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New information from Maszycka Cave and the Late Glacial recolonisation of Central Europe

Stefan Karol Kozłowski [a], Marta Połtowicz-Bobak [b], Dariusz Bobak [b], Thomas Terberger [c,*]

[a] Warsaw University, ul Krakowskie Przedmieście 26/28, PL-00927 Warsaw, Poland
[b] Institute of Archaeology, Rzeszów University, ul. Hoffmanowej 8, PL-35016 Rzeszów, Poland
[c] Unit of Prehistory, Historical Institute, University of Greifswald, Hans-Fallada-Straße 1, D-17487 Greifswald, Germany

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ABSTRACT

Maszycka cave is one of the most important Magdalenian sites in Central Europe. The assemblage is characterized by a considerable number of organic tools including points, *navettes* and a decorated perforated antler. The cave was related to the middle Magdalenian of western Europe and identified as one of the earliest Magdalenian sites of Central Europe. A series of four AMS-dates now assigns the site more precisely to the period 16,350 to 16,100 calBC (*c.* 15.000 BP). No other reliably dated Magdalenian sites of this early period of recolonisation of southern Central Europe are known and its clearest parallels to the west are the Grotte Grappin at Arlay in western France and perhaps the open air site Munzingen in southwestern Germany. After the first short episode of recolonisation, a more permanent Magdalenian expansion into Central Europe started hundreds of years later with sites such as Kesslerloch in northern Switzerland.

1. Introduction

There is an ongoing debate on the Late Glacial recolonisation of Central Europe. According to Housley et al. (1997) the process of resettlement was characterized by a pioneer phase and a subsequent residential phase with groups living permanently in different regions of Central Europe. This model has been challenged by methodological arguments (Blockley et al., 2000) and new archaeological data (Terberger and Street, 2002; Terberger, in press). Nevertheless, the systematic approach against the background of a larger record of radiocarbon dates contributed to a much better understanding of the process. A major problem in the discussion was and still is the lack of reliable radiocarbon dates for the early phase of recolonisation after Heinrich event 2 and the Last Glacial Maximum. This paper presents high precision AMS-dates for the most relevant site of the early Central European Magdalenian, the Maszycka Cave in southern Poland.

2. Maszycka Cave – general information

Maszycka Cave is located on the left slope of the Prądnik valley in the Kracow district (Fig. 1). In Palaeolithic times the cave entrance was about 6 m wide and 2.5 m high (Fig. 2). The entrance chamber (*ca* 40 m^2) and the back chamber (*c.* 13 m^2) are together about 13 m long. The cave mouth opens onto an approximately 10 m long terrace *c.* 20 m^2 in area (Kozłowski and Sachse-Kozłowska, 1995, 115).

Field work was begun in 1883 by G. Ossowski, who excavated the cave and a smaller part of the terrace (together *c.* 60 m^2). In the 1960s, field work outside of the cave by St. K. Kozłowski identified an undisturbed sequence of layers (Fig. 3). The finds were situated in loess layer 4 and in the overlying thin colluvial loess layer which contained the bulk of the material. Some degree of movement was indicated by the character of the sediment, but in general the finds formed "a homogeneous level in the profile" (Kozłowski and Sachse-Kozłowska, 1995, 120). The Late Glacial find layer was clearly separated from the topmost forest soil containing Neolithic and younger find material. In conclusion, a single Late Upper Palaeolithic occupation phase was proposed for Maszycka cave (Kozłowski et al., 1995, 120).

Since the 19th century, the Maszycka cultural material has been assigned to the Magdalenian (Ossowski, 1885) and in the early 20th century the site was widely recognised in Central Europe: "The most important finds of the Magdalenian period [in Poland] are those from Maszycka cave ...The character of the tools indicate an earlier Magdalenian" (Kostrzewski, 1928, 177–178; translation by the authors). Later, the assemblage was compared to the French Middle Magdalenian in general (Kozlowski and Kozlowski, 1964, 186) and the "*Magdalénien à navettes*" facies in particular. The most

* Corresponding author.
E-mail addresses: skkozlowski@op.pl (S.K. Kozłowski), marta.pb@archeologia.rzeszow.pl (M. Połtowicz-Bobak), d.bobak@lithics.eu (D. Bobak), terberge@uni-greifswald.de (T. Terberger).

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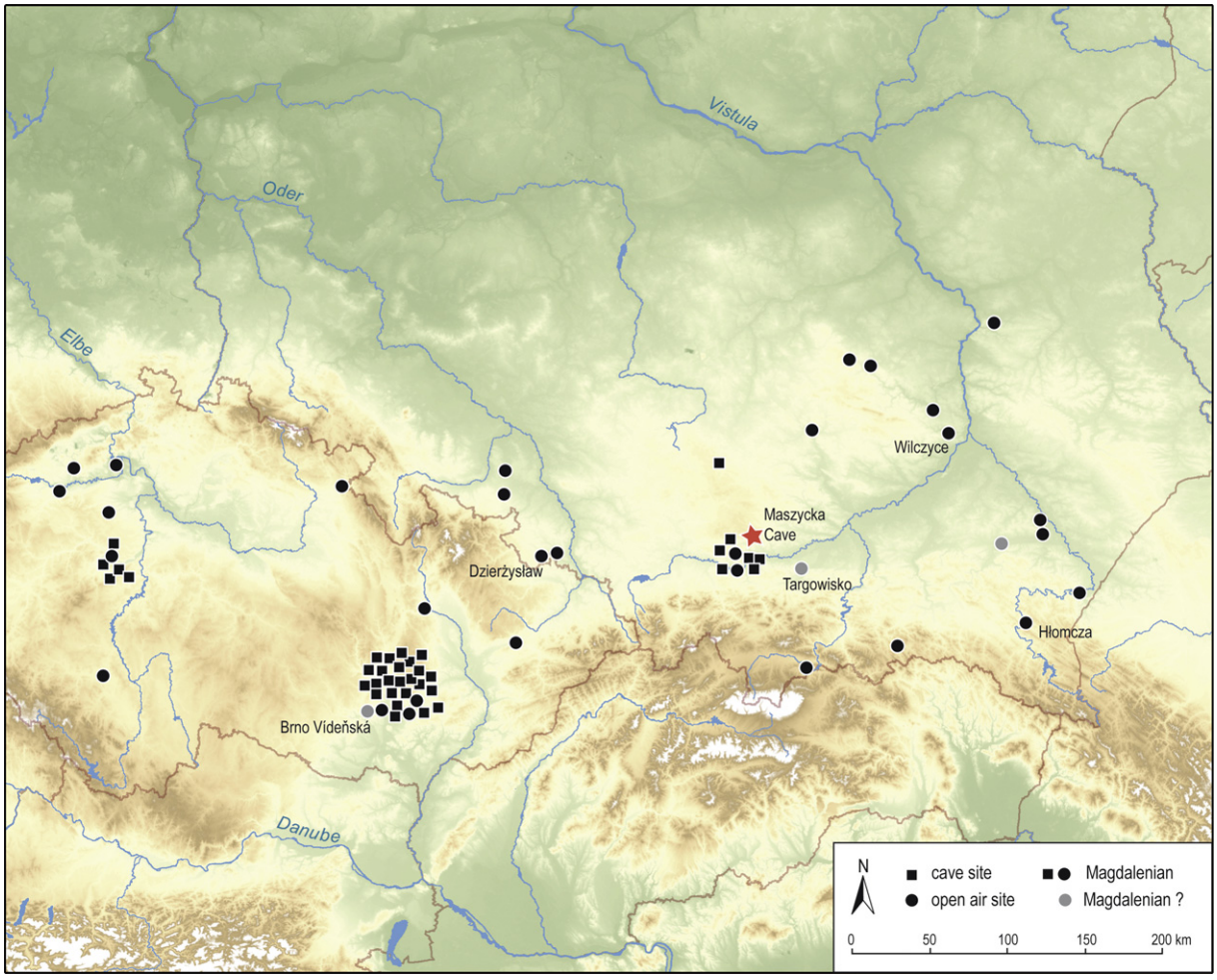

Fig. 1. Map of Magdalenian sites in eastern Central Europe (D. Bobak).

important features of this unit are common elements of the bone and antler industry such as *navettes* and *sagaies à biseau double* (Allain et al., 1985, 94–99; Pozzi, 2004, 17). A close connection to the French Middle Magdalenian was supported by analyses of the new find material and eastern relationships were also proposed, for example due to the presence of slotted bone tools (Fig. 8) (Kozłowski and Sachse-Kozłowska, 1995, 164).

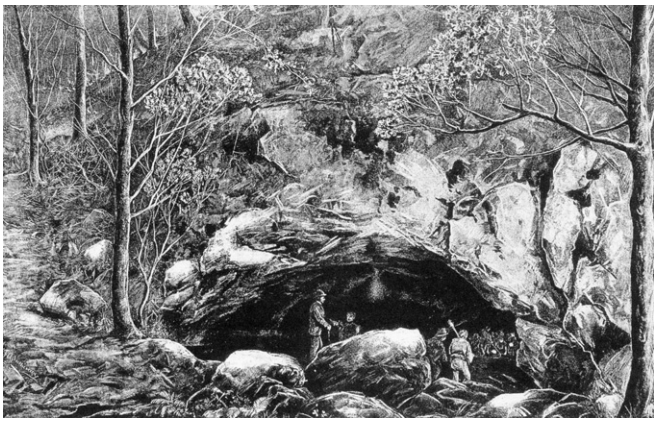

Fig. 2. Entrance of Maszycka cave in 1883 (after Kozłowski and Sachse-Kozłowska, 1995).

3. Find material

The Maszycka material shows remarkable conditions of preservation (Fig. 4) and about 360 faunal remains were identified to species (Fig. 5; Lasota-Moskalewska, 1995). They are dominated by horse, followed by reindeer, red deer, bovines, saiga and bear (mostly *Ursus arctos*). Most of the bones are broken and this probably reflects human activity. Some bones of rhinoceros suggest hunting of this large herbivore, while mammoth is only represented by some ivory artefacts. A minimum number of four individuals were recognized for horse, reindeer, red deer and saiga each, while other species are represented by single individuals (Lasota-Moskalewska, 1995, 234). Traditionally, rhinoceros is identified as a faunal element of the earlier Central European Magdalenian (Weniger, 1985, 94).

About 290 stone artefacts (without chips) are predominantly made of local raw materials (*c.* 95%), with some artefacts supposedly imported from more distant sources to the east and west (Kozłowski and Sachse-Kozłowska, 1995, 125–127). Cores up to *ca* 21 cm in length and regular blades demonstrate production of high quality blanks (Fig. 6). In most cases blades were struck from single platform cores, probably by soft hammer percussion technique. Modified artefacts consist of scrapers (18 specimens), backed pieces/bladelets (11 specimens), retouched blades and flakes, burins (7 specimens) and one perforator. In conclusion, the stone artefact assemblage is of late Upper Palaeolithic character.

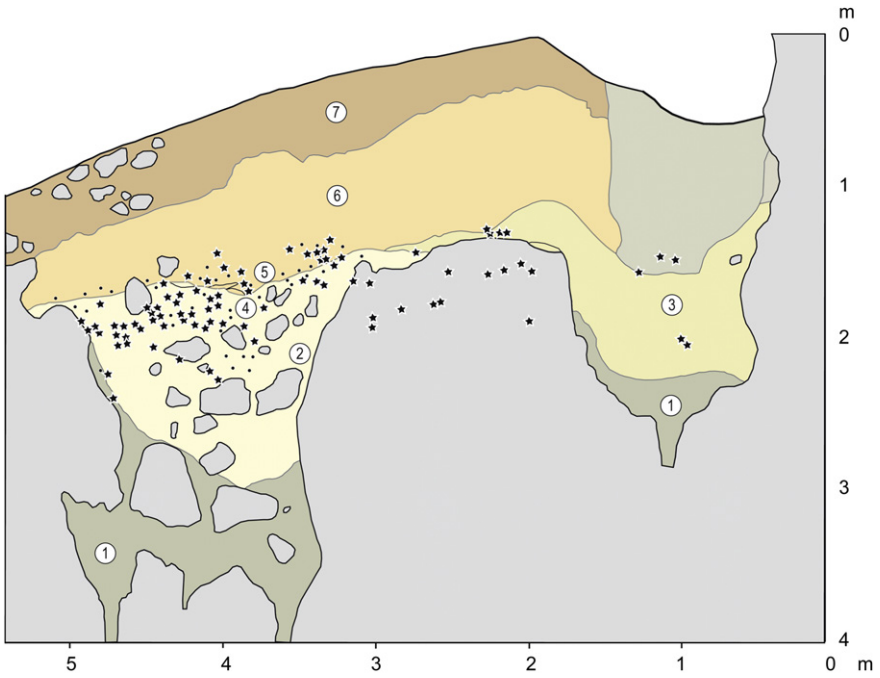

Fig. 3. Stratigraphy of Maszycka cave (after Kozłowski and Sachse-Kozłowska, 1995). Stars: artefacts. 1 clay. 2 eolian loess with rubble (small dots). 3 erosional channel filled with soliflucted clay. 4 on top and in the upper part of the loess with rubble and silt (2–3) isolated Magdalenian artefacts. 5 thin colluvial loess (5–10 cm) containing bulk of Magdalenian artifacts. 6 degraded loess. 7 forest soil with Neolithic/prehistoric finds.

Maszycka cave is rich in organic artefacts and the processing of bone, antler and ivory by the groove and splinter technique is demonstrated by some half-finished products. Points/*sagaies* are most numerous and the maximum length of the antler specimens exceeds 50 cm. Points/*sagaies* of different types and sizes are present (Fig. 4; Kozlowski and Kozlowski, 1964; Kozłowski and Sachse-Kozłowska, 1995, 148 pp.). Most of the specimens have a rectangular section and a single or double bevel base. Many of the pieces are decorated by geometric ornamentation (Fig. 4). Some grooved *sagaies* are also present and they too suggest a close relationship to the western European Middle Magdalenian. This is also indicated by eight *navettes* and their fragments, which are characterised by split ends (Fig. 7) and represent taxonomic markers of the *Magdalénien à navettes*. A close connection to the other organic artefacts is underlined by common elements of decoration. The function of the *navettes* will not be discussed here (Allain et al., 1985, 43–49).

There are other organic artefacts such as awls and polishers, while the most remarkable objects are a large rib and a perforated antler. The rib is about 40 cm long and has long slots along both edges. No organic glue is preserved, but it is quite possible that the slots were used for hafting (backed) bladelets (Fig. 8). The object can be characterised as a dagger and a prestigious function for the tool is suggested by geometric decoration. However, the most impressive tool is made of perfectly polished perforated reindeer antler, which shows phallus-like sculptured ends and additional decoration (Fig. 9).

Fig. 4. Bone and antler artefacts from Maszycka cave. Photo: D. Bobak.

Fig. 5. Skull of a saiga antilope from Maszycka cave. Photo: D. Bobak.

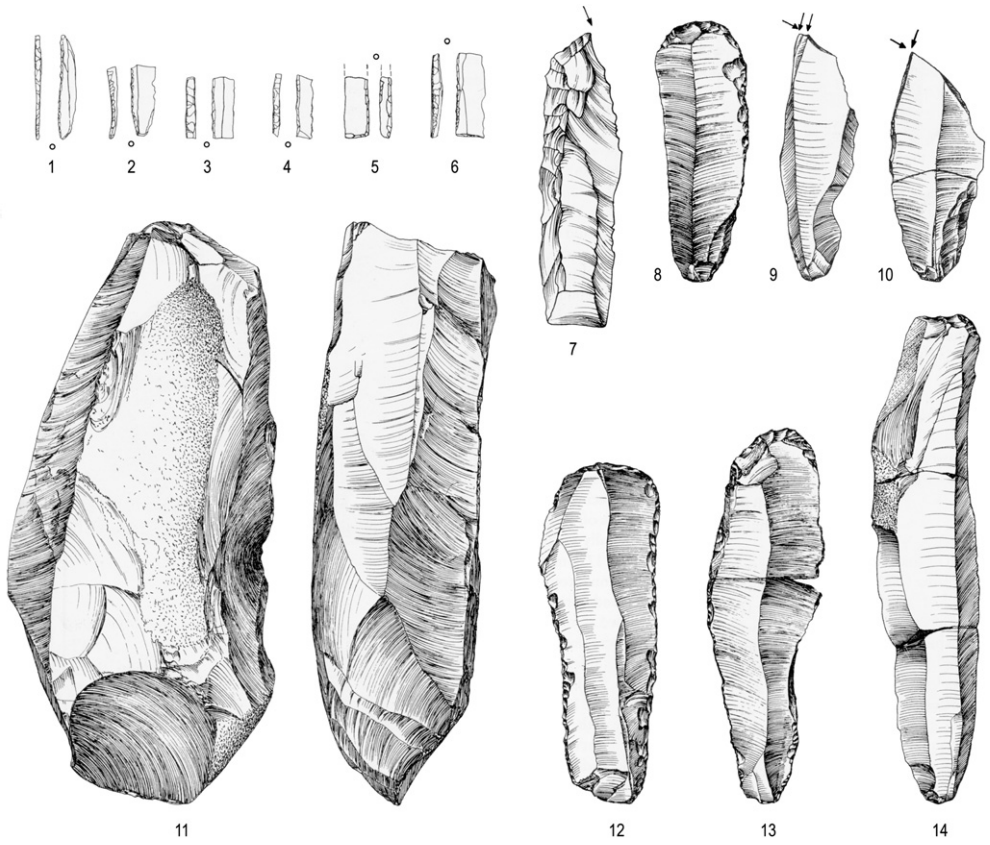

Fig. 6. Stone artefacts from Maszycka cave. Scale 2:5.

4. Numerical dating of Maszycka cave

The presence of *sagaies à double biseau*, the *navettes*, special elements of decoration (*décors en cupules*) and sexual/phallic symbols suggest a close connection of the Maszycka assemblage with the *Magdalénien à navettes* of the French record (Allain et al., 1985, 94–99). Phallic symbols are also present, for example, at the sites of Laugerie Basse and La Garenne.

Although two conventional radiocarbon dates of 15,490 ± 310 BP (Ly-2454) and 14,520 ± 240 BP (Ly-2453) supported the general assignment of the site to an early Central European Magdalenian context (Allain et al., 1985, 81) the two results differed by about 1000 radiocarbon years and three further dated samples gave clearly erroneous results (Kozłowski et al., 1995, 120).

In June 2009, five objects were therefore sampled for AMS-dating in order to test

- the early dating of the Magdalenian assemblage,
- the homogeneity of the find layer and
- the context of the human remains reported from the cave.

The dating was performed by the Leibniz-Laboratory at Kiel and pretreatment of the samples followed modern international standards[1] (Table 1).

A first sample was taken from a *navette* tool made of antler (inventory number 7; Fig. 10, 1). Unfortunately the object did not provide sufficient collagen. The second sample was obtained from another antler *navette* (inventory number 147; Fig. 10, 2) found on top of layer 2 about 4 m away from the cave entrance. The sample provided a date of 14,855 ± 60 BP (KIA 39225).

Fig. 7. Decorated navette from Maszycka cave. Scale 2:3. Photo: D. Bobak.

[1] Letter by P.M. Grootes 19.01.2010: "The sampled bone material was cleaned mechanically and crushed. The crushed bone material from KIA 39224 (sample 1; Maszycka 7) and KIA 39228 (sample 5; Maszycka 514) was subjected to a soxhlet type serial extraction (So) to remove fatty and waxy organic contaminants. In sequence, the material was extracted three times each with boiling tetrahydrofurane (THF), chloroform, petroleum-ether, acetone, and methanol and then rinsed with demineralized water. The material without soxhlet treatment (KIA 39225 to KIA 39227) was treated with acetone and rinsed with demineralized water. Then all of the bone sample material was demineralized in HCl (*ca* 1%). To remove mobile humic acids, the demineralized bone material was treated with 1% NaOH (20 °C, 1 h) and again with 1% HCl (20 °C, 1 h). The preferred dating material, bone collagen, was dissolved overnight as gelatin in H_2O_{dem} at 85 C and pH = 3. The non-soluble fraction, including a possible contamination, was filtered on a 0.45 μm pore silver filter. The gelatin solution was freeze-dried, and the gelatin was combusted as the "collagen sample", which on the whole is the method described by Longin. The combustion to CO_2 was performed in a closed quartz tube together with CuO and silver wool at 900 °C. The sample CO_2 was reduced at 600 C with H_2 over about 2 mg of Fe powder as catalyst, and the resulting carbon/iron mixture was pressed into a pellet in the target holder."

Fig. 8. Large dagger with slots on both sides made of a rib bone from Maszycka cave.

An antler point with simple geometric pattern was selected for sample 3 (inventory number 244; Fig. 10, 3). The date of 15,025 ± 50 BP (KIA 39226) is close to the first result.

Sample 4 was a human skull fragment (inventory number 328; Fig. 10, 4) and the piece gave an almost identical result of 15,015 ± 50 BP (KIA 39227). Sample 5 was extracted from a lower human jaw (inventory number 514; Fig. 10, 5). The date of 15,115 ± 60 BP (KIA 39228) is very slightly older than the other results.

Three of the dates overlap within one standard deviation and all dates overlap within two standard deviations. They support the proposition of a single Magdalenian layer at Maszycka cave dated to *ca* 15,000 BP. At the same time two dates confirm the Magdalenian context of the human remains. The oldest date is related to a lower $\delta^{13}C$ value of −16.03‰ and this value normally indicates a limited reservoir effect. However, use of marine resources for the diet can be ruled out for the individual living far away from the coast and the reason for this value remains unclear at the moment. In conclusion the date seems to be somewhat less reliable.

Calibration was performed by OxCal v4.17 (Bronk Ramsey, 2009; Reimer et al., 2009). Using CALIBrev 5.01 the following calibrated dates (one sigma range) are reported: 16517–16389 calBC, 16225–15999 calBC (probability 19.8% and 48.5%) (KIA 39225); 16609–16504 calBC, 16411–16109 calBC (probability 22.5% and 45.8%) (KIA 39226); 16596–16499 calBC, 16416–16184 calBC (probability 20.5% and 47.8%) (KIA 39227); 16718–16535 calBC, 16356–16279 calBC (probability 56.7% and 11.6%) (KIA 39228). Because of a wiggle around 15,000 BP calibration of the AMS results by the OxCal program (v4.17; Bronk Ramsey, 2009) produces dates between *ca* 16,700 and *ca* 16,000 calBC at the one sigma level (Figs. 11 and 12). However, only the period of *ca* 16,350 or 16,100 calBC fits to the calibration of all dates and makes the range of *ca* 16,350 to 16,100 calBC the parsimonious age for the layer.

The new AMS-dates make Maszycka cave the most reliably dated early Magdalenian assemblage of Central Europe.

Fig. 9. Perforated reindeer antler with phallus-like decorations from Maszycka cave. Photo: D. Bobak.

5. The Magdalenian of eastern Central Europe

Recent years have seen increasing evidence for the eastern Magdalenian and today about 70 sites are known from Poland and the Czech Republic (Fig. 1; Połtowicz-Bobak, 2009; Valoch and Neruda, 2005). No close parallel to the Maszycka cave can be described, but an AMS-date for the site of Brno-Videnská (or Brno-Konevova) obtained on a cutmarked bone testify to human presence in Bohemia at 14,820 ± 120 BP/*ca* 16,500 to 16,350 or *ca* 16,100 to 15,900 calBC (GrA-20001; Verpoorte, 2004, 262). The site was investigated in the 1970s by K. Valoch, who documented two concentrations around fire places. Unfortunately only a few faunal remains and stone artefacts were recovered which were assigned to an Epigravettian hunting camp (Valoch, 1975). Recently Neruda and Nerudova (2009, 2011) re-evaluated the assemblage and suggested two different occupation phases for the site: an earlier Magdalenian phase with cultural material in secondary position, which is associated with the AMS-date and a second undated phase of Epigravettian settlement documented *in situ*. If this interpretation is correct the Brno-Videnská site would demonstrate Magdalenian settlement in Bohemia at about the same period of time when the first Magdalenians were present further north at the Maszycka cave.

Additional information on the early phase of settlement is provided by the site of Targowisko located 30 km east of Krakow (Wilczyński, 2008). The fauna is dominated by horse remains and some reindeer bones were also found. About 4700 stone artefacts were collected, including a considerable number of modified artefacts such as burins and microlithic pieces. Unfortunately it is difficult to clearly identify the cultural context of the site (Magdalenian or Epigravettian?). The most reliable AMS-dates point to the period *ca* 16,500 to 16,350 or 16,100 to 15,600 calBC (Poz-14695: 14,820 ± 70 BP; Poz-14694: 14,520 ± 70 BP; Wilczyński, 2008, 115).

The dynamic phase of Magdalenian occupation of southern Poland and Moravia started more than 1000 years later (Valoch and Neruda, 2005; Ginter and Połtowicz, 2007; Neruda and Nerudová, 2008). Dzierżysław is a rich base camp located in Silesia with settlement features, such as pits and fire places, which probably indicate locations of former huts. More than 43,000 stone artefacts can be related to the "Magdalenian with triangles", which finds a close parallel at the Kniegrotte site in Thuringia (Höck 2000). A few bones of reindeer, horse and mammoth, as well as pollen analysis, indicate a tundra environment for the settlement (Ginter et al., 2005). AMS-dates assign Dzierżyslaw to *ca* 13,500 to 13,180 BP (mean value of 4 dates: 13,320 BP/*ca* 14,700 to 14,200 calBC; outlier date of 14,150 BP not counted; Połtowicz-Bobak, 2009, 56). This dating is in general accordance with results for Kniegrotte cave (mean value of 9 AMS-dates and 1 conventional date: 13,250 BP/*ca* 14,600 to 14,000 calBC; Höck, 2000, 37). One radiocarbon date on an unmodified mammoth bone was excluded. However, it is possible that originally two Magdalenian layers of *ca* 13,550 BP and 13,150 BP were present at the Kniegrotte cave.

Wilczyce is a further rich base camp site where more than 50,000 stone artefacts, many faunal remains of species such as rhinoceros, horse and reindeer, and bone tools were excavated (Fiedorczuk and Schild, 2002; Bałaga et al., 2008). Unfortunately the finds were not located *in situ* and some human foetus bones probably belonged to a destroyed grave (Irish et al., 2008). More than 30 female figurines made of flint are close to the "Gönnersdorf type" (Fiedorczuk et al., 2007) and connect Wilczyce to western Magdalenian sites such as Nebra, Andernach and Gönnersdorf. At Andernach and Gönnersdorf some new AMS-dates obtained recently (Stevens et al., 2009, Tables 1,2) point to *ca* 13,250 BP/*ca* 14,600 to 14,000 calBC (first activities) and *ca* 13.000 BP/13,900 to 13,300 calBC (main occupation phase).

Table 1
New AMS-dates Maszycka cave. ^{14}C dated samples.

Lab-No	Inv.-No	Object	Material	Collagen C	$\delta^{13}C$ in ‰	Conventional age in BP
KIA 39225	Maszycka 147	*navette*	antler	3.5 mg	−20.04 ± 0.45	14.855 ± 60
KIA 39226	Maszycka 244	point	antler	3.3 mg	−17.86 ± 0.35	15.025 ± 50
KIA 39227	Maszycka 328	human skull	bone	3.8 mg	−19.09 ± 0.40	15.015 ± 50
KIA 39228	Maszycka 514	human mandible	bone	4.2 mg	−16.03 ± 0.25	15.155 ± 60

In contrast, Hłomcza is a short term Magdalenian hunting camp with limited find material; unfortunately the site is not precisely dated (Łanczont et al., 2002). Additional evidence for Magdalenian hunting camps is available from Moravian sites such as the Nová Drátenická cave (OxA-1954: 12,900 ± 140, Oxa-1953: 13,870 ± 140 BP), Žitného (GrN-28453: 13,220 ± 90 BP) and Balcarova (GrN-28448: 13,930 ± 100 BP) (Valoch, 2001, 2009; Valoch and Neruda, 2005).

Also undated large (Klementowice Kolonia) and several smaller Late Magdalenian sites (Maly Antoniow, Mnikow, Grzybowa Gora, Okiennik, Krucza Skala, Sromowce Wyzne etc.) are known from southern Poland. They represent different Magdalenian traditions.

In summary, the start of the Magdalenian in eastern Central Europe is marked by the Maszycka cave, while only Brno-Konoveva might also be related to this early phase. The "main phase" of Magdalenian settlement in eastern Central Europe only started after a break of >1300 years and still hundreds of years before the onset of the late Glacial climatic amelioration (Greenland Interstadial 1e) (Połtowicz-Bobak, 2009, 56).

6. Parallels in the west

The Munzingen site located in the upper Rhine valley (Fig. 13) has been discussed as an early Central European Magdalenian for a long period of time, although radiocarbon results varying from 16,000 to 13,000 BP make closer dating of the find layer(s) problematic (Housley et al., 1997, 32). However, some bone points at Munzingen find parallels at French Middle Magdalenian sites such as Lascaux and Arlay (Pasda, 1998; Cupillard and Welte, 2006).

The Arlay site is a more reliable parallel for the Maszycka assemblage (Allain et al., 1985). Six *navettes* and several "*sagaies à doubles biseau souvent strié et à section quadrangulaire*" made of reindeer antler from the Grappin cave at Arlay are very similar to finds from Maszycka cave (Cupillard and Welte, 2006, 647). Additionally an oval decoration on an antler tool fragment closely resembles a *navette* from Maszycka (Fig. 7, Cupillard and Welte, 2006, 647 and 663 Fig. 14, Kozłowski and Sachse-Kozłowska, 1995, Figs. 23–24). Further common elements of decoration are lines of triangle-like motifs or "Y"-motifs and hatched ornaments. The first radiocarbon analysis broadly dated the Magdalenian layer

Fig. 10. AMS-dated objects from Maszycka cave. For description of the finds and AMs results see text.

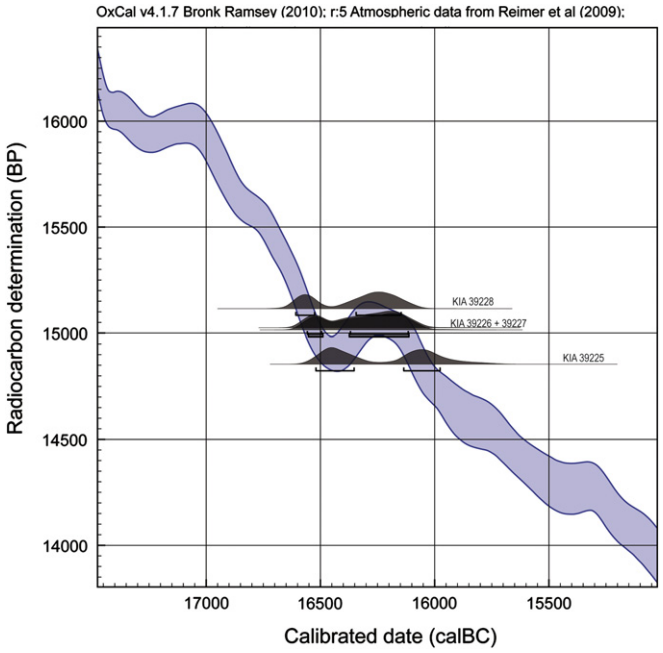

Fig. 11. Calibration of the AMS-dates by OxCal (v4.17; Bronk Ramsey, 2009) on the basis of data from Intcal09 (Reimer et al., 2009).

of interest at the Grappin cave to *ca* 14,200 to 15,800 BP. Unfortunately, the new AMS-dates do not really improve the situation. A horse bone from layer C was dated to 15,335 ± 100 BP (Ly-3161), while a reindeer bone from the same layer is dated much earlier to 16,840 ± 110 BP (Ly-3160) (Cupillard and Welte, 2006, 635). It is unclear whether there are two different (Middle) Magdalenian layers or if the earlier date is linked to a so far unidentified Badegoulian assemblage. At the same time it is unclear, whether both the samples were taken from modified bones. The AMS-date of *ca* 15,300 BP is rather close to the new AMS-dates for Maszycka cave, but the single result needs further confirmation. In conclusion the attribution of the site to the *Magdalenien à navettes* is still valid.

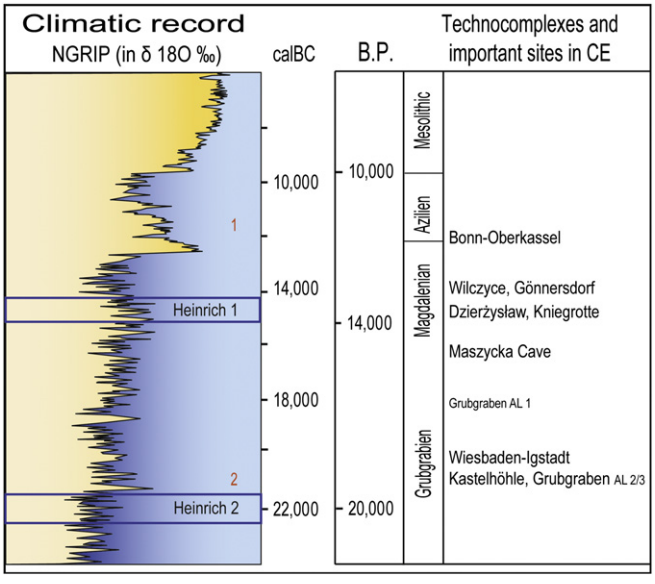

Fig. 12. Chronostratigraphy of the Last Glacial Maximum to the Late Glacial period with technocomplexes and important sites of Central Europe Red numbers refer to the Greenland Interstadials. (For interpretation of reference to color in this figure caption, please refer to the web version of this article.).

To the southwest, sites such as Verlay, Le Placard and La Garenne can also be associated with this cultural entity (Allain et al., 1985). At La Garenne systematic research of the lithic industry was supported by a series of radiocarbon dates. They assign level A with the *Magdalénien à navettes* "*…dans une fourchette des quelques siècles autour de 15,000 BP …*" (Aubry et al., 2007, 707) and the authors conclude a short period of time for the "*faciès à navettes du Magdalénien de la Garenne*".

The following phase of the Middle Magdalenian is dated to *ca* 14,500 to 14,000 BP/ (Primault et al., 2007, 10). Direct dates on saiga antelope remains indicate the species to be a typical element of this dry period of time (Dujardin and Tymula, 2005, 782).

In southern Central Europe the Kesslerloch cave with numerous finds – among them the famous decorated spear throwers (Heierli, 1907; Stodiek, 1993) – represents the subsequent phase of the Magdalenian. The typological evidence suggests a *Magdalénien IV* context for Kesslerloch cave (Bosinski, 1982, 27 and 55). Two AMS-dates on worked shed reindeer antler place the lower Magdalenian find layer of the site (level III Ac) to the time period *ca* 14,150 ± 100 BP/*ca* 15,450 to 14,150 calBC (OxA-5749) or to 13,670 ± 100 BP/*ca* 14,950 to 14,750 calBC (OxA-5750) (Housley et al., 1997, 29). However, improvement of bone and antler pretreatment chemistry (i.e. Jacobi et al., 2009) raise expectations of more accurate dating of the (lower) Magdalenian layer at Kesslerloch cave in future.

In conclusion the early Magdalenian layer at Maszycka cave remains an isolated phenomenon in Central Europe and the *Magdalénien à navettes* finds its next reliable parallel at the Grotte Grappin, Arlay in the French Jura at a distance of *ca* 1300 km to the west!

7. The early recolonisation of Central Europe

There is increasing evidence for a first phase of recolonisation in Central Europe from refugia in more southern regions soon after Heinrich Event 2 (Fig. 12). The most reliable evidence is available from sites such as Kastelhöhle-Nord in the Swiss Jura, Wiesbaden-Igstadt in the central Rhineland, Mittlere Klause in the Altmühl valley and Grubgraben in lower Austria (Street and Terberger, 2000; Terberger and Street, 2002; Terberger, in press). A close connection between human presence and the more favourable conditions of GI 2 is quite possible, but cannot be demonstrated because of insufficient dating precision. Most of the radiocarbon dates point to a phase from *ca* 19,500 to 18,500 BP/21,600 to 20,000 calBC. At Kastelhöhle-Nord, three radiocarbon dates were obtained on modified bones: 19,620 ± 140 BP (OxA-9738); 19,200 ± 150 BP (OxA-9739) and 18,530 ± 150 BP (OxA-9737) (Terberger and Street, 2002, 694; Sedlmeier, 2010, 12). The assemblages show similarities to the western Badegoulian (Terberger, 1998, 435; Sedlmeier, 2010, 25).

The radiocarbon evidence is in favour of dating these Central European sites somewhat before the initial stage of the Badegoulian which is normally dated younger than 19,000 BP (Terberger and Street, 2002; Terberger, in press). For the moment a settlement expansion from west to east is a less plausible scenario than the opposite way from east to west. There are isolated earlier dates for the Badegoulian for example from Le Placard (Dujardin and Tymula, 2005, 783) and new AMS-dates seem to support an earlier start of the Badegoulian (Ducasse and Lelouvier, in press).

For the subsequent period a few isolated cave sites such as Svobodně Dvory from eastern Central Europe with radiocarbon dates of the 17th millennium BP can be mentioned (Verpoorte and Šida, 2009, 329), but these sites do not demonstrate undisputable human presence. More promising evidence is available from Grubgraben layer 1 (Montet-White, 1990), which is dated to *ca* 18,300 to 17,500 calBC (Lv-1825: 16,800 ± 280 BP; Damblon et al., 1996). The lithic assemblage of layer 1 is characterised by the

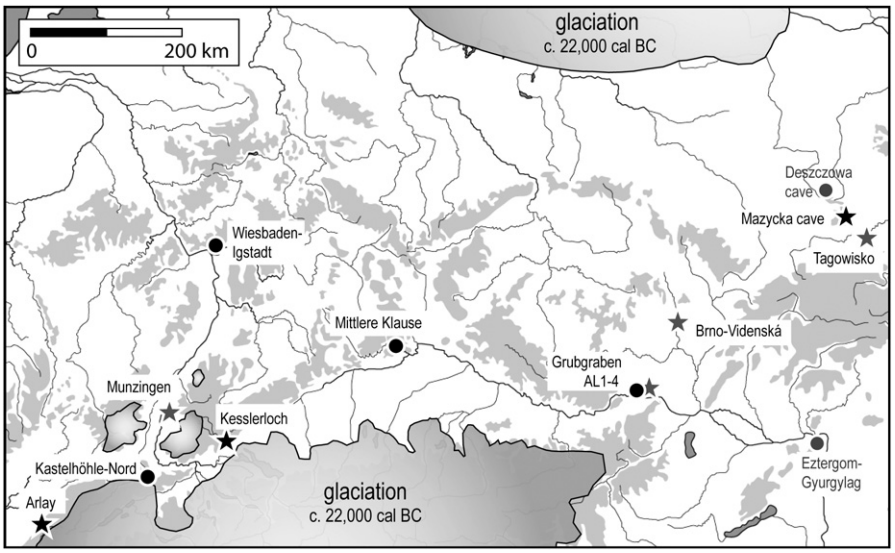

Fig. 13. Important sites mentioned in the text. Circles: sites dated after Heinrich event 2, *c.* 19,000–18,500 BP/*c.* 21,300–20,000 calBC. Stars: early Magdalenian sites of Central Europe. Grey: identification uncertain. For more detailed information see text.

systematic production of bladelets, with a bone flute and a decorated perforated antler being the most prominent finds (Einwögerer and Käfer, 1998). Unfortunately no detailed information is available for the assemblage and further analysis is needed to better evaluate the significance and relationship of Grubgraben layer 1. No reliable parallel can be mentioned from neighbouring regions to the west and north. Recently an early Magdalenian assemblage with backed bladelets published from the Grotte du Taillis du Coteaux (layer IIIa) close to Antigny in Poitou-Charentes was dated to about the same time period (*ca* 17,100 BP; Primault et al., 2007, 15).

Undisputable evidence for a second phase of recolonisation of (southern) Central Europe is related to the *Magdalénien à navettes* from Maszycka cave. The similarities to the sites in France mentioned above leave little doubt about the western affiliation of the assemblage. An isolated AMS-date from Arlay is about 200 years older than the layer from Maszycka cave, but this cannot be used to propose an earlier start of this phase in the west. It is quite possible that *Magdalénien à navettes* sites separated by a distance of more than 1000 km date more or less to the same short period around 15,000 BP/*ca* 16,350 to 16,100 calBC (see above). The middle Magdalenian in France is characterised as a phase when ideas and objects circulated over long distances (Langlais, 2010, 283).

The fact, that no sites from this period were identified yet from the Swabian Alb or from Bavaria, suggests this phase represented a short occupation episode leaving little traces in the landscape. However, the variety of raw materials and imported pieces from Maszycka cave argue for a hunter-gatherer group familiar with the resources of the landscape.

If this scenario is correct, the Danube valley was probably the route of expansion. A few artefacts from Maszycka cave are assigned to a southern German raw material source and would support this route (Kozłowski and Sachse-Kozłowska, 1995). Work is in progress to confirm this identification. Super regional contacts from west to east around 15,000 BP might also be reflected by a decorated bone pendant from the site Bois-du-Roc à Vilhonneur, Charente. The unusual geometric pattern covering the surface finds its best parallels at the Mezin site, Ukraine (Dujardin and Gomez de Soto, 2001). An east-west corridor at this time is suggested also by the presence of saiga antelope both at western sites and at Maszycka cave (Kozłowski et al., 1995, 165; Dujardin and Tymula, 2005).

After a break of *ca* 1000 years the Kesslerloch cave in south-western Central Europe represents a later phase of Magdalenian expansion from the west. From *ca* 14,500 to 13,900 calBC/13,200 BP onwards and well before the onset of Greenland Interstadial 1 Central Europe saw a remarkable increase of Magdalenian sites up to the border of the upland zone in the north and greater Poland in the east (Street et al., 1994; Housley et al., 1997; Fiedorczuk et al., 2007).

In conclusion, these results are in favour of interpreting the recolonisation of Central Europe after the Last Glacial Maximum as a sequence of episodes of expansion, perhaps interrupted by phases of regional extinction, and intervening centuries with no human presence in Central Europe. Similar ideas on a more general scale have been discussed by Hublin and Roebroeks (2009) for the presence of Neanderthals in northern environments.

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