherer Lifeways. Smithsonian Institution Press, Washington-London.

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, J.K., 1988. Problems of continuity and discontinuity between the Middle and Upper Paleolithic of Central Europe. In: Dibble, H.L., Montet-White, A. (Eds.), Upper Pleistocene Prehistory of Western Eurasia. The University Museum, University of Pennsylvania, pp. 349–360.

Kozłowski, S.K., 1994. The West Carpathians and Sudeten at the end of the Upper Palaeolithic. Preistoria Alpina 28/2 (1992), 127–137.

Kozłowski, J.K., 1996. Cultural context of the last Neanderthals and early modern humans in Central-Eastern Europe. In: The Colloquia of the XIII International Congress of Prehistoric and Protohistoric Sciences, Colloquium X: The Origin of Modern Man, Forli, pp. 205–218.

Kozłowski, J.K., 1999. Les origines de la récolonisation de la partie septentrionale de l'Europe centrale après le Pléniglaciaire. Folia Quaternaria 70, 317–331.

Kozłowski, J.K., 2000. Southern Poland between 50 and 30 kyr B.P., environment and archaeology. In: Orschiedt, J., Weniger, G.-C. (Eds.), Neanderthals and Modern Humans. Discussing the Transition: Central and Eastern Europe from 50.000–30.000. Neanderthal Museum, Mettmann, pp. 76–91.

Kozłowski, J.K., 2002. La Grande Plaine de l'Europe avant le Tardiglaciaire. In: Otte, M., Kozłowski, J.K. (Eds.), Préhistoire de la Grande Plaine du Nord de l'Europe: Les échanges entre l'Est et l'Ouest dans les sociétés préhistoriques. ERAUL 99, Liège, pp. 53–65.

Kozłowski, J.K., Kozłowski, S.K., 1996. Le Paléolithique en Pologne. Jérôme Millon, Grenoble.

Kozłowski, J.K., Pettitt, P.B., 2001. Absolute dating of the Polish Magdalenian. Fontes Archaeologici Posnanienses 39, 31–35.

Kozłowski, S.K., Sachse-Kozłowska, E., 1995. Magdalenian Family from the Maszycka Cave. Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz 40, 115–205.

Küssner, M., 2010. The Late Upper Palaeolithic in the catchment area of the River Sale – facts and considerations. Qartär 57, 125–137.

Lindner, L., 2005. A new look at the number, age and extent of the Middle Polish Glaciations in the southern part of central-eastern Poland (In Polish with English abstract). Przegląd Geologiczny 53, 145–150.

Litt, T., Behre, K.-E., Meyer, K.D., Stephan, H.-J., Wansa, S., 2007. Stratigraphische Begriffe für das Quartär des norddeutschen Vereisungsgebietes. Eiszeitalter und Gegenwart 56, 7–65.

Lorenc, M., 2006. Radiocarbon dating of some Late Pleistocene faunal assemblages in caves in Poland. Acta Zoologica Cracoviensia 49A, 41–61.

Marks, L., 2011. Quaternary glaciations in Poland. In: Ehlers, J., Gibbard, P.L., Hughes, P.D. (Eds.), Quaternary Glaciations – Extent and Chronology. A Closer Look, Developments in Quaternary Science. Elsevier, Amsterdam, pp. 299–304.

Mellars, P., 2005. The impossible coincidence. A single-species model for the origins of modern human behavior in Europe. Evolutionary Anthropology: Issues, News, and Reviews 14 (1), 12–27.

Mellars, P., 2006. Archaeology and the dispersal of modern humans in Europe: deconstructing the "Aurignacian". Evolutionary Anthropology: Issues, News, and Reviews 15 (5), 167–182.

Mojski, J.E., 1993. Europa w plejstocenie. Polska Agencja Ekologiczna, Warszawa.

Monigal, K., 2006. Transit lounge of Eastern Europe: multicultural crime during the late Middle Paleolithic and Early Upper Paleolithic. In: Conard, N.J. (Ed.), When Neanderthals and Modern Humans Met. Kerns Verlag, Tübingen, pp. 189–211.

Nadachowski, A., Żarski, M., Urbanowski, M., Wojtal, P., Miękina, B., Lipecki, G., Ochman, K., Krawczyk, M., Jakubowski, G., Tomek, T., 2009. Late Pleistocene Environment of the Częstochowa Upland (Poland) Reconstructed on the Basis of Faunistic Evidence from Archaeological Cave Sites. Institute of Systematics and Evolution of Animals Polish Academy of Sciences, Kraków.

Nadachowski, A., Lipecki, G., Wojtal, P., Miękina, B., 2011. Radiocarbon chronology of woolly mammoth (*Mammuthus primigenius*) from Poland. Quaternary International 245, 186–192.

Napierala, H., Uerpmann, H., 2012. A 'new' palaeolithic dog from central Europe. International Journal of Osteoarchaeology 22 (2), 127–137.

Neruda, P., 2006. Neandertálci na Kotouči u Štramberka. Archeologické Památky střední Moravy, 12. Olomouc.

Neruda, P., Nerudová, Z., 2009. Moravský Krumlov IV – vícevrstevná lokalita ze středního a počátku mladého paleolitu na Moravě. (Moravský Krumlov IV -a multilayer Middle and Early Upper Palaeolithic site in Moravia). Anthropos, 29 (N.S. 29). Moravské Zemské Muzeum, Brno.

Neruda, P., Nerudová, Z., 2011. The Middle–Upper Palaeolithic transition in Moravia in the context of the Middle Danube region. Quaternary International. http://dx.doi.org/10.1016/j.quaint.2011.08.035.

Pasda, C., 1998. Der Beginn des Magdaléniens in Mitteleuropa. Archäologisches Korrespondenzblatt 28 (2), 175–190.

Rasmussen, S.O., Andersen, K.K., Svensson, A.M., Steffensen, J.P., Vinther, B.M., Clausen, H.B., Siggaard-Andersen, M.-L., Johnsen, S.J., Larsen, L.B., Dahl-Jensen, D., Bigler, M., Röthlisberger, R., Fischer, H., Goto-Azuma, K., Hansson, M.E., Ruth, U., 2006. A new Greenland ice core chronology for the last glacial termination. Journal of Geophysical Research 111 (D06102), 1–16.

Reimer, P.J., Baillie, M.G.L., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Bronk Ramsey, C., Buck, C.E., Burr, G.S., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hajdas, I., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., McCormac, F.G., Manning, S.W., Reimer, R.W., Richards, D.A., Southon, J.R., Talamo, S., Turney, C.S.M., van der Plicht, J., Weyhenmeyer, C.E., 2009. IntCal09 and Marine09 radiocarbon age calibration curves, 0–50,000 years cal BP. Radiocarbon 51, 1111–1150.

Richter, J., 1997. Sesselfelsgrotte III. Der G-Schichten-Komplex der Sesselfelsgrotte. Zum Verständnis des Micoquien (Forschungsprojekt „Das Paläolithikum und Mesolithikum des Unteren Altmühltals II" Teil III). Quartär-Bibliothek 7, Saarbrücken.

Richter, J., 2002. Die 14C-Daten aus der Sesselfelsgrotte und die Zeitstellung des Micoquien/M.M.O. Germania 80, 1–22.

Rink, W.J., Schwartz, H.P., Valoch, K., Seitl, L., Stringer, C.B., 1996. ESR dating of Micoquian industry and Neanderthal remains at Külna cave, Czech Republic. Journal of Archaeological Science 23, 889–901.

Scott, E., 2009. Calibration introduction. Radiocarbon 51, 283–285.

Semal, P., Rougier, H., Crevecoeur, I., Jungels, C., Flas, D., Hauzeur, A., Maureille, B., Germonpré, M., Bocherens, H., Pirson, S., Cammaert, L., De Clerck, N., Hambucken, A., Higham, T., Toussaint, M., Van der Plicht, J., 2009. New data on the Late Neanderthals: direct dating of the Belgian Spy fossils. American Journal of Physical Anthropology 138, 421–428.

Sitlivy, V., Zięba, A., Sobczyk, K. (Eds.), 2008. Middle and Early Upper Palaeolithic of the Krakow Region. Piekary IIa. Musées Royaux d'Art et d'Histoire, Bruxelles.
Sitlivy, V., Zięba, A., Sobczyk, K. (Eds.), 2009. Middle and Early Upper Palaeolithic of the Krakow Region. Księcia Józefa. Musées Royaux d'Art et d'Histoire, Bruxelles.
Skrzypek, G., Wiśniewski, A., Grierson, P.F., 2011. How cold was it for Neanderthals moving to Central Europe during warm phases of the last glaciation? Quaternary Science Reviews 30, 481–487.
Street, M., Terberger, T., 1999. The last Pleniglacial and the human settlement of Central Europe: new information from the Rhineland site of Wiesbaden – Igstadt. Antiquity 73, 259–272.
Street, M., Terberger, T., Orschiedt, J., 2006. A critical review of the German Paleolithic hominin record. Journal of Human Evolution 51 (6), 551–579.
Stuart, A.J., Sulerzhitsky, L.D., Orlova, L.A., Kuzmin, Y.V., Lister, A.M., 2002. The latest wooly mammoths (*Mammuthus primigenius* Blumenbach) in Europe and Asia: a review of the current evidence. Quaternary Science Reviews 21, 1559–1569.
Svensson, A., Andersen, K.K., Bigler, M., Clausen, H.B., Dahl-Jensen, D., Davies, S.M., Johnsen, S.J., Muscheler, R., Rasmussen, S.O., Röthlisberger, R., Steffensen, J.P., Vinther, B.M., 2006. The Greenland Ice Core Chronology 2005, 15–42 ka. Part 2: comparison to other records. Quaternary Science Reviews 25, 3258–3267.
Svensson, A., Andersen, K.K., Bigler, M., Clausen, H.B., Dahl-Jensen, D., Davies, S.M., Johnsen, S.J., Muscheler, R., Parrenin, F., Rasmussen, S.O., Röthlisberger, R., Seierstad, I., Steffensen, J.P., Vinther, B.M., 2008. A 60 000 year Greenland stratigraphic ice core chronology. Climate of the Past 4, 47–57.
Svoboda, J., 2005. The Neanderthal extinction in eastern Central Europe. Quaternary International 137, 69–75.
Svoboda, J., 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.
Svoboda, J., Simán, K., 1989. The Middle–Upper Paleolithic transition in southeastern Central Europe (Czechoslovakia and Hungary). Journal of World Prehistory 3 (3), 283–322.
Svoboda, J., van der Plicht, J., Kuzělka, V., 2002. Upper Palaeolithic and Mesolithic human fossils from Moravia and Bohemia (Czech Republic): some new 14C dates. Antiquity 76, 957–962.
Terberger, T., 2003. Vom Gravettien zum Magdalénien in Mitteleuropa – Aspekte der menschlichen Besiedlungsgeschichte in der Zeit un des zweite Kältemaximum der letzten Eiszeit. Archäologisches Nachrichtenblatt 8, 55–62.
Terberger, T., Street, M., 2002. Hiatus or continuity? News results for the question of Pleniglacial settlement in Central Europe. Antiquity 76 (293), 691–698.
Urbanowski, M., Socha, P., Dąbrowski, P., Nowaczewska, W., Sadakierska-Chudy, A., Dobosz, T., Stefaniak, S., Nadachowski, A., 2010. The first Neanderthal tooth found North of the Carpathian Mountains. Naturwissenschaften 97, 411–415.
Valde-Nowak, P., Nadachowski, A., Madeyska, T. (Eds.), 2003. Obłazowa Cave: Human Activity, Stratigraphy and Palaeoenvironment. Institute of Archaeology and Ethnology, Polish Academy of Sciences, Kraków.
Valoch, K., 1966. Die altertümlichen Blattspitzenindustrien von Jezeřany (Südmähren). Acta Musei Moraviae 50, 6–60.
Valoch, K., 1988. Die Erforschung der Külna-Höhle 1961–1976. Moravské Muzeum e Anthropos Institut, Brno.
Valoch, K., 2010. Europäische Beziehungen des mährischen Magdalénien. In: Połtowicz-Bobak, M., Bobak, D. (Eds.), The Magdalenian in Central Europe. New Finds and Concepts. Fundacja Rzeszowskiego Ośrodka Archeologicznego, Instytut Archeologii Uniwersytetu Rzeszowskiego, SKAM – Flintreaders Society, Rzeszów, pp. 9–21.
Verpoorte, A., 2004. Eastern Central Europe during the Pleniglacial. Antiquity 78, 257–266.
Verpoorte, A., Šída, P., 2009. The Magdalenian colonisation of Bohemia (Czech Republic). Archäologisches Korrespondenzblatt 39 (3), 325–332.
Weniger, G.-C., 1989. The Magdalenian in western Central Europe: settlement pattern and regionality. Journal of World Prehistory 3 (3), 323–372.
Wilczyński, J., 2007. The Gravettian and Epigravettian lithic assemblages from Kraków-Spadzista B+B1: dynamic approach to the technology. Folia Quaternaria 77, 37–96.
Wilczyński, J., 2009. Targowisko – a new Late Glacial site in southern Poland. Eurasian Prehistory 6, 95–118.
Wiśniewski, A., 2006. Paleolit środkowy w dolinie Odry. Wydawnictwo Uniwersytetu Wrocławskiego, Wrocław.
Wiśniewski, A., Stefaniak, K., Wojtal, P., Zych, J., Nadachowski, A., Musil, R., Badura, J., Przybylski, B., 2009. Archaeofauna or palaeontological record? Remarks on Pleistocene fauna from Silesia. Sprawozdania Archeologiczne 61, 34–64.
Wiśniewski, A., Adamiec, G., Badura, J., Bluszcz, A., Kowalska, A., Kufel-Diakowska, B., Mikołajczyk, A., Murczkiewicz, M., Musil, R., Przybylski, B., Skrzypek, G., Stefaniak, K., Zych, J., 2013. Occupation dynamics north of the Carpathians and Sudeten during the Weichselian (MIS5d–3): the Lower Silesia (SW Poland) case study. Quaternary International 294, 20–40.
Wojtal, P., 2007. Zooarcheological Studies of the Late Pleistocene Sites in Poland. Institute of Systematics and Evolution of Animals Polish Academy of Sciences, Kraków.
Woodburn, J., 1982. Egalitarian societies. Man 17 (3), 431–451.
Zotz, L., 1939. Die Altsteinzeit in Niederschlesien. Curt Kabitzsch, Leipzig.
Żarski, M., Urbanowski, M., Kenig, K., Marcinkowski, B., Grabowska-Mirosław, J., 2012. Stratification and dating of the sediments from Stajnia Cave. In: Urbanowski, M. (Ed.), Stajnia Cave 2006–2010. Multidisciplinary Research. Chronicon, Wrocław.