From the Atlantic to Beyond the Bug River

Finding and Defining the Federmesser-Gruppen/Azilian

RGZM

Sonja B. Grimm · Mara-Julia Weber
Ludovic Mevel · Iwona Sobkowiak-Tabaka (eds)

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NOT QUITE AS FAR AS FROM THE ATLANTIC TO BEYOND THE BUG RIVER – AN EDITORIAL

To Martin Street, our friend and teacher

The history of this volume begins in September 2012 when three of the editors met at MONREPOS Archaeological Research Centre and Museum for Human Behavioural Evolution (part of the Römisch-Germanisches Zentralmuseum, Leibniz-Forschungsinstitut für Archäologie, a member of the Leibniz Association). While Sonja B. Grimm has been writing her PhD about the transition from Magdalenian to Federmesser-Gruppen in North-West Europe (Grimm 2019) there, Ludovic Mevel stayed for several months to analyse some of these assemblages technologically to compare them to French inventories within a Post-Doc project (Mevel / Grimm 2019). During this time, Iwona Sobkowiak-Tabaka came to examine some Federmesser-Gruppen material from Central Rhineland sites for comparative reasons within her habilitation project about the Federmesser-Gruppen on the North European Plain (Sobkowiak-Tabaka 2017). She was hosted by Martin Street who also functioned as Sonja's tutor. In this culture clash of English, French, German, and Polish traditions of thoughts on the Federmesser-Gruppen and Azilian, we realised that it could be very fruitful to bring together these different approaches of material culture and spatial studies. In a direct comparison we hoped to find answers to questions such as:

What do we actually know about the groups living in Western and Central Europe during the Weichselian Lateglacial Interstadial? How are they reflected in the archaeologically defined groups that we call Azilian and Federmesser-Gruppen? Do they represent related groups or even a single entity? Or were they formed by many rather different groups of hunter-gatherers with a similar way of life? Were they contemporaries or chronological successors? And how are these related to the Epigravettian industries in Southern and South-eastern Europe?

In order to gather different ways of approaching these questions, Martin Street suggested to organise a session on behalf of the UISPP commission »The Final Palaeolithic of Northern Eurasia« but left the details to us »younger ones«. Yet, Martin's influence as researcher, mentor, host, peer, and friend was always present during the process of organising and holding the session as well as in the production of this volume.

Considering the geographic extent of assemblages attributed to the Azilian and / or Federmesser-Gruppen and the differences therein, we quickly dropped the idea of also including the Epigravettian. Instead, to include directly the Northern European research tradition in the organising team, we turned to Mara-Julia Weber working in Schleswig and together prepared a session for the XVIIth UISPP congress. So in September 2014, a session with the title »From the Atlantic to beyond the Bug River – Finding and defining the Federmesser-Gruppen / Azilian on the North European Plain and adjacent areas« was held in Burgos (Spain). It consisted of an introductory talk, nine presentations and a poster covering the area from the United Kingdom, France, Germany, the Czech Republic, and Poland. Hence, from the northern Carpathians to beyond the English Channel would have been the more appropriate title to describe the actual geography covered by our contributions. Three of these presentations were – by the time – on-going PhD projects (W. Mills, M. Monik, F. Sauer) which showed that the questions relate to a topical subject of study and the results will be picked up by a young generation of scientists.

However, the variety of nomenclature already displayed in these talks showed the necessity but also the difficulty of the prospective discussion. Federmesser-Gruppen and Azilian were used almost evenly but also Arch-Backed Point (ABP) groups, Lateglacial, Late Palaeolithic, and Late Upper Palaeolithic were used to describe the material from this period. This plurality might indicate a few different groups but often they rather referred to different scales or appeared rudiments of different scholarly traditions (cf. Sauer/Riede 2019). In general, terms such as Federmesser-Gruppen, Azilian, Penknife Point phase, Tjongerian, Curve-Backed Point groups, or ABP are general representatives for a period when foragers roamed in a boreal environment and, thus, were already different from the classic Upper Palaeolithic hunter-gatherers of the Late Pleistocene steppe landscapes but were not fully Mesolithic yet. The difference to perhaps more local groups such as the Tjonger group, Witowian, or Atzenhof group is often fuzzy. These variable levels reflect different spatial and chronological sections of the hardly distinguishable scale of human social units. It is generally difficult to identify these units based on archaeological material that is then compared over increasingly large areas and timespans. This taxonomic approach becomes particularly difficult if it is applied to periods when only low cost strategies are used (Vaquero/Romagnoli 2018) such as it appears during the here discussed period. The decrease of elaborate and standardised behaviours – compared to the previous Magdalenian technological behaviours – reflected in the material record give only very few possibilities to link differences in the material to group traditions. These few and/or small differences are then likely to be overestimated.

Besides the difficulty of identifying the material, processes during and after the Younger Dryas also affected the *in situ* preservation and visibility of the material. For instance, taphonomic disturbances of the material deposition occurred when deep frozen grounds melted and caused significant *in situ* sediment loss or the material became inaccessible due to cover by sometimes very thick coversands. Finally, the preservation conditions become less favourable for organic material in environments with richer biogenic interactions and reduced mineral coverage. The long bog development that occurred during the Holocene seemed to have no equivalent in the Lateglacial Interstadial. Hence, less diverse remains were preserved to base the studies on.

Furthermore, chronostratigraphic terms such as Meiendorf, Bølling, or Allerød were also used differently (cf. Terberger/Barton/Street 2009, tab. 1). So when trying to at least correlate the archaeological terms spatially and chronologically again quite some confusion can be caused. This also applies to the radiocarbon dates that are sometimes given as raw radiocarbon data (in this volume identified as ^{14}C-BP) and sometimes calibrated data (in this volume given as cal. BC). The difference is occasionally not visible.

Hence, before being able to explore the inconsistent use of terminology as one of the main aims of the session, we had to find a way between the wide-spread wish to remain within the own frame of traditions and the establishment of a shared frame of references. Although we attempted to unify some general terminology within the different contributions, different concepts remained and the need for a common analysis to come up with a classification we can all work with is still a desideratum. However, single-minded attempts will not solve the problem but rather add yet another new taxonomy that has not grown from a reunification of traditions. Instead of this top-down approach, a bottom-up approach of unifying the recording systems is on its way, for example the work of L. Mevel using one technological approach to describe the assemblages from the Paris Basin and the Rhineland was taken to the north in cooperation with M.-J. Weber and will be continued in a PhD thesis about the Federmesser-Gruppen in northern Germany and Denmark by T. Burau. Anyway, to come to results that can be compared across wider geographic areas, we all have to leave the comfort zone of our national narratives and analytical traditions and see what in a greater framework is possible. In this volume, we assemble contributions from different parts of North-Western and Central Europe (France, UK, Belgium, Germany, Poland, Czech Republic). Lithic industries still remain the main archaeological source (Sobkowiak-Tabaka; Pyżewicz et al.; Valde-Nowak and Kraszewska) but recent research has also been

exploring and combining further sources of information such as faunal and spatial data and geo- and environmental archives (Bignon-Lau; Mills; Crombé; Sauer; Monik and Pankowská). With regard to the research topics addressed, one can observe two main perspectives by which the relationship between archaeological entities in the mid-Lateglacial Interstadial is regarded: spatial behaviour on variable scales, from site to landscape, on the one hand and the cultural attribution of single lithic inventories on the other hand.
We may not have come closer in defining the Federmesser-Gruppen and/or Azilian but we hope that this book will keep the discussion about these Final Palaeolithic hunter-gatherer groups on-going, especially as they received some relevance in relation to the Epigravettian in the light of aDNA results (Posth et al. 2016; Fu et al. 2016).

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WILLIAM MILLS

IS THERE ANY ORDER TO THIS CHAOS? PATTERNS OF SPACE, STONE, AND PLACE IN LATEGLACIAL SOUTH-EAST ENGLAND AND THE CHANNEL RIVER NETWORK

This paper presents a qualitative archaeological overview of the south-east of England and the Channel River network as well as some initial spatiotemporal renderings that enable a better understanding of the Lateglacial (LG) North-West European lithics and techno-cultures.

Significant quantities of data covering LG human activity in South-East England are currently held across a number of domains with varying degrees of quality and quantity, managed by different institutions in the United Kingdom (UK). As part of my doctoral research, I have explored methods for comparing and integrating these datasets within a Geographic Information System (GIS) during the initial stage of my analysis of British LG assemblages of the Channel River catchment. The methodology presented here enables spatial analyses at specific scales, different chronologies and palaeo-environmental backgrounds for a fully integrated interpretation of archaeological finds, sites, and distributions. This is illustrated with a pilot study of the archaeology associated to the Wey and Mole River catchments.

This work is driven by questions connected to the evolution of research on the LG of Britain over the last 30 years. My methodology combines GIS with an ongoing regional lithic analysis, both tools used to explore the overarching theme of this research. LG site locations and the potential role played by rivers in LG landscapes (Howard et al. 2015) are seen to create dynamic environments for human activities (Barton / Roberts 1996; Barton et al. 2003; Jacobi 2004; Conneller 2007; Barton et al. 2009; Barton 2012). This will assist in the contextualisation of LG distribution patterns from South-East England within the dynamic landscape of the Channel River catchment, one of the most extensive fluvial systems in Northern Europe during the LG (Gibbard / Rose / Bridgland 1988; Coles 1998; Antoine et al. 2003b; 2007; Gupta et al. 2007; Gibbard 2007; Westaway / Bridgland 2010)[1]. By characterising the Channel River's changing role as a dividing or linking factor dominating the North-West European landscape during the LG and Early Holocene, a new perspective for analysing LG site distributions is envisaged.

This doctoral project is divided into five phases:

1) Collection of background data and initial assessment of the national LG distributions; creation of a topographic template using GIS; modelling of river catchments; selection of case studies based on available datasets,
2) Lithic data collection and assessment: characterisation of industries based on an extensive literature review and comparative examinations; a test study assessing the databases in the selected region; ground testing by assessing selected collections; re-recording of principal South-East English assemblages within the study area using a revised recording methodology; assessing the diagnostic values of the criteria used to interpret the assemblages,
3) Integration of qualitative assessments of the assemblages (e. g. recovery and taphonomic assessment) and the diagnostic elements (e. g. lithics analysis) into the database,
4) Expansion into a larger regional context with the integration of palaeo-environmental and dating datasets within a chronological framework,
5) Spatial analysis of the distributions in relation to the course of the Channel River using GIS.

The methodological, landscape modelling, and database assessment aspects of the first two phases of this research were presented at Burgos in October 2014, and are the subject of this paper. These are based on the following questions:

1) What is our current understanding of the LG landscape distribution of South-East England, and which datasets exist for its interpretation?
2) What are the resolutions for the different datasets, and how is it possible to apply different types of analysis so as to optimise the use of the available data at different scales?

COMPOSITION OF THE LG DATASETS FOR SOUTH-EAST ENGLAND

Current context and distribution of the LG archaeology of South-East England

Cave sites have dominated our perspective of LG archaeological contexts for nearly a century (Garrod 1926; Campbell 1977; Collcutt 1984; Barton/Roberts 1996; Barton et al. 2003; Jacobi 2004). In more recent years the archaeological assemblages recovered from caves have once again been at the forefront of LG research, with a focus on radiocarbon dating and faunal analysis, as caves currently provide the best conditions for preserving organic materials of this age (Jacobi/Higham 2009; 2010). Nevertheless, it has also long been recognised that the limestone regions, where most cave sites are located, represent only a small proportion of the potentially occupied land in Britain during the LG (Reid 1913; Coles 1998). Although not as well-known or immediately as apparent as the cave sites, the distribution and recent discovery of open-air sites continues to suggest a much more extensive occupation of Britain (Barton 1986; 1992; Barton/Roberts 1996; Barton et al. 2003; 2009; Cooper 2006; Conneller/Ellis 2007; Garton/Jacobi 2009; Ballin et al. 2010; Jones 2013; Attfield et al. 2014).

The nature of archaeological research in England has changed dramatically over the last 30 years, notably with the introduction of »Planning Policy Guidance 16« in 1990. This policy transformed the way planning permission was provided, culminating with the introduction of the National Planning Policy Framework (NPPF) in 2012 (Cooper 2012; Department for Communities and Local Government [DCLG] 2012; Flatman/Perring 2013; Historic England 2014). All of the LG excavations undertaken since 1990 in South-East England, except for Avington VI, and two test pits at Brockhill, Surrey, by the Surrey Archaeological Society, have been developer led (Dumont 1997; Barton 1998; Cooper 2012; Mills 2013). The nature of the excavations and research has also resulted in a transformation of how the results of interventions are published, with the vast majority within the realms of »grey literature« (unpublished reports for developers), and only rare sites published as collaborations between university researchers and commercial archaeological »units« in academic journals such as »Proceedings of the Prehistoric Society«, or as monographs (Farr 2009; Cooper 2012; Cooper/Green 2016).

A new challenge concerning the exponential number of interventions associated to developer funded excavations is keeping track of current work, and compiling recognised or »diagnostic« elements (individual finds, scatters, excavations, and palaeo-environmental sequences) within a searchable framework for future cross-referencing and consultation. Currently the Archaeology Data Service (ADS) is hosting an initiative to create a searchable online index to grey literature throughout the UK. Already over 30,000 reports have been indexed (ADS 2015a; Cooper/Green 2016).

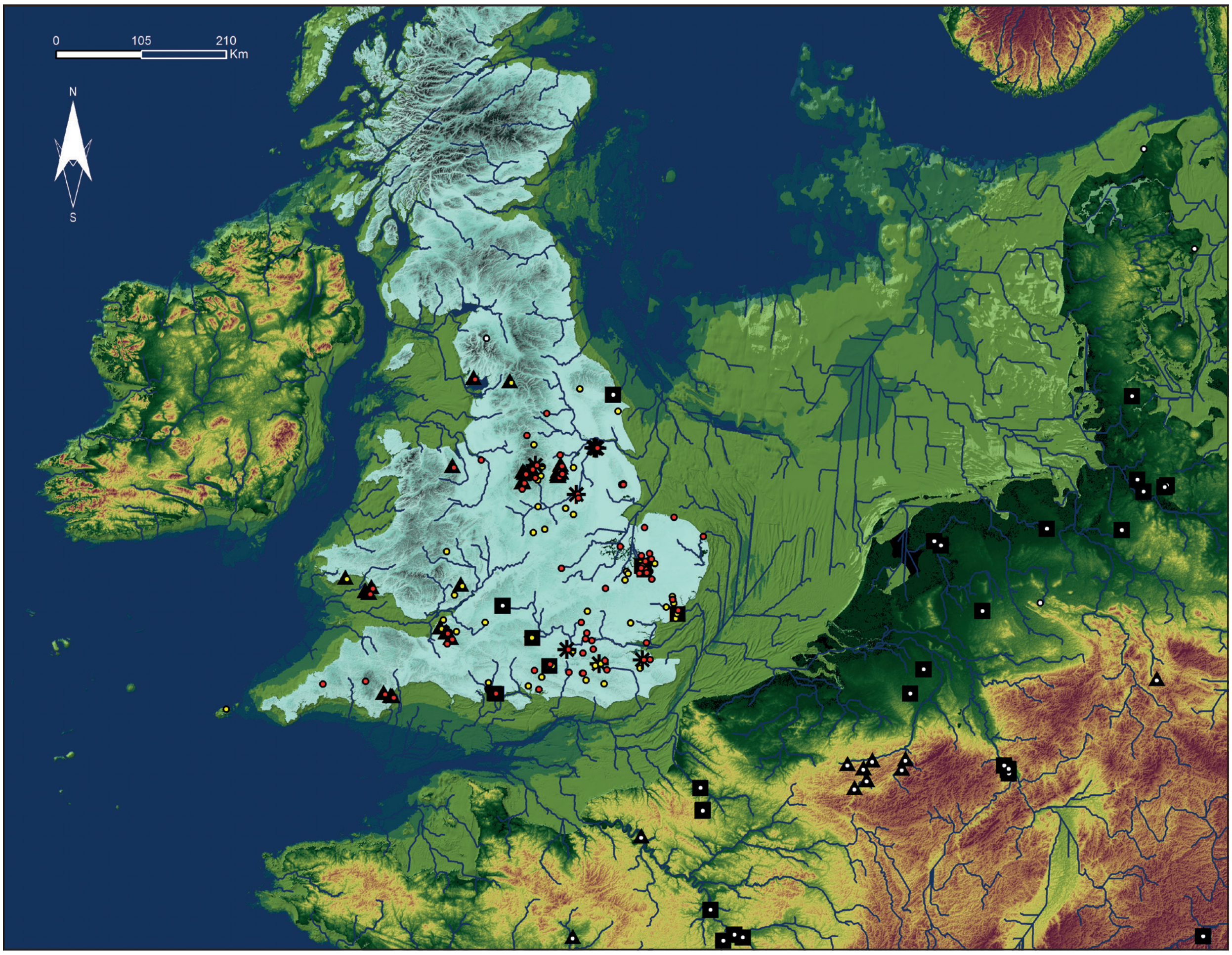

Fig. 1 The distribution of LG events in the CoB dataset ordered by site-type. Background DEM: OS Land-Form Panorama.

LG datasets for England and Wales

Over the past 20 years in Britain several substantial datasets with information regarding LG sites and findspots have been made digitally accessible for research (Evans 2013; Cooper/Green 2016). Open access to this data provides a unique opportunity to reassess the nature of LG occupation in Britain. However, there is little consistency between the form of the datasets, and a considerable amount of work on data standardisation, scaling, and transformation is necessary before any form of GIS spatial analysis can be attempted. The quality of the data should not be assumed, and my research includes a thorough re-examination of a sample of archaeological material recorded in the datasets for South-East England as a control.

One of the principal datasets used for this research is the Colonisation of Britain (CoB) (**fig. 1**) (Wessexarch.co.uk 2013). The CoB was constructed from Roger Jacobi's research card index developed for the »Gazetteer of Mesolithic sites in England and Wales« (Wymer/Bonsall 1977), which he continued to compile and update throughout his career (ADS 2015b). It is now curated by the British Museum (Harris 2015), and has been digitised by Wessex Archaeology as the Palaeolithic and Mesolithic Lithic Artefact (PaMELA) database, with its online searchable component being the CoB (ADS 2015b). This database covers all Mesolithic and Upper Palaeolithic sites in Britain known and recorded by Jacobi who researched the LG from the early 1970s until 2009. This database was preferred for this pilot study due to its internal consistency, informed choice of detail, and concise nature. More importantly it can be considered as being the most reliable and extensive dataset available, as it was compiled by one of the foremost researchers of Mesolithic and LG archaeology in Britain (Ashton/Harris 2015). Roger Jacobi's work was carried out over nearly a 40-year period during which time many elements of his understanding of the lithic industries were refined, redefined, and reinterpreted. However, the LG component was apparently not updated in light of his recent publications on the subject, and excavations post 2000 are absent, therefore the CoB requires cautious application in view of recent research developments (Jacobi 2004; Jacobi/Higham 2009; 2010).

For the purposes of the CoB dataset, Wessex Archaeology attributed chronological interpretations to his find descriptions based on what were considered as »type fossils« and associated a chronological attribution (ADS 2015b; Wessexarch.co.uk 2013). As a result, in the CoB, LG events were divided into four categories: Creswellian, Late Upper Palaeolithic (LUP), Final Upper Palaeolithic (FUP), and Terminal Upper Palaeolithic (TUP). These terms are not fully defined by Wessex Archaeology, but Creswellian is self-explanatory, and following the most frequent usage by Roger Jacobi in his publications (Jacobi 2004; Jacobi/Higham 2009; 2010; Harris 2015) it is assumed that the term FUP refers to Federmesser-Gruppen-type assemblages, and TUP to Long Blade assemblages, with LUP referring to other LG assemblages including those containing shouldered points and »Zinken« typologies (Jacobi/Higham 2010). Although these attributions are arguable, as discussed below, at a larger scale they do enable a preliminary overview of the general LG spatial distribution in Britain and South-East England. A priority for this ongoing research is to refine these chronological attributes and bring the database up to the current LG techno-typological framework for North-West Europe.

The CoB dataset was cross-referenced and supplemented with publications providing detailed specific gazetteers covering the Upper Palaeolithic and Mesolithic (Wymer/Bonsall 1977) and Long Blade industries (Barton 1986). Several other national datasets were consulted including

1) National Monuments Record (NMR),
2) Regional and district Historic and Environmental Records (HER's),
3) English Heritage Excavation Index; provided by Historic England (formerly English Heritage),
4) Archaeological Data Service (ADS).

Finally, data from recent excavations have been added from the public domain and »grey literature« sources. The assimilation of these datasets enables a reassessment of past collections within a cohesive research framework, integrating major sites, local museum collections, and individual finds at local, regional, and national scales as well as creating the potential for their integration into future research. This is a pivotal element of my current research as the different databases provide very diverse levels of information. Considering the recent advances in the characterisation strategies used to distinguish LG industries, a reassessment of past recording methods is also undertaken (Pelegrin 2000; Barton et al. 2003; Coudret/Fagnart 2006; Debout et al. 2012). However, due to the size of the collections this is a formidable task beyond the limits of the current research at a national scale. Therefore, as a pilot project I have conducted a thorough reassessment of the LG archaeological assemblages and datasets concerning the catchments of the Rivers Wey and Mole in South-East England. This is currently being extended to a wider area of South-East England including other tributaries of the Channel River such as the Bournemouth Avon, the Test and the Arun Rivers.

METHODOLOGY: SPATIAL ANALYSIS, LITHIC ANALYSIS, SCALES AND POTENTIAL

Archaeological considerations and components

This project re-examines LG flint assemblages and their characterisations. This techno-typological approach combines quantifying datasets so as to make them comparable, within the conceptual framework of the

»chaîne opératoire« *sensu* Inizan et al. (Inizan et al. 1999; see Pelegrin 2000; Soressi/Geneste 2011). This approach is used for the identification, interpretation, and analysis of recurrent methods, technologies, and tool types that may be considered as diagnostic (or not) for the LG.

The objective is to formulate characterisations of individual sites to assist the consideration of groups of sites within a coherent analytical framework. Ultimately the aim is to recognise and associate signatures related to behaviours, movements, and decision-making patterns in relation to the river valleys of the Channel River catchment. These river valleys are the most prominent geomorphological features of the open-landscape, and this landscape is overwhelmingly representative of the living habitat. This approach also assists in bridging the gap between cave and open-air datasets. Furthermore, it is intrinsically relevant to the current archaeological dynamic, following the recent discovery of several open-air LG sites by development funded archaeology along river valleys in southern England (Cooper 2006; Conneller/Ellis 2007; Barton et al. 2009; Lewis/Rackham 2011; Jones 2013; Attfield et al. 2014).

In order to interpret and cross-reference the database for South-East England, the different types of open-air LG signatures are emphasised. Paramount are the stratigraphic context and the different taphonomic processes that open-air sites undergo. These often lead to a very poor preservation of organic material, crucial for direct dating and the functional analysis of sites. Amongst the taphonomic processes the potential for the disturbance or redisposition of materials within alluvial contexts must also be taken into account, as well as the advantages of a relatively fast burial and preservation of artefacts (Needham/Macklin 1992). Although quite often the potential for direct dating is low, this often contrasts with a high spatial and technological resolution that can be gained from the extensive horizontal analysis of refitting lithic assemblages on open-air sites.

Since the 1980s detailed techno-typological analyses have demonstrated that lithic industries in North-West Europe, through extensive refitting programs, can be technologically and methodologically characterised (see Karlin/Newcomer 1982; Cziesla et al. 1990; Barton 1992; Bodu 1994; De Bie/Caspar 2000; Biard et al. 2004; Coudret/Fagnart 2006; Lewis/Rackham 2011). These will constitute the technological reference sites within this analysis. This has been combined with an extensive amount of experimental research so as to characterise the traits and concepts behind the production of LG assemblages (Pelegrin 2000). The aforementioned refitting technological reference sites, in combination with the characterised technological attributes from well dated sites, form the analytical framework used in my research. This allows the incorporation of a much larger distribution of open-air sites, aiming to provide a broader perspective on human activities, associated to this period (Barton 1986; 1992; Cooper 2006; Conneller/Ellis 2007; Barton et al. 2009; Lewis/Rackham 2011; Grant et al. 2014). I emphasise the distinction between elements associated by proxies and directly dated to this period (Blockley et al. 2006) within the site distribution patterns so as to evaluate and clarify the levels of comparison.

Digital Elevation Maps (DEM) and background topographic representation

The elements described above provide a backdrop for specific hypothesis-driven spatial analyses that can be assimilated using a GIS, in this case ESRI ArcGIS 10.2.1. This integration of multiple datasets enables cross-referencing at multiple scales of analysis as well as advanced relational and spatial analysis of site distributions (Connolly/Lake 2006). After defining the criteria for the necessary types of information recorded and assessing diagnostic characterisation and resolutions of lithic assemblages, the resulting dataset will be integrated into a dynamic and comprehensive palaeo-environmental and chronological platform for further spatial analysis. The work of Crombé et al. (2011) in Belgium will be used as an initial template for the analysis of spatial distributions of LG events, leading to the first cross-channel comparison using an equivalent framework.

Base maps

The use of DEMs enables a topographic base-plate for the subsequent datasets. Although many climatic, ground cover and soil changes have arisen since the LG (Catt 1979; Macphail/Scaife 1987; Branch/Green 2004), and eustatic uplift must also be taken into consideration for southern England (Lambeck 1995; Shennan et al. 2006; Westaway/Bridgland/White 2006; Bridgland et al. 2010; Bradley et al. 2011), one can consider the overall topographic features as approximatively representative of LG landforms and topography. The most dramatic difference compared to current topographic features, other than sea level, is found along the river courses as a result of the sedimentation of floodplains and river valleys during the Holocene; however, the river valleys persist (Brown 1997; Bridgland et al. 2006; Antoine et al. 2003a; 2007; Westaway/Bridgland 2010; Green/Farr/Branch 2013; Howard et al. 2015). Several DEMs, each with their particular pros and cons, have hence been combined to create a homogeneous land-surface (**fig. 2**)[2].
The technicalities involved in the construction of the DEM used here will not be discussed in detail, simply the concepts behind its creation and application. To create the palaeo-river flows, the Gebco08 DEM (www.gebco.net) was used as it represents continuous surface covering all of Northern Europe, including the bathymetry of the English Channel and the North Sea. The continuous nature of this DEM enables the modelling of river channels based on topography. This is equivalent to pouring a bucket of water over the modelled landscape and calculating in which direction the water will flow and accumulate to create rivers (Connolly/Lake 2006). The bathymetric data has been supplemented with the Ordnance Survey Land-Form Panorama for the topography of the UK, and SRTM90 DEMs for Ireland and Continental Europe.
Past sea levels are primary factors when considering the LG in relation to the exposure of landforms and their associated topography and fluvial systems. Although both LG sea levels (Shennan et al. 2006; Bradley et al. 2011; Brooks et al. 2011; Sturt/Garrow/Bradley 2013) and palaeo-channels (Antoine et al. 2003b; Gibbard/Lautridou 2003; Gibbard 2007; Lewin/Gibbard 2010; Westaway/Bridgland 2010) have been considered in detailed local and regional studies, they have not been combined with LG archaeological distributions around the English Channel since the seminal work on the now submerged Northern European landscape (Coles 1998). The topography used here is based on contemporary bathymetry, as it is believed that most of the major palaeo-valleys apparent in the bathymetry were created pre-LG and have subsequently guided the river channels during the LG (Gupta et al. 2007; Gibbard 2007; Brooks et al. 2011). The exact location of the individual channel beds remains uncertain without further ground testing, due to the Holocene infilling of the channels (Sturt/Garrow/Bradley 2013; Howard et al. 2015). The resolution is high enough for the consideration of active river valleys and large scale dynamics (Brooks et al. 2011). So as to test the model for currently submerged areas a higher resolution DEM was used (EMODnet), and compared to recent mapping and analysis of submerged palaeo-channels (Gibbard/Lautridou 2003; Gupta et al. 2007; Gibbard 2007). The correlation is very good by eye, coinciding with palaeo-geographic publications (Antoine et al. 2003a; Westaway/Bridgland 2010; Brooks et al. 2011) and will subsequently be quantified using GIS spatial analyses.
When applying this dataset it is possible to approximate the exposed landforms in relation to different sea levels, enabling a more faithful representation of site distributions within the LG landscape. Following this, regional and local analyses are being carried out and integrated based on higher resolution DEMs and LiDAR where available, and/or relevant to the scale of analysis. High-resolution datasets have been obtained from

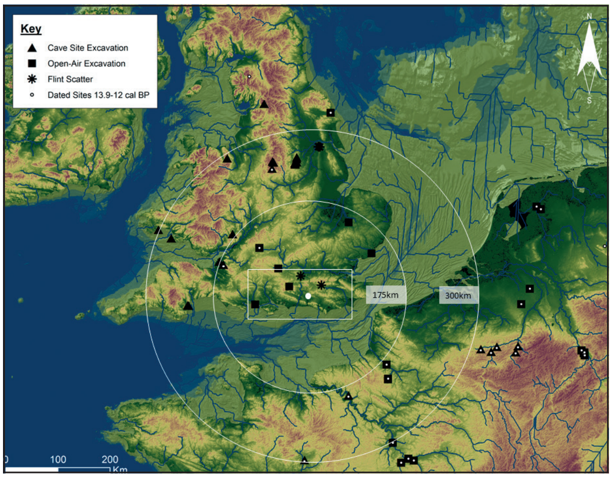

Fig. 2 Example map showing LUP and FUP sites (from the CoB dataset) at a low scale of analysis which illustrates the relevance of North-West European sites to the study area (white rectangle), with examples of chronologically high-resolution (directly dated) sites (white dots). – (Data for Continental Europe after Miller 2012). – The elevation is based on a combination of GEBCO08 (www.gebco08.net), SRTM90 (http://srtm.csi.cgiar.org/), and EMODnet (www.emodnet-hydrography.eu) DEM/DTMs. The shaded region around the estuary of the Channel River represents the estimated rise of sea levels during the Allerød. – (After Brooks et al. 2011; Sturt/Garrow/Bradley 2013).

the Ordnance Survey and the Environmental Agency for the case studies of the Wey and Mole River system as well as the Bournemouth Avon and Test Rivers. These are being used to investigate individual site locations and groups of sites within the same river valley in more detail.

Representing thematic datasets

Following the setup of the topographic basemap, thematic geo-rectified datasets have been added for cross-referencing and contextualisation of the archaeological distributions. The additional information added so far is:

1) Geological bedrock (British Geological Society),
2) Drift geology (British Geological Society),
3) Ground cover (urban, forested, agricultural) (Ordnance Survey),
4) Waterways and wetlands (Ordnance Survey and Environmental Agency),
5) Current areas susceptible to flooding (Ordnance Survey and Environmental Agency).

SCALING THE DATASETS – RIVER CATCHMENTS AS SCALES OF ANALYSIS

The choice of river systems and their catchments as a scale of analysis allows for a quantitative investigation of the relationship between LG event locations and rivers. This follows patterns perceived in recent research around the Channel network (Coudret/Fagnart 2006; Barton et al. 2009; Bignon 2008; Debout et al. 2012). River courses serve as significant landscape features at local, regional, and supra-regional scales. River catchment areas can also act as a scale for people living in the environment as rivers are often used as regional identifiers in ethnographic and historic research, as well as in LG archaeology (Tyrrell 1911; Reid 1913; Brown 1997; Coles 1998; Grøn 2005; Coudret/Fagnart 2006; Langlais 2008; Bignon 2008; Barton et al. 2009; Schulting 2010). Considering waterways as scales of analysis, one can move from individual river tributaries to larger river networks. The rivers should be represented as dynamic landforms bordering and/or within local and regional environments, which have the potential to divide or link human activity throughout the LG and Early Holocene.

The methodology applied will distinguish sites with different attributes such as sites with faunal remains and well preserved techno-typological contexts in England. When considering true distances and sea levels of the LG, this methodology provides a scale which encourages comparisons with Northern Europe (**fig. 2**). The inclusion of North-West Europe is an important factor as lithic industries have been compared techno-typologically over the last 30 years (and typologically since 1926 [Garrod 1926]), with similar characteristics being found to those recognised in British assemblages (Barton 1992; Barton / Roberts 1996; Jacobi 2004; Barton et al. 2003; 2009; Jacobi / Higham 2010). This comparative framework is particularly significant considering that South-East England was part of the continental landmass at the time. There is also a need to use appropriate maps for this representation when considering the archaeology of the period, so as to appreciate the potential spatial dynamics (Reid 1913; Coles 1998; Grimm 2011). If ever there was a factor which fragmented the landscape seasonally or during different climatic periods, it would have been the rivers, and although well represented for the Lower and Middle Palaeolithic on maps they are too rarely present on LG maps (Bridgland et al. 2010; Dinnis 2011).

DATING THE LG OF SOUTH-EAST ENGLAND

Direct dating

As stated above, direct dating of human presence in the LG is mainly constrained to the faunal records from cave sites in Britain. There are two notable exceptions in southern Britain: the open-air sites of Flixton and Three Ways Wharf, which have reliable dates on cutmarked horse bones, but these both date to the very end of the LG (Barton / Roberts 1996; Jacobi / Higham 2009; Lewis / Rackham 2011; Conneller / Higham 2015). The preservation of hearths in LG contexts is very rare, and has so far only been found in two caves (e. g. Three Holes Cave and Mother Grundy's Parlour – see Roberts 1996 and Jacobi / Higham 2010), being absent in British open-air sites (Barton et al. 2003). Several extensive radiocarbon programs have been applied to the British LG (Campbell 1977; Collcutt 1984; Housley et al. 1997); however, it is only more recently that a high-resolution AMS dating program has resulted in a reliable chronological framework (Jacobi / Higham 2009; 2010). The quality of this latter dating program is assured by the strict selection of the dated elements: they were all cutmarked bones from known LG contexts from cave sites across the UK. What is important for the interpretation of site distributions is that the AMS dates indicate brackets of known occupation in the western and northern regions that infer the crossing and potential occupation of the southern or eastern landmass, and therefore this pattern of occupation can be extrapolated for open-air sites, albeit not applied directly.

We have to turn once again to Northern Europe for the closest directly dated lithic assemblages (**fig. 2**) that may be used as references, most notably from the Rhine-Meuse Delta, the Somme Valley, and the Paris Basin (Miller 2012). Considering the evidence for long distance travel and / or exchange in the LG there is a need to expand comparative research further afield in the future, most notably taking into consideration the Neuwied Basin (Baales / Street 1997; Stevens et al. 2009; Street / Jöris / Turner 2012) and industries to the east of the Channel River catchment (Grimm / Weber 2008; Riede / Edinborough 2011; Grimm / Jensen / Weber 2012) where both areas have strong palaeo-environmental and chronological evidence.

Indirect dating

OSL dating has been applied to recently excavated British LG open-air sites; however, there are problems with outlier results and the time range is often too broad (Barton 1992; Barton et al. 1998; Conneller /

Ellis 2007; Barton et al. 2009). Only one site has so far rendered what seem to be truly consistent dates: Guildford Fire Station, excavated in September 2014 by Oxford Archaeology (Gerry Thacker, pers. comm.). Thermoluminescence dating has also been applied at Hengistbury Head (Barton 1992), and although this indicates a LG date, the resolution is too coarse to place the archaeology confidently within a specific part of the LG.

Palaeo-environmental records

The high-resolution palaeo-environmental datasets for the LG are for the most part from deep stratigraphic sequences preserved in wetlands (Walker/Coope/Lowe 1993; Walker et al. 1994; 2003; 2012). These sequences have been studied using multi-proxy analyses resulting in high-resolution reference sequences for the LG. By comparing these different environmental records to well-established Greenland ice core data, a high-resolution trend for the LG and Early Holocene has been developed for England (Lowe et al. 1999). However, all of these records are found in Ireland, Wales, and northern England, and there are so far no published high-resolution examples from local southern sequences. Considering the scales of interpretation, it is possible to apply for the most part the general palaeo-environmental trends recorded in these regions to South-East England (Macphail/Scaife 1987; Sidell et al. 2000; Branch/Green 2004; Parker/Goudie 2007; Preece/Bridgland 1998). Nevertheless, one must bear in mind that the conditions would be a lot more continental (**fig. 2**) without the current English Channel, the North Sea, and the proximity of the Atlantic Ocean. For LG research this region must be considered as an integral part of the North European Plain, both archaeologically and palaeo-environmentally, and therefore Northern European sequences will also be taken into account.

Faunal remains

The LG zooarchaeological data is again biased towards western and northern Britain where, as mentioned above, LG bone assemblages are almost uniquely from cave sites (Currant/Jacobi 2001; Yalden 2007). In the few cases where bone and organic material (e.g. antler) have been found on LG open-air sites in South-East England it has been in very poor condition, and only evidence of the larger mammals (e.g. horses) has been preserved (Lewis/Rackham 2011; Conneller/Higham 2015). This represents a very limited picture of human interactions with the local biota; however, it remains the only direct evidence of behaviours within the open landscape. Research on the nature of LG horse behavioural patterns will be integrated to enhance the model for human dynamics in the landscape of the early LG (Bignon 2008).

Sedimentary records

Many LG open-air sites are dated contextually, most notably in relation to the fluvial sedimentary record (Conneller/Ellis 2007; Barton et al. 2009; Lewis/Rackham 2011). LG fluvial dynamics have been characterised for South-East England (Gupta et al. 2007; Westaway/Bridgland 2010; Murton/Belshaw 2011), but the best associations of LG fluvial records with LG archaeology are found in northern France, most notably along the Somme and Seine Basins (Antoine et al. 2003b; 2007), and in Belgium along the Meuse catchment (Crombé et al. 2011; Busschers et al. 2007). These sedimentary sequences are one of the strongest contextual markers that we have, which help us to understand when the sites were occupied and in which type of locations these occupations were taking place. The fluvial dynamics are also essential for the interpretation of the taphonomic processes that may have affected the archaeological record (Needham/Macklin 1992; Brown 1997).

METHODS FOR DISTINGUISHING LG SITE DISTRIBUTIONS

When considering the LG archaeological distribution of South-East England, the focus is usually restrained to lithic assemblages due to the aforementioned limited survival of organic materials. This requires taking into account the types of records or »events« – a term used by Heritage England referring to individual records in the database (Evans 2013) – in this case isolated or groups of lithic artefacts/assemblages. Three scales of analysis have been applied to the CoB database: low (sub-continental), medium (regional), and high (local) in combination with three scales of archaeological resolution: low, medium, and high, as described below (**fig. 3**). The combination of these qualitative attributes will be used to weight individual events for spatial analysis to test against research and taphonomic biases in the first instance, before querying the dataset for geomorphological spatial relationships. Within the CoB database there are four types of events: cave excavation, open-air excavation, scatters, and stray-finds. The application of different scales of analysis to different types of data is considered here.

Low-resolution events (stray-finds and un-contextualised events)

When considering stray-finds, which represent the bulk of the CoB dataset (**fig. 3**), it is important to question whether it is possible to use this data and at which resolution of analysis and interpretation. Arguably an isolated find is not significant. At the other extreme every event with distinctive attributes associated to LG activity may be considered as an indication of potential activity in the landscape, albeit within a larger chronological bracket. The situation is more complex when the finds are possible projectile points which one would expect to find isolated in the landscape due to hunting activities. Nevertheless, »points« remain arguably the most studied and »diagnostic« lithic components of LG archaeology. It is therefore necessary to compare datasets inclusively and exclusively of these individual finds at different scales, to assess whether they can have a relevant (or statistically significant) signature.

For example, a local analysis of isolated »projectile« points (typological) will provide a very different representation to isolated debitage (technological). The »points« may tentatively be attributed to a specific chronological bracket of the LG, whereas an individual blade based on technological and methodological characteristics might be associated to multiple industries, if at all accepted as diagnostic in isolation (for example the TUP blades of the CoB discussed below). Stray-finds are already included in the CoB database with detailed descriptions of the individual finds; it is therefore a worthwhile sample with which to test this hypothesis. To integrate the data, I am introducing this lower scale into my research. When analysed from a regional scale upwards, localised concentrations of »points« and/or debitage would be of interest. It is important to distinguish concentrations of stray-finds from concentrations of sites. For example, the category of »long blades« (blades over 12 cm length associated to the Long Blade technocomplex), by far the largest proportion of TUP entries in the CoB, bears the potential for many biases. These blades are a lot more visible to fieldwalkers and have a relatively low diagnostic resolution, potentially over-representing the TUP in some regions. These lithic concentrations will be analysed as possible signatures of landscape use meriting further investigation. This is therefore a resolution that is best used to indicate potential for future research or so as to explore local research patterns.

Medium-resolution events (isolated scatters and un-dated and / or non-refitting sites)

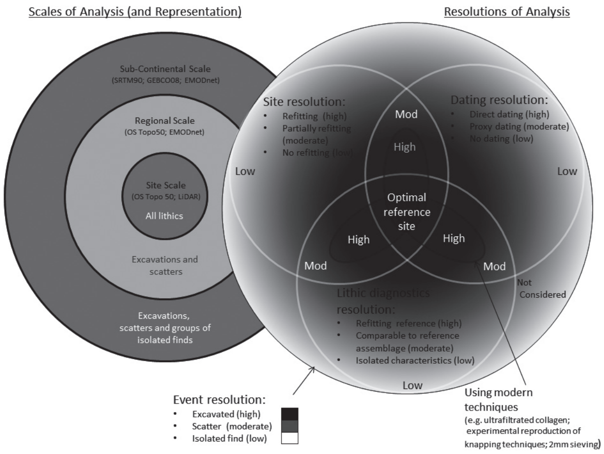

Fig. 3 Scales of analysis and resolutions of analysis used for the categorisation of the archaeological records in the CoB dataset.

Examples found in South-East England are open-air scatters, single occupation sites, and multiple occupation sites. Palimpsests are frequent amongst LG open-air sites, along with their inherent complications. The most suitable scale of analysis is very much dependant on the nature of each open-air site (**fig. 3**). Characterisation of these assemblages can be problematic unless coherence can be demonstrated (Collcutt / Barton / Bergman 1990; Barton 1992). In the past this has been done in the following ways:

1) Through substantial refitting which demonstrates chronological contemporaneity of the scatter, assuming re-use of artefacts can be ruled out (medium to high-resolution),
2) Using a techno-typological analysis based on our current understanding of stone tool production and clear diagnostic markers in association with the debitage (medium-resolution),
3) By the presence of typological elements considered as diagnostic of specific LG industries (low to medium-resolution).

Due to a lack of direct dating, the interpretation of LG assemblages in South-East England is dependent on direct typo-technological comparison to reference sites in the UK, and mostly Northern Europe. There is therefore a need to distinguish appropriate reference sites, relative to the scale and type of analysis carried out.

For multiple occupation sites, the duration of the time lapse between different occupations needs to be taken into consideration (Barton 1992; Coudret / Fagnart 1997; De Bie / Caspar 2000). In some cases there is refitting which isolates individual episodes and stratigraphy to corroborate a chronological bracket. This enables a relatively high resolution of different activities within a site (Zubrow / Audouze / Enloe 2010).

A distinction between taphonomically *in situ* sites and disturbed sites needs to be made. This requires reference to specialist reports (e. g. geoarchaeological, micro-morphological) demonstrating the integrity of the archaeological horizon, and is thus limited to more recent excavations (Conneller / Ellis 2007; Barton 1992; Barton et al. 2009; Lewis / Rackham 2011). When these types of reports are absent, the resolution of the assemblage is difficult to ascertain and must therefore remain low to medium, unless internal coherence has been clearly demonstrated. The resolution for these sites could therefore be relatively high from a techno-typological perspective due to refitting and context, but of a relatively low chronological resolution due to the absence of direct dating. Multiple occupation sites have the additional particularity of demonstrating recurrent uses of a location under changing landscape conditions over both short and long periods of time, which in itself is informative of behavioural patterns. The scales and extent of refitting should also be taken into consideration, from demonstrating integrity of an assemblage to potential technological analysis.

Open-air multiple occupation sites have similar conditions for accumulations as cave sites. Most of the British cave assemblages will therefore be classified as medium-resolution as well. Although they have the

best dated material, the contexts are often not secure enough to ensure a direct association with lithic assemblages (Jacobi 2004; Jacobi/Higham 2010). This is because the majority were excavated at an early period in time and without appropriate archaeological methods and controls. The cave assemblages can thus provide a high chronological resolution (as well as direct behavioural and environmental evidence) with directly dated cutmarked fauna, but there is most often a low techno-typological resolution, as refits are limited. The cave assemblages are mostly reliant on the presence/absence of typological attributes and are difficult to relate laterally to other assemblages (Jacobi 2004; Jacobi/Higham 2010).
Some of the site-types mentioned above may have a medium to high chronological or technological resolution, and this is distinguished within this model. If a site does not have both resolutions, it is hard to consider it as a secure reference site.

High-resolution and reference events (single occupations; directly dated sites; reference sites)

Single occupations within multiple occupation sites and single occupation sites are considered at the highest end of the resolution scale used here. When excavated with modern recovery methods these can provide detailed techno-typological information sometimes associated with spatial and behavioural dynamics (Brézillon/Leroi-Gourhan 1966; Karlin/Newcomer 1982; Stapert 1989; Cziesla et al. 1990; Barton 1992; Bodu 1994; De Bie/Caspar 2000; Debout et al. 2012; Bodu/Debout/Bignon 2006). When found in stratigraphic context, these high-resolution technological sites, albeit very often lacking in organic material for direct dating, are the foundations for this framework of LG technocomplex characterisations.
It is important to distinguish these high-resolution technological sites as they are constantly referred to when analysing lower resolution sites and individual finds in attempts to find techno-typological parallels. Furthermore when comparing several of these high-resolution sites dating to a similar chronological period, trends in behavioural patterns, »diagnostic« technologies, and tool types may be distinguished in the repetitive and/or isolated occurrences and patterning. Sites which are securely dated and have substantial techno-typological refitting are considered as reference sites in this analysis. Unfortunately, in the UK we only have high-resolution technological or high-resolution chronological sites, and we have to turn to Northern Europe for the directly dated techno-typological reference sites (**fig. 2**).

PRELIMINARY REMARKS ON THE COB EVENT DISTRIBUTION

Low scale distribution

The CoB dataset highlights some distinct patterns of LG activity in England and Wales (**fig. 1**), many of which have already been remarked upon by Jacobi, the creator of the card index (Jacobi/Higham 2009; 2010). Immediately concentrations are apparent, and these can initially be explored through the themes of archaeological context (caves/open-air), historic context (intensely researched areas), and geology (ground cover, soil depth). When considering quantities of recovered LG material, cave sites by far and large contain the highest proportion of artefacts within the CoB database; however, in today's archaeological setting, ironically it is the urban sprawl and its spread that is leading to the discovery of the most recent high-resolution sites recovered through development archaeology.

Cave sites

Cave sites are concentrated to the west and north of England and Wales (**fig. 1**) and have a very long history of research, unfortunately linked to very poor stratigraphic control. Making direct parallels to South-East England is limited to cautious typological and very rare technological comparisons. It has been noticed for quite some time that there is a trend for the vast majority of Creswellian activity to be found in cave assemblages as opposed to the more open-air signature of Azilian/Federmesser-Gruppen-type material (Barton et al. 2003; Jacobi 2004; Jacobi/Higham 2009; 2010).

Open-air sites

Open-air excavations are predominantly found to the east and south-east of England in the CoB (**fig. 1**), throughout a relatively large area. These excavations were carried out over a long time period, dating back to the early 20th century. Most of these sites are found in vicinity to major rivers, which is of particular interest for this research. Nevertheless, it cannot immediately be determined whether or not these are linked to preferential preservation or past human preferences. The time period at which sites were excavated can often be linked to the quality of the assemblage recovery. This is important when considering a potential absence of smaller diagnostic elements, particularly before the practices of systematic fine sieving and stratigraphic control. The CoB lacks the most recent excavations that are currently not only the largest LG assemblages nationally (Attfield et al. 2014) but have also been at the forefront of typological and technological research (Conneller/Ellis 2007; Barton et al. 2009; Attfield et al. 2014). These are currently being added to the dataset for this project.

Flint scatters

Flint scatters (surface collected assemblages) are generally considered as homogeneous entities (**fig. 1**). There are four significant concentrations: along the South Downs in the south-east, along the Thames Valley, along the edge of the Wash near Cambridge, and along the Trent Valley close to Creswell Crags, all of which are in areas which have a long tradition of archaeological research. The latter group is of particular interest as these are the only open-air assemblages in proximity to the cave sites, indicating a strong potential for further research, a point emphasised by the recent work at Farndon Fields (Garton/Jacobi 2009). Although scatters cannot be key reference sites, they may have technological and typological parallels, and they do indicate a degree of spatial occupation.

Stray-finds

Stray-finds represent the bulk of the CoB LG events (**fig. 1**), and these have mostly been found by field walkers, as indicated in the CoB notes. The principal concentrations are along river valleys and close to major cities. The highest concentrations are found along the Thames Valley. Considering that the Thames River is the largest river system in the region and would have provided an attractive mosaic of resource rich environments, a high concentration of finds is not surprising and may represent a genuine occupation pattern. One must also bear in mind that the discovery of many finds may be linked to current fluvial dynamics as the

foreshore is undergoing active erosion exposing artefacts in a populated region, which also happens to be a focus of active research (Cohen/Milne/Wagg 2012). Most notable in the database is the high attribution of blades of long dimensions (>12 cm) with opposed negative removals attributed to the Long Blade techno-complex in the TUP. This is a very weak diagnostic attribute, and in the author's opinion it is most likely Jacobi's short hand indicating a potential rather than a definite cultural attribute. This Long Blade distribution creates a very strong signature within the database, and therefore may be misleading for the interpretation of TUP occupation. Nevertheless, most Long Blade sites are found along the Thames and its tributaries (Barton 1986; Lewis/Rackham 2011). The second highest density is found to the south-east of the Wash, on the edges of Cambridgeshire and Norfolk. The reasons behind this concentration are difficult to ascertain; however, they may once again be linked to the long archaeological tradition in this region, which is further marked by the presence of numerous open-air sites. On the other hand, when considering the Allerød landscape, it is important to consider that this would be a strategic location for movement coming from the continent, circumventing the Channel River if it was a barrier (Barton/Roberts 1996). The region is near large bodies of water rich in resources, and therefore intensive occupation might be expected (**fig. 2**).
A more sparsely spread concentration can be found along the Trent Valley and around Creswell Crags, which is unsurprising as there is a long history of Palaeolithic research (Garton/Jacobi 2009). Interestingly, like many open-air sites and scatters, these events are associated to large active river systems. Further research will attempt to assess these hypotheses with a coherent spatial dataset to examine the spatial distributions.
In summary, there is a concentration of cave sites to the west and north, whereas the open-air sites are distinctly found to the east and south-east, highlighting a geological and taphonomic influence in the distribution of LG records. It is also noticeable that whereas the east and south-east have been impacted to a greater extent by recent development projects and are dominated uniquely by open-air sites, most of the archaeological research in the west of the country has focused on the cave sites. One can also recognise an absence of locations on a south-west to north-east diagonal from Devon to north-western Norfolk. This void is most likely due to a bias in archaeological research, although changes in the bedrock, soil development, and erosion are likely contributing factors. Perhaps one of the most interesting aspects to emerge from this review is that there are very few open-air sites in the vicinity of the cave sites. The reasons for this pattern need further investigation as to whether this is linked to landscape use, taphonomic factors, or collection biases. An ongoing avenue for future research would be to compare site locations to drift and bedrock British Geological Survey (BGS) maps.

COB: ASSESSMENT OF THE TYPOLOGICAL DISTRIBUTIONS (LOW SCALE, MEDIUM- TO LOW-RESOLUTION)

I will here present initial remarks on the typological distribution used in the CoB. These are based on attributions given by Wessex Archaeology using typological characteristics recorded in Jacobi's card index (**tab. 1**). My current research involves reassessing these typological categories from a typological perspective as well as integrating technological associations so as to integrate them into the existing North-Western European LG framework.
The Creswellian distribution (**fig. 4a**) is represented by two point types: Cheddar points and Creswell points. These two point types are largely used as diagnostic elements of the Creswellian (Jacobi 2004; Barton et al. 2009). However, it must be stressed that Creswellian sites can only be confidently identified when associated with the appropriate technological debitage (Barton et al. 2003; Jacobi/Higham 2010). Another aspect

Creswellian	bi-truncated trapezoidal backed blades (Cheddar points), obliquely-truncated backed blades (Creswell points)
Late Upper Palaeolithic	shouldered points, »Zinken«
Final Upper Palaeolithic	»penknife« points, convex-backed blades
Terminal Upper Palaeolithic	long blades, bruised blades, Brancaster cores

Tab. 1 Associated descriptive information for the CoB categories. »Only records where type fossils were present have been assigned a chronological tag. No attempt has been made to apply calendrical dates to the chronological periods within the database«. – (After ADS 2015b).

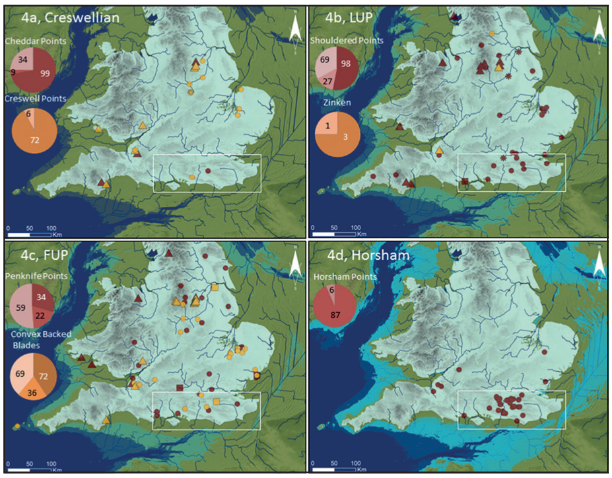

Fig. 4 Chronological interpretation of LG typological criteria of the CoB dataset based on Jacobi's index cards (Wessexarch.co.uk 2013): **a** Creswellian events based on Cheddar (red) and Creswell (orange) points. – **b** LUP events based on shouldered points (red) and »Zinken« (orange). – **c** FUP sites represented by »penknife« points (red) and convex-backed blades (orange). – **d** Early Mesolithic Horsham points. – The dark hue with white numerals represents the number of events from cave excavations, the medium hue open-air excavations and the lightest hue stray-finds.

of the Creswellian distributions is the clear concentration in the west, most notably amongst the cave sites. The rare open-air events found in South-East England consist mostly of individual finds, and are therefore not very confidently attributed to the Creswellian. There is potentially much more variation than initially perceived for Cheddar points (Jacobi/Roberts 1993; Debout et al. 2012), as well as hints from the recent dating programs to a later phase associated to bi-points (Jacobi/Higham 2010).

The LUP is defined with shouldered points and »Zinken« as type-fossils (**fig. 4b**). There is a relatively balanced distribution of finds in both cave and open-air locations. These types have never been directly associated to a refitting assemblage in the UK. Although found at Hengistbury Head the shouldered points were not directly associated to the refitting groups, and because they were found at a distance from the refitted excavated area, the question of multiple occupations remains for these elements (Barton 1992). Furthermore, there are no well dated assemblages containing these artefacts, so their association remains typological. These have most often been compared to Hamburgian assemblages based on the presence of shouldered points (Burdukiewicz 1986; Barton 1992; Barton/Roberts 1996), and this question is being re-examined in light of recent publications on this technocomplex, bearing in mind the amount of variation found amongst shouldered points (Burdukiewicz 1986; Burdukiewicz/Schmider 2000; Grimm/Jensen/Weber 2012). Another element here associated to the LUP are »Zinken«; however, there are only four true »Zinken« recorded amongst these assemblages.

The FUP sites and find locations are represented in **figure 4c**. This distribution map represents penknife points and convex-backed blades associated to Azilian/Federmesser-Gruppen-type industries. There is clearly a much wider distribution of this material and a predominance of open-air locations. This pattern has already been frequently discussed in the literature concerning the LG occupation of Britain (Barton/Roberts 1996; Jacobi/Higham 2009; 2010). Another aspect is the stratigraphic context of the assemblages, as a clear sequence separating Creswellian and FUP material has only been reliably identified within one cave sequence at Three Holes Cave (Barton/Roberts 1996). Very relevant here is the fact that the greatest proportion of »diagnostic« elements of the Federmesser-Gruppen distribution are »point« stray-finds. These represent the majority of the current dataset with only nine points found in caves and one on an open-air site. When considering that the strongest signature of Azilian/Federmesser-Gruppen-type occupation is based on two types of artefact, both of which are stray-finds, much caution should be taken. Using such an event as a diagnostic element to interpret land-use, especially an isolated projectile point compared to other technocomplexes represented by sites, will be neither at the same scale nor resolution. The geographic extent of the distribution does hint towards a larger use of space (Jacobi 1990). These open-air events lack direct dating, and are here, as for the LUP, interpreted based on typological features alone. It is however interesting that both curve-backed points and »penknife« points are represented in similar proportions. Further contextualisation is therefore needed, with an emphasis on technological reference sites where refitting analyses have been undertaken.

The distribution of Early Mesolithic Horsham points (**fig. 4d**), a very distinct point type, offers a good comparison for spatial distribution in South-East England, and these are here used as a control sample (Clark 1933; Reynier 2005). Although concentrated in the south-east, the outliers are found amongst other areas of long research associated to the Creswellian, LUP, and FUP. This strongly suggests a collection bias, though it does maintain a clear south-eastern distribution (Reynier 2005). However, there are local variations in the site and find locations, recognised at a higher scale of analysis, which will be discussed in case studies.

Overall, there are difficulties with the lumping of some of these typological categories, and a clearer definition based on more distinctly described techno-typological characteristics is now required. Continued comparative work is needed in light of recent research, exploring the relationship of these British assemblages to more clearly dated industries in Northern Europe, most notably sites along the Somme River catchment, the Paris Basin, and the Meuse River (Barton/Roberts 1996).

THE RIVERS WEY AND MOLE PILOT STUDY (HIGH SCALE)

As a pilot study, before expanding this methodology based on the CoB dataset, the catchments of the Rivers Wey and Mole were chosen for their high concentration of open-air sites (**fig. 5**) covering all of the LG categories used in the CoB: Creswellian, LUP, FUP, and TUP, and the full spectrum of open-air site-types. The Rivers Wey and Mole flow in a general south to north direction and are tributaries of the River Thames, which in turn was a tributary of the Channel River in the LG. The Rivers Wey and Mole are also significant because they traverse two major geomorphological regions: the Weald and the Thames Basin (Goudie 1990; BGS 1992). These catchments have seen continuous prehistoric research for over a century (Whimster 1931; Clark 1933; Hooper 1933; Oakley et al. 1939; Clark/Rankine 1939; Pitts/Jacobi 1979; Ellaby 1987; Cotton/Crocker/Graham 2004; Bird/Council/Arch 2006) with several high-resolution LG sites recently excavated (Jones 2013; Attfield et al. 2014). The Wey and Mole also contain all of the categories of sites mentioned above: individual find spots, groups of finds, open-air scatters, multiple occupation sites, and short-term site occupations (**fig. 5**).

The CoB database combined with recent excavations provides 19 LG events along the courses of the Rivers Wey and Mole. The first stage is therefore to identify these sites and findspots and understand how and on what basis they were defined. This will then be evaluated on a scale of resolution consisting of »weighting« the »diagnostic« value of the elements in relation to the sample size, diagnostic features, and contextual evidence. »Ground truthing« has been carried out by returning to museums and recording the material morphometrically in combination with a technological analysis (Barton 1992; Scerri et al. 2015).

As a control sample, the Early Mesolithic record of Horsham points, which are very characteristic (Clark 1933; Reynier 2005), has been used to distinguish potential variations in spatial dynamics and find distributions within the catchments of the Rivers Wey and Mole.

An initial distinction can be made between the concentration of LG occupations on the lower part of the rivers north of the North Downs, in contrast to the Early Mesolithic events located on higher grounds, and in proximity to stream sources. This pattern appears to be quite robust in a region that has been scoured by archaeologists since the 19th century. Most interestingly recent high-resolution LG sites have been discovered in areas with the thickest alluvial cover indicating a strong potential for future sites in the region. These two elements combined indicate a predisposition for FUP hunter-gatherers to locate themselves near developed rivers. Furthermore, the rare Creswellian and LUP findspots are located on higher ground in vicinity to Early Mesolithic locations. The location of Horsham sites on the higher greensands deposits has already been remarked upon and may be a habitat preference based on climate and soil type, contrasting with the FUP distribution (Clark 1933).

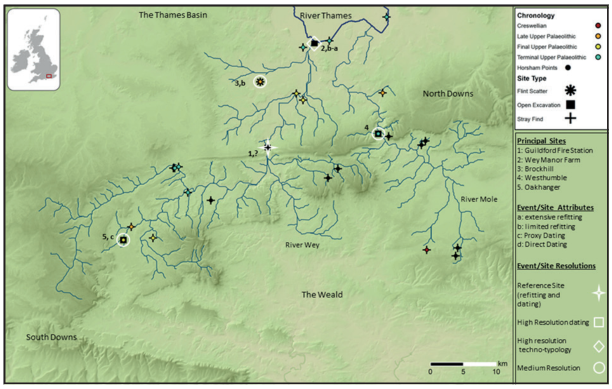

Fig. 5 CoB database: LG distribution within the Wey and Mole catchments. The Horsham points are used as a control sample. The different event resolutions are illustrated and will be used to weight the information individual sites contribute for spatial analysis.

The two most recent excavations, Wey Manor Farm (Jones 2013) and Guildford Fire Station (Attfield et al. 2014), both high-resolution refitting sites, although initially interpreted as Creswellian, also have attributes consistent with early Federmesser-Gruppen/Azilian industries recently characterised in northern France (Bodu/Debout/Bignon 2006; Valentin 2008; Antoine et al. 2012). (N.B.: Guildford Fire Station has not yet undergone refitting; however, during excavation it showed very high potential.) Guildford Fire Station is currently undergoing analysis; however, a preliminary inspection of the Wey Manor Farm material by the author indicates that there may be early Federmesser-Gruppen/Azilian traits. This is of particular interest considering recent hypotheses of the use of river systems during the Allerød along the adjacent Bournemouth Avon River (Barton 2012).

This case study demonstrates the potential of applying high scale analyses for distinguishing not only the qualitative distribution of sites, but also functions as an approach for preparing the dataset for spatial analysis and exploring landscape use. Following this preparation, this dataset is now being used directly for spatial analyses using GIS as well as selecting specific sites for further lithics analysis. The River Wey and River Mole case study stands as a methodological template that is being applied to adjacent river valleys (e.g. Arun, Avon and Test River Valleys), all of which contain significant sites associated to Azilian/Federmesser-Gruppen-type industries. This project can also be expanded to a wider scale to consider the relationship between sites in the rest of Britain and Northern Europe with similar archaeological signatures, most notably around the Channel River catchment area.

CONCLUSIONS

The catchment of the Channel River network and its tributaries present a distinct geographical entity that was dominant in North-West Europe during the LG, with the southern tributaries linking the north and south of Continental Europe (**fig. 6**). South-east England occupies an interesting location at the heart of

Fig. 6 There are several complex mobility systems, seasonal and/or combined, that in combination with historical and taphonomic biases present a confused »chaotic« appearance underlain by several layers of dynamic systems that need unravelling. Both the Channel River and the Palaeo-Elbe would have created at least seasonal barriers to movement (white dashed lines) during the LG (Gupta et al. 2007; Westaway/Bridgland 2010). The currently submerged Channel River (blue dashed lines) could also have played the role of a network of tributaries connecting regions if the valleys or waterways were used. Britain, Belgium, and the Netherlands are on the watershed line between the Palaeo-Elbe catchment to the east and the Channel River catchment to the west, a region of high ground/dryland always accessible throughout the LG (red dashed line), linking Britain to the North European Plain (Ward/Larcombe/Lillie 2006).

this network, a crossroads of branching tributaries and potential dryland corridors linking Northern Europe. The combination of methods used here, consisting of GIS-based procedures for data integration, and assessment of the lithic signatures has been shown to be a useful tool for reassessing the LG occupations of Britain. One of the greatest challenges is to find ways to integrate variable datasets appropriately, at different scales of analysis.

In summary, the four methodologies being developed throughout this early phase of research are:

1) A deep critical assessment of available national datasets and the role they can play in current LG research,
2) GIS as an integrative tool, combining multiple datasets into a quantifiable and visual research platform at different scales of analysis,
3) Combining lithic technological and typological recording systems,
4) Modelling and considering the role of the Channel River, and LG river dynamics, in relation to LG site distributions, considering possible natural links and barriers in the landscape under varying LG conditions.

The preliminary results have proven promising with significant patterning observable in the distributions at a local and regional scale. The first results of the pilot study using the Wey and Mole River catchments as a test case have produced some encouraging results and demonstrate the high potential of applying this approach more widely. The hypothesis of a more intensive use of river valleys during the Allerød contrasting with earlier Creswellian and later Early Mesolithic patterns is beginning to take a more affirmative role. However, there remain many archaeological and taphonomical biases that need to be disproved.

One of my main research objectives is to integrate the broadest spectrum of available data to attempt to qualify the reference sites and integrate lower resolution sites. It also plays a role in reviving historic collections and creating a platform for the integration of »grey literature« while maintaining a focus for both future research and development archaeology.

The novel integration of the Channel River and its tributaries as a framework for analysing the LG of South-East England, and the relationship of this archaeology with what is now Continental Europe, appears to hold a great deal of potential for generating new behavioural questions about hunter-gatherers. One such question I will be exploring in future work is the extent to which rivers divided or linked LG landscapes both in terms of human perception and cultural links, and more practically by, for example, funnelling or blocking animal and human migrations. The notion of »river catchments« as a scale of analysis relating to these highly dynamic LG living environments will be developed around the Channel River network, framing questions of LG dynamics.

I would like to conclude with a few words concerning the Channel River. The combination of attractive riparian environments, strategic vistas overlooking the canyons and mesas of the Channel River system (Gupta et al. 2007) would likely have been accompanied by the sounds of the encounter between one of the largest rivers in Northern Europe with the strong tides of the Atlantic during the LG (Uehara et al. 2006) to possibly even create a tidal »Channel bore« resounding through the canyons, rendering this now submerged dramatic visual and aural landscape significant during the LG.

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Notes

1) Based on the models created by the author the estimate for the flooded Irish Channel / Sea catchment at the onset of the Allerød (GI 1c-a) is c. 110,000 km², the one for the Palaeo-Elbe is c. 320,000 km², and the Channel River c. 517,000 km². At some point during the Allerød the rising sea levels flooded Hurd Deep (Antoine et al. 2003b; Westaway / Bridgland 2010; Brooks et al. 2011), separating the Seine from the Channel River (reducing the area by c. 100,000 km²), although they continued to share the same estuary (**fig. 1**).

2) The basemap for the construction of fluvial channels is currently being updated to Gebco2014, OS Panorama to Terrain 50 and SRTM90 to SRTM1. Additionally new DEMs, made available by the European Environmental Agency, are being tested.

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Summary

A novel perspective on Late Glacial archaeological distributions of South-East England framed within the dynamics of the Channel River network is presented. The Colonisation of Britain dataset of Late Glacial archaeological events is assessed within the dynamic framework of the Channel River system. The main focus is on the region of South-East England, considering its position towards the centre of the Channel River network and the interconnectivity of this region with North-West Europe. Multiple datasets are integrated at different scales of analysis, with an emphasis on the characterisation of open-air lithic assemblages. The methodology for this doctoral research is presented here with some preliminary results, concluding with directions for future research.

Keywords

Lateglacial, Channel River, River Wey, GIS, lithics

OLIVIER BIGNON-LAU

ABOUT THE EARLY AZILIAN WAY OF LIFE IN THE PARIS BASIN: ECONOMICAL AND SPATIAL INSIGHTS FROM ZOOARCHAEOLOGICAL DATA

This article aims at compiling zooarchaeological works on the Early Azilian site of Le Closeau (Rueil-Malmaison, dép. Hauts-de-Seine/F), which were carried out at different stages of the study. This work therefore consists in putting into perspective the spatial analyses of bone remains (Bignon 1998; 2000) with hunting practice studies (Bridault 1995; Bemilli 1998; 2000; Bignon 2003; 2008), in order to get a comprehensive picture of the economy of animal resources. The prospect of understanding the main economic objectives, from game acquisition to its processing and until its final disposal, is part of a palaeo-ethnological approach originally developed for the Magdalenian deposits of the Paris Basin (Leroi-Gourhan/Brézillon 1972; Julien/Karlin 2014). In this way, the planimetric excavation of occupation soils allows us to do a socio-cultural study in which the remains of human activities (*via* their technological significance) provide information on social behaviour. We will here attempt, through archaeozoological analyses, to shed light on the way of life of Early Azilians in the Paris Basin.

THE EARLY AZILIAN OF THE PARIS BASIN AND THE LE CLOSEAU SITE

In the regional context of the Paris Basin, the Early Azilian is a cultural entity that has delivered only very few sites to date, in comparison with Magdalenian sites (Bodu 2000; Bodu/Debout/Bignon 2006; Debout et al. 2012). The only three sites for which this cultural association is recognised are the lower level of Le Closeau, the Cave of the Horse in Gouy (dép. Eure/F; see Bodu 1995; 1998; 2000; Valentin 1995; Bodu/Valentin 1997) as well as Hangest III.1 (dép. Somme/F; see Coudret/Fagnart 1997; Fagnart/Coudret

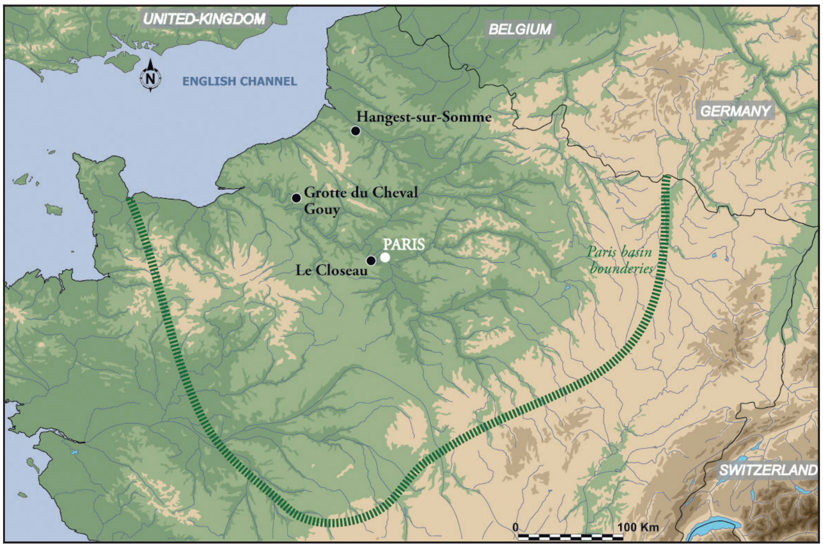


Fig. 1 Map of Early Azilian sites in the Paris Basin. – (CAD Bignon-Lau 2015).

Site	Commune	*Locus*	Lab. no.	Material	^{14}C Dates (BP)	Calibration cal. BC	Reference
Le Closeau	Rueil-Malmaison	4	OxA-5680 (Ly-166)	bone undet.	12,090±90	12,223-11,796	Bodu 2000
Le Closeau	Rueil-Malmaison	4	OxA-6338 (Ly-313)	bone undet.	12,050±100	12,224-11,681	Bodu 2000
Le Closeau	Rueil-Malmaison	33	GrA-18860	horse	12,510±80	13,158-12,326	Bodu et al. 2006
Le Closeau	Rueil-Malmaison	33	GrA-18815	large bovid	12,480±70	13,109-12,303	Bodu et al. 2006
Le Closeau	Rueil-Malmaison	46	GrA-11664 (Ly-789)	horse	12,350±60	12,791-12,149	Bodu et al. 2006
Le Closeau	Rueil-Malmaison	46	GrA-11665 (Ly-790)	red deer	12,360±60	12,812-12,158	Bodu et al. 2006
Le Closeau	Rueil-Malmaison	46	GrA-18816	wild boar	12,350±70	12,835-12,133	Bodu et al. 2006
Le Closeau	Rueil-Malmaison	46	AA-1881	wild boar	12,423±67	12,994-12,220	Bodu et al. 2006
Le Closeau	Rueil-Malmaison	46	AA-1882	cave lion	12,248±66	12,598-12,003	Bodu et al. 2006
Le Closeau	Rueil-Malmaison	56	GrA-18819	cervid	12,340±70	12,814-12,125	Bodu et al. 2006
Grotte du Cheval	Gouy		Gif-92346	bone undet.	12,050±50	12,104-11,811	Bodu et al. 2006
Hangest III.1	Hangest-sur-Somme		OxA-4432 (Ly-86)	bone undet.	11,660±110	11,785-11,340	Fagnart 1997
Hangest III.1	Hangest-sur-Somme		OxA-4936 (Ly-22)	bone undet.	11,630±90	11,760-11,326	Fagnart 1997

Tab. 1 Radiocarbon dates of Early Azilian sites of the Paris Basin (after Bodu/Debout/Bignon 2006). Calibrated dates have been obtained with OxCal 4.2 – 2014.

2000; **fig. 1**). Lithic production aimed at long, regular blades for making the tool kit, and shorter, lighter blades for the manufacture of lithic points (Bodu 2000; Bodu/Debout/Bignon 2006). A number of longer blades feature low angle retouches along their edges (Bodu/Mevel 2008) and are found associated with a fairly limited range of tools (mainly short scrapers and burins). Axial lithic points (Christensen 1998) are exclusively represented by symmetrical *bipointes* (Bodu/Debout/Bignon 2006; Debout in prep.). These items are very valuable because they do characterise Early Azilian sites in the Paris Basin as in all regions of France especially well (Célérier/Chollet/Hantaï 1997; Mevel 2010). The Hangest III.1 site stands out on this topic by its hunting equipment and percussion type. Indeed, on the latter site, the backed bladelets, two notched points and one *bipointe*, as well as the »Lacan« burins hint at the Upper Magdalenian, but the use of soft stone percussion rather suggests the Early Azilian (Fagnart/Coudret 2000; Valentin et al. 2006): the cultural status of the assemblage is thus very ambiguous.
Radiocarbon dating of the Early Azilian occupations at Le Closeau and the Cave of the Horse at Gouy shows that these human groups developed during the second half of the Bølling in the Paris Basin (between 13,158-12,326 and 12,224-11,681 cal. BC; **tab. 1**). The Hangest III.1 site also seems to be chronologically different from the two other regional sites; however, radiocarbon estimates could be slightly younger and a dating of slightly before 12,000 ^{14}C-BP is more likely (Coudret/Fagnart 1997). There is actually a large overlap between the dating of Early Azilian sites and the one known for the Magdalenian occupation in the

Locus	Excavation (m²)	Number of remains	Flint artefacts	Lithic tools	Faunal remains (NR)
4	182	6,424	2,379	351	3,900
46	193	6,519	2,309	413	3,856

Tab. 2 Quantitative comparisons between *loci* 4 and 46 – Le Closeau. – (After Bodu/Debout/Bignon 2006).

region (between 13,000 and 11,800 ^{14}C-BP; Debout et al. 2012). The issue of the relative contemporaneity of these two cultural entities is well documented by the remarkable knowledge of morphosedimentary contexts of the Paris Basin developed over the past years (Antoine et al. 2000; Pastre et al. 2000). The stratigraphic analyses thus confirm the antiquity of the Early Azilian and its association to the Bølling at the Le Closeau site (Bodu 1998; 2000; Chaussé 2005): the lower level was found below the »Allerød soil«, a baseline level of that very chronozone recorded in several deposits in the Paris Basin and in the Somme Valley. As Berit Valentin Eriksen (2000) noted, we cannot exclude that there was some contemporary existence, or even coexistence, between different Azilian and Magdalenian cultural traditions.

Excavated between 1994 and 2000 on an area of 29,000 m² (Bodu 1995; 1998), Le Closeau is a key site for anyone wishing to understand the diversity of sub-stages of the Azilian, from the Bølling to the Allerød (53 *loci*). The lower level, which contained the seven Early Azilian *loci* (**fig. 2**), is of unprecedented preservation quality in the Paris Basin. Combined with extensive planimetric excavations (on an area of almost 15,000 m²), conducted by Pierre Bodu, occupations of the lower level therefore have the unique potential to support palaeo-ethnological research like the topic proposed here.

We will thus focus our research on these seven Early Azilian *loci* (an excavated total area of 1,000 m²), located on the banks of a former channel of the Seine. About 80 m apart, and separated by a sand mound, the two major occupation units (*loci* 4 and 46) seem to have had a domestic usage, as suggested by their central hearth around which the largest concentrations of lithic and faunal remains are found (Bodu 1995; 1998; Bodu/Debout/Bignon 2006). In addition, the boundaries of an inner area seem to have been marked by the presence of numerous limestone, sandstone or gritstone (*meulière*) blocks, which form a complete border in the case of *locus* 46 or a partial one for *locus* 4. *Loci* 4 and 46 also share other common characteristics, quantitatively (**tab. 2**; Bodu/Debout/Bignon 2006), or in their spatial structure (Bodu 1995; 1998; Bignon 2000): most of the flint surrounding the hearth is spread over the western half; hematite working took place north of the hearth; the cleaning of the hearth area and its surroundings led to the constitution of dumps/refuse areas outside the area enclosed by large stone blocks. The other *loci* (33, 50, 56, 57, 58) are regarded as ancillary units in contrast to the large units. Indeed, these small concentrations are mainly focused on flint knapping activities, although rare faunal remains sometimes show consumption and processing of animal parts (*locus* 56). The presence of these units surrounding the two large main units has prompted attempts to refitting flint items (Debout in prep.; pers. comm.). The first results already show a movement of elements between the ancillary activities places (*loci* 56 and 58) and between a main unit and an ancillary unit (*loci* 46 and 33). Two blades were also refitted between the major units 4 and 46 (Bodu/Debout/Bignon 2006; **fig. 2**), which does not necessarily imply the absolute contemporaneity of these two units, as it could represent material later borrowed by the occupants of *locus* 46. Furthermore, the exceptional presence of cave lion remains (*Panthera spelaea*) in *loci* 46 and 56 strongly suggests that these bones belong to one single specimen, its disposed remains hinting at a processing in different places (Bodu/Bemilli 2000). This work of linking different *loci* illustrates the occupation complexity throughout the site. We will demonstrate by the spatial analyses of the faunal remains, which is particularly focused on *locus* 46, that the complexity is the same at the scale of each unit.

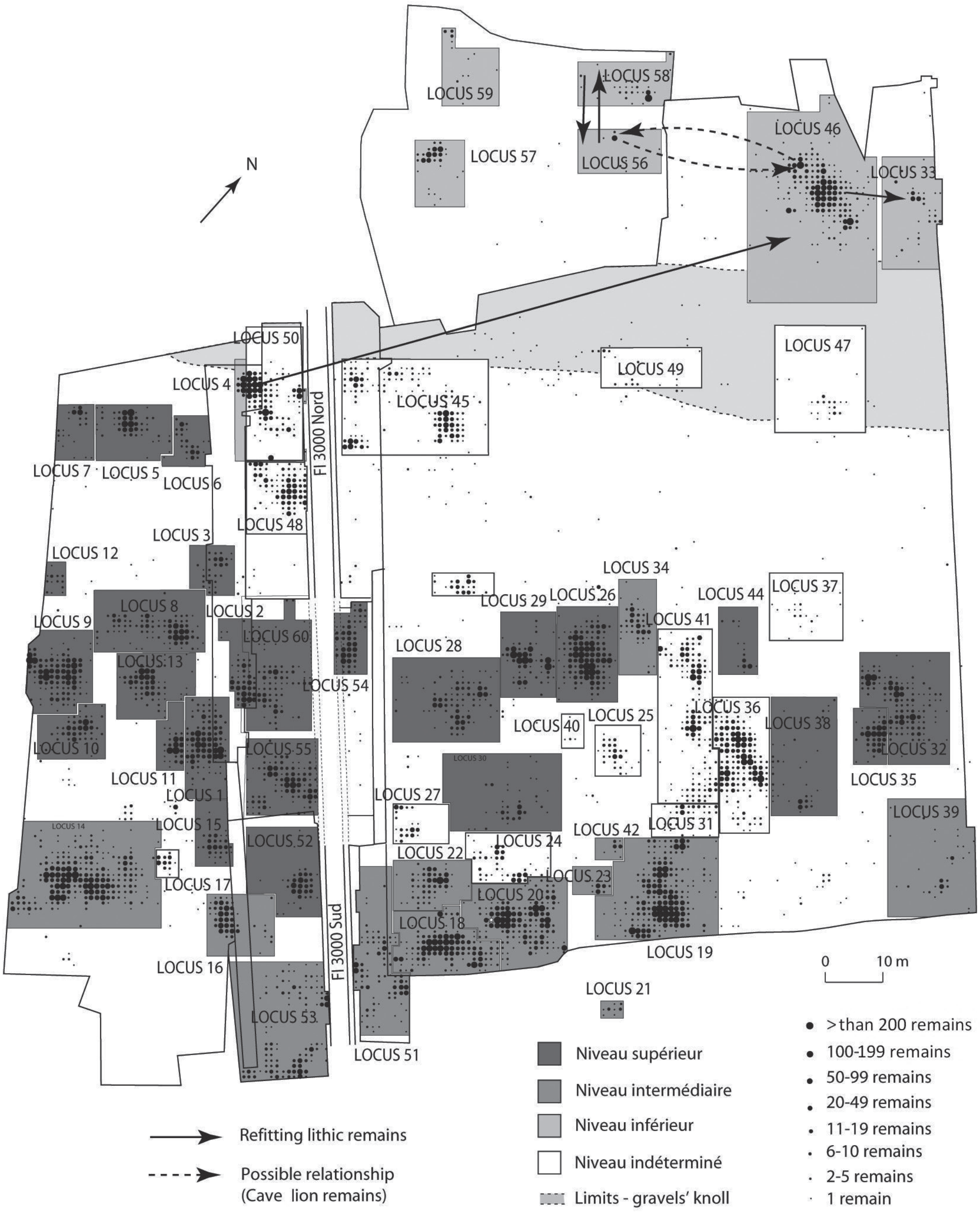


Fig. 2 Lower level of Le Closeau: seven Early Azilian *loci* (4, 33, 46, 50, 56, 57, 58) and their relationships. – (CAD Bignon-Lau 2015, after Debout et al. 2012).

THE ECONOMY OF ANIMAL RESOURCES

Faunal spectrum, key prey species and taphonomy

The faunal spectra review of the two major units will be preferred here (**fig. 3**) and specifically put into perspective with the data from the numerous Magdalenian sites. *Loci* 4 and 46 have a very similar structure in terms of quantitative representation of animal species (Bridault 1995; Bemilli 1998). These units have four species in common in order of importance, in Number of Remains (NR), as in the Minimum Number of In-

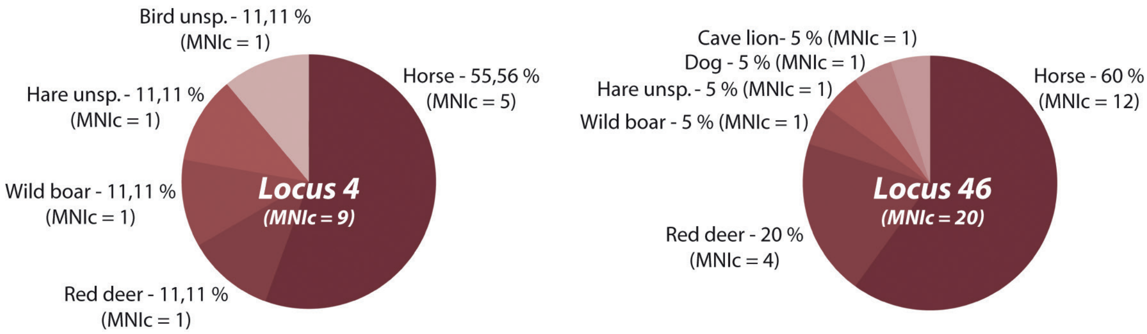


Fig. 3 Faunal spectrums of *loci* 4 (NR* = 148) and 46 (NR* = 733) – Le Closeau: Number of Remains (NR, %) *specifically identified; Minimal Number of Individuals by comparison (MNIc). – (CAD Bignon-Lau 2015).

dividuals by frequency (MNIf): horse (*Equus caballus arcelini*, *s.l.*), red deer (*Cervus elaphus*), wild boar (*Sus scrofa*), and an unidentified hare (*Lepus* sp.). The dominant presence of horse is a link with the fauna hunted by regional Magdalenian groups during the Bølling (Bignon 2007a; 2008). In terms of number of identifiable specimens and individuals, red deer comes second in *loci* 4 and 46, after horse in each case. Therefore, red deer seems to have been regularly sought at Le Closeau, although its relatively low representation assigns it to a secondary prey role. This taxon is also present in the Magdalenian spectra, but only sporadically, and often in marginal proportions, as in Marsangy (dép. Yonne/F; see Poplin 1992) or Etigny-le-Brassot (dép. Yonne/F; see Lhomme et al. 2004). More recently, it has also been identified and dated at the Magdalenian site Bonnières-sur-Seine (dép. Yvelines/F; unpublished analysis by Debout/Bignon-Lau). The presence of wild boar, albeit modest, in several Le Closeau ancient levels (*loci* 4, 46) is, however, unprecedented for the Bølling period but confirmed by two direct radiocarbon dates (**tab. 1**). The unidentified hare (*Lepus* sp.) is also relatively common on Magdalenian sites. In our comparative perspective, the identification of dog remains (*Canis familiaris*, *locus* 46; Pionnier-Capitan et al. 2011) and several remains of cave lion (*loci* 46, 58; *Panthera spelaea*; Bemilli 1998; 2000) is particularly noteworthy. These findings are at odds with the composition of the faunal record during the regional Magdalenian period in the current state of research (Bignon 2003; 2006a; 2007a; 2008).

However, nothing really indicates a palaeo-environmental rupture compared to glacial fauna still attested during the Bølling – quite the contrary. Horse is a constant throughout the Upper Palaeolithic in the Paris Basin (Bignon-Lau 2014), as well as red deer, which has also been identified on other Magdalenian sites, as mentioned previously. We just point out that, since the Middle Pleistocene, red deer are attested in both temperate interglacial forests and in the steppe-predominated complexes of the glacial phases; suggesting that this species has a very wide tolerance to moving into different habitat types according to climatic fluctuations (Sommer et al. 2008). Wild boar has an omnivorous diet and is very generally considered as the typical ubiquitous species, despite its alleged preference to thrive in wetlands (Bridault 1993; 1995); research on the spread of wild boar populations in present-day Northern Europe shows that the primary factor limiting their distribution is the availability of food resources, strongly connected to broadleaved forests (Rosvold et al. 2010; Danilov/Panchenko 2012). It is not possible to say more about the hare in Le Closeau, which was only identified at the genus level.

Beyond this, the isotopic analyses of cave lion collagen provide valuable information that confirms the complex structuring of landscapes and environmental communities during the Bølling. Indeed, it appears that the preferred prey species of these large carnivores were neither horse nor red deer, as isotope analysis only reflects the known values for reindeer (Bocherens et al. 2011). Far from the idea that these spectra can be considered as accurate reflections of palaeo-environments (presence-absence, respective proportions; see

Bignon 2003), these analyses, on the contrary, strengthen the selective nature of economic choices in terms of prey acquisition. Although it appears that the Early Azilian people at Le Closeau could potentially have hunted reindeer, this cannot be proved at the sites known so far and it is evident that horse (and to a lesser extent red deer) was favoured.

Taphonomic parameters must be taken into account in assessing the representativeness of bone remains of the Le Closeau lower level *loci*. Now, the sand mound has clearly played a role in the differential preservation of *loci* 4 and 46, located on either side of it (**fig. 2**). Even if the main accumulation factor is the anthropic agent and if one finds no dispersion or accumulation caused by the river (Bignon 2003), *loci* 4 and 46 of Le Closeau do not share the same taphonomic features.

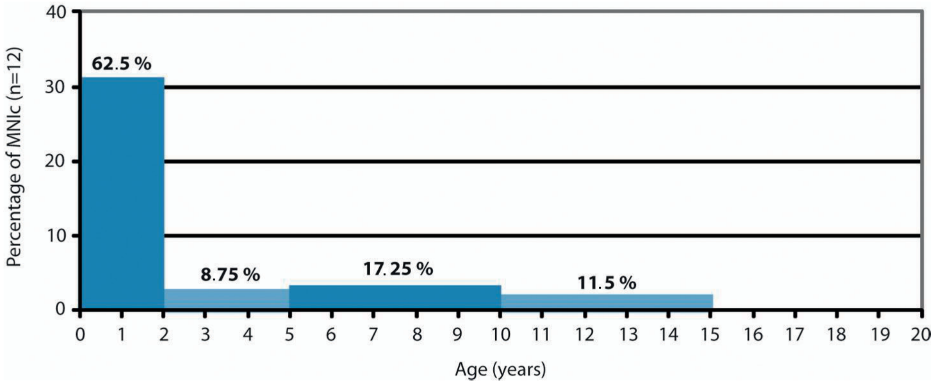
Locus 4 shows poor conservation, the primary cause of which is linked to a differential, shallow deposition of faunal remains (Bridault 1995). This translates into a strong impact of weathering on bone remains, which are also almost systematically covered with many rootlet traces. No traces of carnivore action have, however, been observed on the faunal remains, the spiral fractures of which suggest fresh bone fracturing caused by humans. This is coupled with a very likely significant alteration of animal carcasses, as evidenced by the bones with traces of fire (over 8 %; Bignon 1998). This taphonomic context, conducive to significant dissolution, caused the differential conservation of faunal remains, as attested by the absence of the horse vertebrae and ribs (see below). However, density analyses (CT; Lam / Chen / Pearson 1999) compared to the survival rate of skeletal parts (% PO) puts the impact of a differential preservation in perspective, since even if a positive correlation exists, it is not significant (Bignon 2008). Finally, the preservation conditions of *locus* 4 may have been more damaging to animal species with a more fragile skeleton than to large herbivores.

The good conservation of the bones from *locus* 46, however, suggests more favourable taphonomic conditions. The absence of weathering traces and the less patinated lithic material (compared to *locus* 4) indicate a homogeneous, faster deposition (Bemilli 2000). This process has certainly mobilised a sufficient amount of sediment to prevent the bones from being altered by rootlets, traces of which are infrequent in *locus* 46. Carnivores do not seem to have played a significant role in the unit, as few traces are associated with them (0.2 % of the NR; Bemilli 2000). However, intense human activity is noted, characterised by a high level of bone fracturing (performed on fresh bones) and a potentially substantial destruction of animal carcasses by fire (by specimen weight, 86.1 % of remains and splinters bear traces of fire; Bignon 1998; 2000). Finally, the preservation of faunal remains is good, as evidenced by the presence of rather fragile skeletal parts (vertebrae, ribs, skull), even exceptionally good in the case of horse intercostal cartilages (Bemilli 2000). Yet the comparison of density analyses (CT) with survival rates of skeletal parts (% PO) shows, as in *locus* 46, a positive, although not significant, correlation (Bignon 2008). Anyhow, in view of its best overall conservation, *locus* 46 will logically be preferred for the spatial analyses discussed later.

Game, hunting and seasonality

As it was a preferred prey of the Early Azilians, close attention will be paid to horse acquisition methods from the major settlement units of the Le Closeau site. While building on initial zooarchaeological studies (Bridault 1995; Bemilli 1998), the analysis of dental elements required a long refitting work of the series and an improvement of age references in order to get the Minimum number of individuals by combination (Vigne 1988). The age determination is based on wear / replacement reference series and, for the (deciduous and permanent) cheek teeth series, on the crown height method (Levine 1982; Bignon 2003; 2006b; 2007b). These efforts have resulted in a considerable increase in the number of individuals between the MNIf and MNIc (Bignon 2003; 2008; Bignon / Bodu 2006).

Fig. 4 Mortality profile of horses in *locus* 46 – Le Closeau. – (CAD Bignon-Lau 2015).



A higher number of horses has been identified for *locus* 46 (MNIc = 12), compared to that for *locus* 4 (MNIc = 5). In both *loci*, the slaughtered horses for the most part belong to the most extreme age groups, the juveniles and the very old adults (Bignon 2003). For *locus* 4, the MNIc is not high enough to be able to suggest a mortality profile. Nevertheless, the horses' palaeo-demographic composition is as follows:

- two foals/yearlings (0-2-year-old group), one approximately 12-month-old and another 15-month-old;
- an adult (5-10-year-old group) with an average age of 6.56 years (± 1.18);
- an adult about 9-10-year-old (5-10/10-15-year-old group);
- an old adult about 12-year-old (10-15-year-old group).

When considering the equid slaughter profile in *locus* 46 (**fig. 4**), it also appears to be characteristic of the attritional model (Levine 1982). In such a model, the youngest and oldest animals are killed because of their lack of experience or speed to escape their predators. The slaughter profiles of the attritional type more specifically match pursuit hunting or stalking, conducted individually or in very small groups (Levine 1979; Bignon 2003; Bignon/Bodu 2006). It is also clear, given the large number of foals for both *loci*, that the harems (horse family groups) have been specifically targeted by the Early Azilians (Bignon 2003). Targeting harems hints at a coherent tactical choice with pursuit hunting or stalking, aiming to potentially hit a larger number of equids per hunting expedition. Food products derived from horse can be estimated by calculating the GUI (General Utility Index; Outram/Rowley-Conwy 1998) at about 600-650 kg in *locus* 4 and about 1.4 tons in *locus* 46 (Bignon 2008).

In addition to the mortality pattern, clues about seasonality provide insights into hunting tactics (hunting objectives specific to each hunting episode) and contribute to highlight hunting strategies (hunting objectives for one or more annual cycles; see Bignon 2008; 2014). Information on the horse slaughter season was essentially obtained by the crown height method of deciduous cheek teeth (Bignon 2003; 2006b; 2007b). Both foals/yearlings in *locus* 4 delivered fairly accurate information dating their being killed between May and July (with a confidence interval of ± 1 month; **fig. 5**). More numerous clues about seasonality from *locus* 46 show that horse hunting took place in different seasons (**fig. 5**). However, the results indicate a greater occurrence for two very specific periods: either when this animal was at its weakest (in late winter-early spring), or at its most corpulent (in autumn). These identified clues about seasonality demonstrate the existence of several hunting episodes on horse family bands (harems, regularly composed by juvenile and older horses), which ultimately led to the attritional mortality profiles. The observed seasonal distribution suggests that only a few animals were slaughtered during each hunting episode, which tends to confirm the repeated implementation of pursuit hunting or stalking tactics. In this perspective, one can even consider that not all hunting episodes were successful. The seasonality of horse hunting episodes and the small number of individuals killed during each expedition could hint at individual hunting or hunts in small

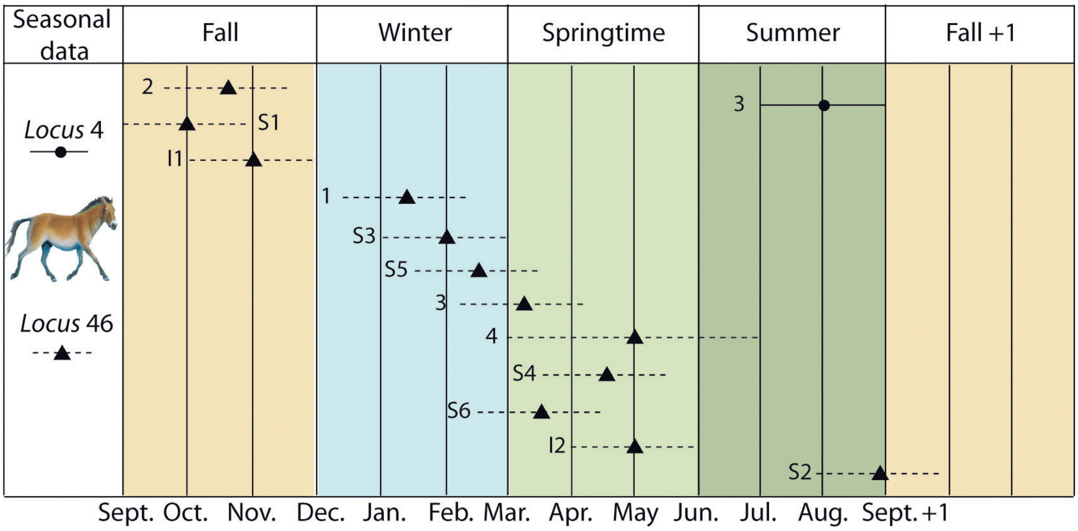


Fig. 5 Seasonal data from juvenile horses of *loci* 4 et 46 – Le Closeau. – (CAD Bignon-Lau 2015).

groups. In other words, the dominant hunting strategy of the Early Azilians from Le Closeau, in the absence of elements hinting at a change in hunting objectives, essentially consists of a succession of individual hunts on the preferred game, which are hardly profitable when linked to how often they occurred. In relation to that conclusion, the question of the status of the dog discovered in *locus* 46 arises. Either this animal is an integral part of the individual hunting pattern and the usual meat processing followed its death during a hunting episode, or this domestic canid was not alongside hunters but rather deliberately killed as prey during a hunt, which would explain the scarcity of carnivore bite marks on the bones in *locus* 46 (Bemilli 2000). While it is difficult to provide a definitive solution to all these hypotheses which are equally plausible, this case is food for thought on the emergence and use of dogs during the Upper Palaeolithic (Musil 1974; 2000; Benecke 1987; Morel/Müller 1998; Sablin/Khlopachev 2002; Savolainen et al. 2002; Street 2002; Vigne 2005; Germonpré et al. 2009; Pionnier-Capitan et al. 2011; Germonpré/Láznicková-Galetová/Sablin 2012; Boudadi-Maligne/Escarguel 2014).

Of red deer, the second most hunted species by importance in *loci* 4 and 46, there is only one individual in this first unit. However, the four individuals found in *locus* 46 suggest a greater interest by Early Azilians in this taxon. The age of these specimens (Bemilli 2000) would indicate hunting choices similar to those adopted for horses. Slaughter focused indeed on a young under 3-year-old deer and two old adults of the over 10-year-old group, in addition to a 6-8-year-old adult. No clue about seasonality is available for this taxon, but in view of the palaeo-demographic data and the conclusions reached for horses, these specimens might possibly have been killed during several hunting episodes. This way, red deer could potentially have brought hundreds of kilograms of food supplies to the occupants of *locus* 46.

Wild boar, represented by an individual in each large unit, can hardly be considered a key prey or preferred target when considering that the *loci* were frequented for at least several months (*locus* 4), if not on an annual cycle (*locus* 46). Indeed, this animal has certainly been encountered while hunting, and is therefore more related to opportunistic acquisition than to an assertive economic choice. It seems that the same conclusion can be drawn for lion, since the presence of this taxon is extremely rare since the Last Glacial Maximum (Bocherens et al. 2011), and its ferocity will have incited extreme caution. Finally, hare, which is represented by a single specimen in the two major studied units, is likely to result from an occasional acquisition, probably related to trapping activity.

The settlement pattern of Le Closeau during the Early Azilian

Economically, our zooarchaeological observations indicate that the lower level occupations of Le Closeau represent a succession of short stays at different times of the year. This occupation saw the first Azilians conduct butchery activities and dispose of non-edible body parts. The relatively high rhythmicity of occupation is likely to be related to individual hunting or hunts in small groups, hardly profitable, requiring hunters to return to the dwelling units regularly for processing the killed prey (Bignon 2008). These hunting tactics also reveal that the size of the social group that stayed regularly in Le Closeau main units was most probably quite modest. The question of animal processing methods will be explored in more detail below in our spatial analyses to reflect the dynamics of archaeological deposits.

Our zooarchaeological considerations provide a high consistency within the relatively small amount of the various remains, which strongly suggests a short-term occupation (Bodu/Debout/Bignon 2006). The small amount of lithic products in *loci* 4 and 46 (**tab. 2**) hints at an occupation period lasting not much longer than a few weeks in total and suggests a limited number of knappers (Bodu 1995; 1998; 2000; Bodu/Debout/Bignon 2006). The initial results of lithic refitting did highlight blank production sequences suggesting different levels of skill; it is, however, too soon to conclude that the occupants of the lower level of Le Closeau were family units (Bodu/Debout/Bignon 2006). In addition, the main activities were the production of projectile implements and the repair of hunting equipment as well as meat processing and hide working operations, as highlighted by traceological studies (Beyries 1998; Christensen 1998).

SPATIAL ANALYSES OF FAUNAL REMAINS FROM *LOCUS* 46

General spatial data

The analyses below were based on quantified data (weight and number of identified specimens) to capture the distribution of the faunal remains by qualitative criteria (species, anatomical segments, skeletal parts; see Bignon 1998; 2000). This is aimed at reproducing the way the butchery operations took place in the *locus* 46 area (**fig. 6A**), beginning with game segmentation. Our observations are made at the square metre scale, but counts of remains smaller than 1 cm were made at the level of 1/16th of a square metre. Four anatomic segments have been defined, including several skeletal elements: the vertebral elements (vertebrae and ribs); the cranial elements (skull, mandibles and teeth); the anterior limbs and the posterior limbs. However, some of the autopod elements (phalanges or metapodials) were not taken into consideration, since although the specific identifications were undisputable, their precise association to the anterior or posterior limbs was not sure. Through the segmentation process, our spatial analysis seeks to find some dynamics that relate to the processing and consumption-disposal phases of animal remains.

The distribution of the numbered bones (larger than 1 cm; **fig. 6B**) allows us to observe that the vast majority of these remains are concentrated within the occupation area the boundaries of which are marked by large stones. Within the area enclosed by these blocks, the homogeneous and dense distribution of bone remains smaller than 1 cm identifies this area as the preferential area of animal processing. 95 % of the burned bone remains smaller than 1 cm, associated with a gray coloration of the sediments, identify a central hearth area (D/E-268/269 square metres) visibly constituted by several contiguous small pits without stone structures (Bodu 1998; 2000). The fact that the distribution of bone remains smaller than 1 cm is confined to the limit of the stone block boundary leads us to infer that these have served to consolidate a covered structure (Bignon 1998; 2000). Outside of this domestic space, two adjacent layers to the east and

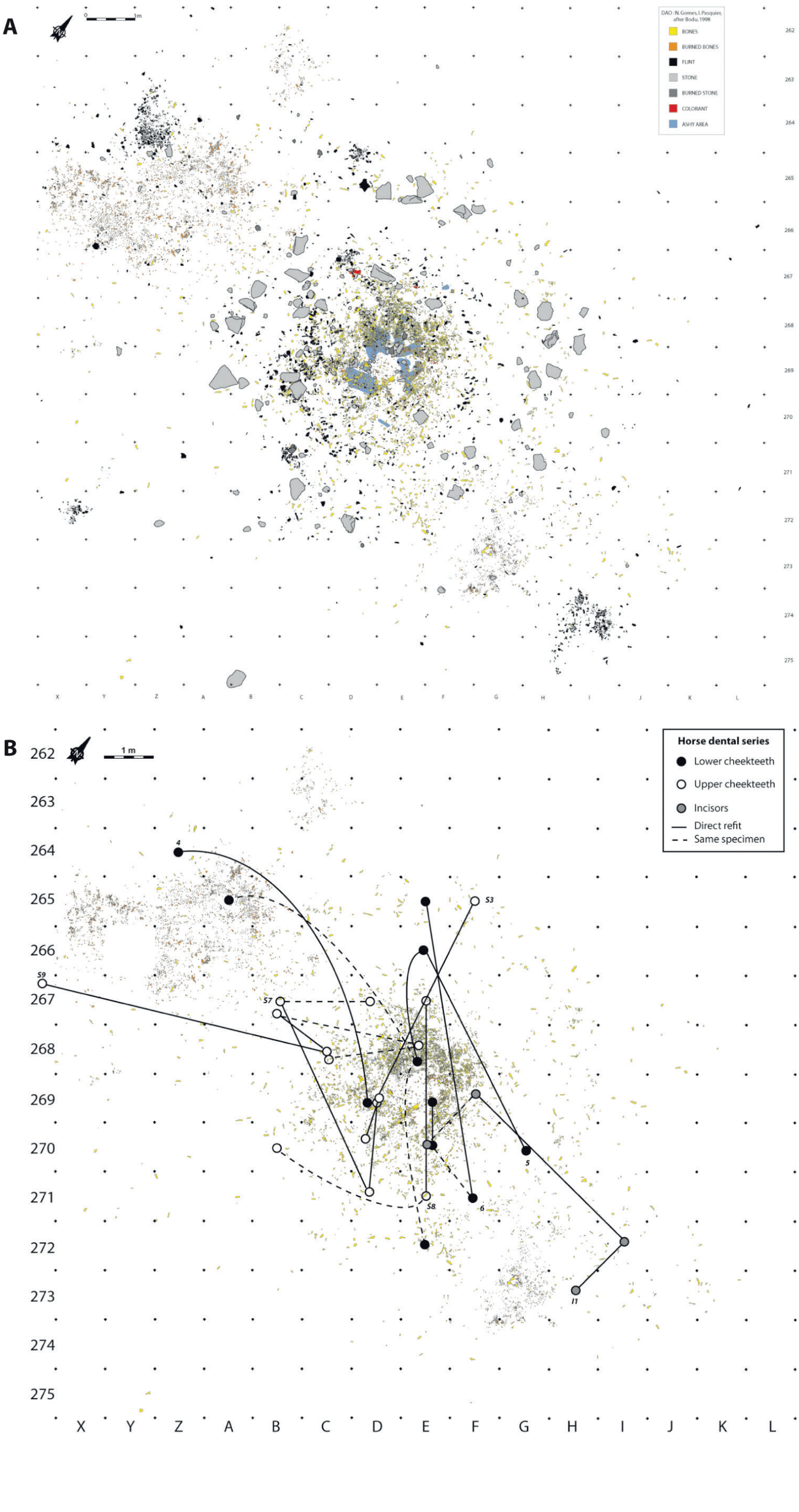


Fig. 6 *Locus* 46 – Le Closeau: **A** general distribution of remains. – **B** distribution of faunal remains larger than 1 cm and refitted dental series. – (CAD Bignon-Lau 2015).

west have been identified as dumps/refuse areas. This characterisation is strongly linked to the composition of the bone remains and matches the one found for the hearth area, but without any trace of reddening or ashy colour of the sediment (95 % of burned bone remains smaller than 1 cm; Bignon 1998; 2000; Bodu 1998; 2000). Through numbered faunal remains (**fig. 6B**), a subdivision into concentric areas by differential density appears within this covered structure. The unstructured hearth area, at the centre, delivers the highest concentration of faunal remains. In the immediate outskirts of the hearth area, far fewer bone remains form a concentric ring. Between the hearth surroundings and the area where the large stones form a relatively continuous border, a scarcity (or even interruption) of the presence of skeletal remains is observed, revealing a third concentric area. A final zone has been identified at the border of the blocks, and this is characterised by the presence of more bone remains, which form a continuous arc on more than a half of *locus* 46 (from D265 to C272). Of all the bone remains, it should be noted that the further away from the hearth area the fewer remains with burn marks were found. However, unburned remains still represent between 5 and 25 % of the specimen weight in the same area.

These observations allow us to reveal a first series of interpretations pertaining to the use of space in *locus* 46, the resulting activity management and dynamics of bone deposits. The structure that defines the habitat and the presence of a central hearth area conditioned the concentric distribution of the remains. As such, the area virtually devoid of any bone remains reveals the circulation path within *locus* 46 around the hearth. The low presence of any type of remains is most marked in the north-west quarter within the unit, which could also have served as a resting area (**fig. 6A**). The human circulation is also visible in the outside dumps/refuse areas: to the west, the continued absence of remains between C266 and E265 suggests an exit; to the east, it is rather a set of remains spreading from the outskirts of the hearth to the dump/refuse area that lead us to locate a second exit between D272 and F272. Subsequent analyses will help with the identification of this south-east exit, but the feature's distinct characteristics raise questions on their simultaneous, alternate or consecutive use to suit different stays that occurred in this unit.

In addition, the spatial organisation of faunal remains does not only arise from structural constraints, it is also the result of disposal strategies aimed at maintaining the organisation of inhabited space. These disposal strategies can be defined as the combined effects of maintenance (displacing remains) and disposal (by voluntary combustion of bones). To this end, while it is likely that several Azilians took part in the butchery activities, all could not stand in one place, especially above the hearth area. The middle of the space inside *locus* 46 was a very busy area, but the millimetric remains found anywhere within the structure suggest that a partial cleaning was conducted. As shown by some refitted dental series (**fig. 6B**), several types of movements are observed between elements: hearth area to immediate surroundings area, hearth area to stone block border, hearth area or its immediate surroundings to external disposal areas (to the east or west). These movements of remains are the product of cleaning, a certain concern for maintenance of working or resting places, which would explain the overrepresentation of fauna at the hearth area (and the fact that only 15 % of the numbered remains are burned). This gathering of faunal remains in the middle of the occupied space is to be related with their recurring use as fuel: one third of the fauna by specimen weight was burned (Bignon 1998; 2000). Beyond such use, it is not contradictory to think that the intention of the first Azilians was both to eliminate a large part of the volume of bone waste, but also to avoid attracting predators to occupations. Through the combustion process, heavily burned millimetric remains helped delimitate the hearth area and identification of the outer dumps/refuse areas.

In addition to general observations on a more dense faunal distribution in the eastern half of *locus* 46, it is noticeable that knapped flints are in contrast more present in the western half (Bodu 1998; 2000). While fracturing operations were still carried out, as evidenced by the abundance of millimetric fragments, many blade products were discovered at the hearth area and in the western half of the unit

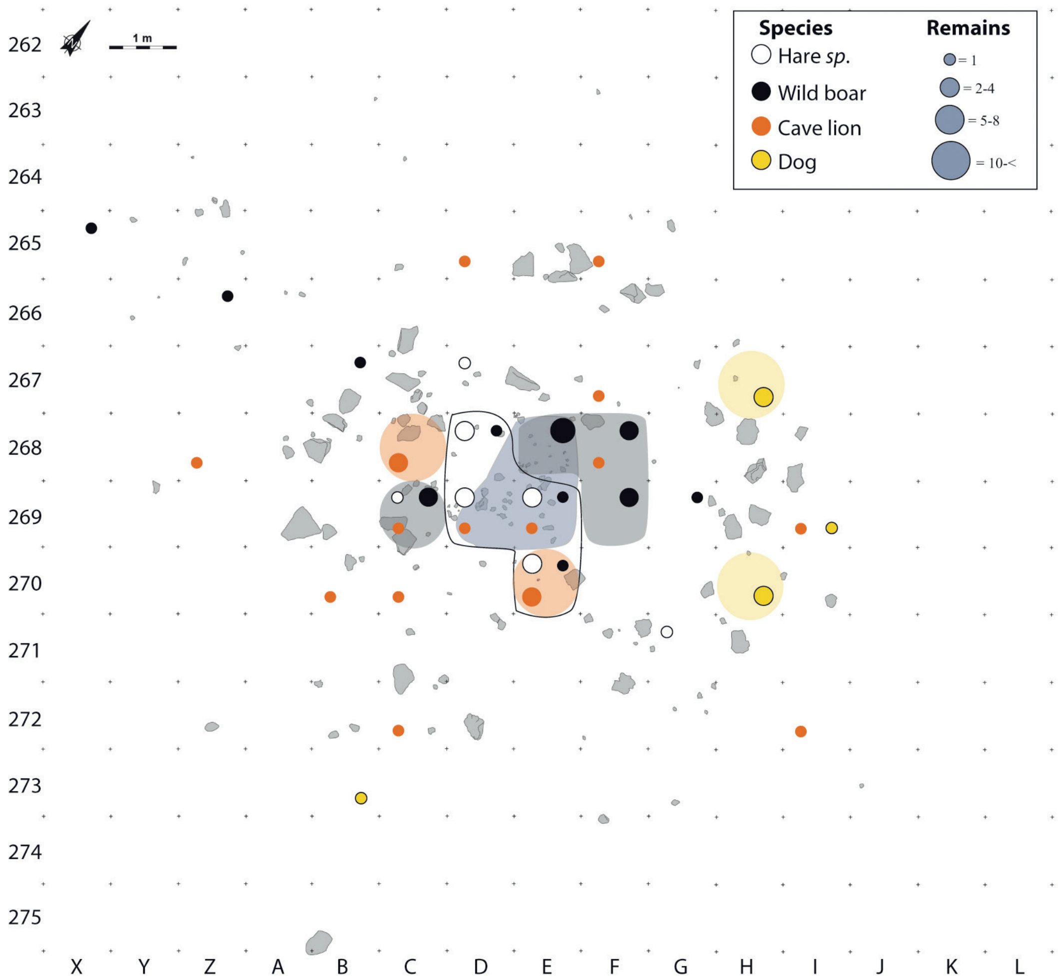


Fig. 7 Distribution of poorly represented species. – (CAD Bignon-Lau 2015).

(Bodu/Mevel 2008). Now, the traceological studies have shown that meat cutting operations (on blades with marginal retouches) and hide processing (mainly on retouched blades) were carried out (Beyries 1998; Christensen 1995; Bodu/Mevel 2008). This information complements the spatial distribution pattern related to butchery activities and the work on animal remains in general.

Distribution of poorly represented species

The species which are identified by a small number of remains help to understand spatial dynamics related to animal processing (Bignon-Lau et al. 2013; **fig. 7**). For example, hare remains (*Lepus* sp.) offer a fairly low dispersion within *locus* 46: they are mainly concentrated at the central hearth (D-E268-269) and its southern and western surroundings. Despite the many missing bones there, it was not possible to identify any remains for this species in the outer dumps/refuse areas.
Compared to the distribution of hare remains, the distribution of wild boar remains appears much less compact and homogeneous. Within the inner space of *locus* 46, the largest concentration is located north of the hearth area and along its north-east periphery, but some remains were found in a marginal position south of the hearth. Outside, only the western dump/refuse area contains a few disposed remains. It should

be noted that Céline Bemilli (1998; 2000) suggested wild boars were brought in in quarters, given the many absences in anatomical representation and imbalances in the lateralisation of present skeletal elements. Precisely for the same reason, this assumption was also made to characterise how cave lion was brought to this unit. The distribution of lion bones is also noteworthy, being relatively heterogeneous south of the hearth area. Besides, it is in these spaces that the sawed phalanges of this big cat were discovered (C268, C270). However, other autopod remains (fragments of phalanges with cut marks and metacarpals) were identified north of the hearth, in the north-east of the stone border (possible indication of an import or use of pelt?). The few remains discovered outside of the occupation structure are metapodial (C272, I272) or radius (Z268) fragments.

Unlike other minority species, dog remains are not located in the internal space of the occupation, but mainly in the east, pushed away to the stone border (metapodials and phalanges, H267, H270; mandible, I269). A second, isolated lower molar, relating to the mandible found in I269, was identified near the south-east exit (B273).

After the spatial analysis of minority species, it appears that no valid distribution pattern can be identified for all these taxa. In contrast, butchery activities indicate that several working areas existed, or occasionally co-existed, within the occupation structure of *locus* 46. This plurality of animal processing areas may be put in relation with the fact that anatomical portions of several large mammals might have been selectively brought in. As for the most common species (horse and red deer), it is thus significant to determine whether a differential distribution by skeletal segment is noticeable.

Distribution of red deer remains

The examination of the spatial distribution of the segments will begin with the few cranial (n = 22) and vertebral (n = 22; **fig. 8A**) elements. At the heart of the occupation unit, remains relating to the cranial segment are concentrated in the hearth area and at the south-east exit. An isolated specimen is present in the east of the circulation path, very close to the only two remains located north of the stone circle. We see that the cranial remains were preferably disposed in the western dump / refuse area, perhaps in several stages as their fragmented distribution would suggest. As for the vertebral remains, they are, like the cranial segment, concentrated at the hearth, but are also found further east in the immediate vicinity of the combustion area. With the exception of a specimen south-east of the circulation path, only the eastern area of dumping has received disposals from the red deer vertebral segment.

More deer remains have been identified for the anterior (n = 31) and especially the posterior (n = 55; **fig. 8B**) limb segments. The stronger presence of anterior limb elements is observed at the centre of *locus* 46. It is, however, noteworthy that the northern edge of the hearth area contains some remains, and that some others were found to the south of the circulation path (C270, F270). It is at the north-west edge of the stone border that anterior limb remains are particularly present; apart from this, they are totally absent at the edge of the occupation in its eastern half. For the same anterior bones, it seems that they were rarely disposed in dumps / refuse areas, in the east as in the west, revealing some balance in these maintenance strategies.

Like anterior elements, the fragments of the posterior segment are massively represented at the hearth area. At the periphery of the hearth, it was possible to recover remains from the latter segment in almost the entire circumference. However, their south-eastern distribution within the structure (as far as the exit) seems even more pronounced. As such, despite a wide collection at the hearth level, we can see that the anterior segments tended to be exploited in the north-east, while the posterior segments were mostly exploited in

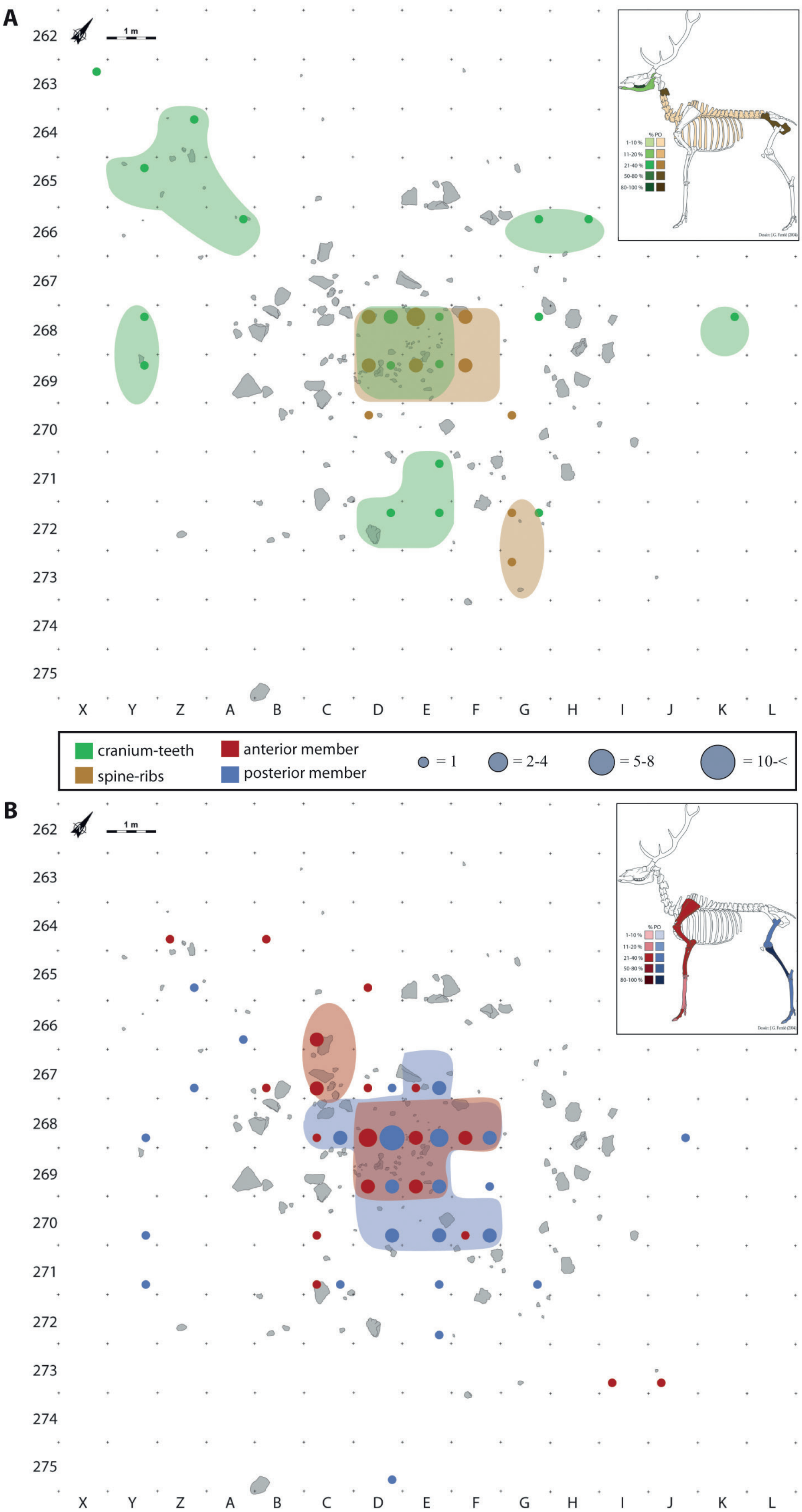


Fig. 8 Distribution of red deer remains (*Cervus elaphus*) in *locus* 46 – Le Closeau: **A** skeletal elements of spine and ribs. – **B** skeletal elements of anterior and posterior members. – (CAD Bignon-Lau 2015).

the south-east. Moreover, it is in this very area that the only remains connected to the stone circle are observed. As for the discharge strategies towards the outer areas, it is obvious that the western dump/refuse area was very clearly favoured. Some isolated remains south and south-west seem to result from occasional disposals. In the absence of remains smaller than 1 cm, one cannot infer that these outer areas were animal processing areas.

Distribution of horse remains

We will begin the study of the spatial distribution of horse (**fig. 9A**) by the vertebral (n = 47) and cranial (n = 200) segments. Their clear difference in number is related to the numerous teeth and their degree of fragmentation. The cranial segment distribution within *locus* 46 is very widespread, but even in this configuration, the highest rates are recorded at the hearth area. In the domestic space, however, two other activity areas specifically contain the remains of this anatomical part, one in the east (F-G268-269) and the other in the south-east (D270, E270-272). The continuous distribution in the latter area between the hearth and the south-east exit relates to an area where many skulls and mandibles were fractured, releasing a large amount of lower and upper dental elements. It is remarkable that some red deer skull fragments were also observed precisely at the south-east exit (**fig. 8A**). In this location, the repetition of the same objectives may indicate the seeking of more light (sunlight), potentially increased at the south-east exit. Compared to the domestic space, very few cranial segment remains were found at the stone border, the most significant presence being located in the north and south-east. Thus, even if the cranial segment remains are fairly well represented in both dumps/refuse areas, these elements have been disposed slightly more often in the one located to the west.

The vertebral remains, which are far less numerous, have a less wide dispersion: they are mainly concentrated south of the central combustion area. Some remains were found, to a lesser extent, along the immediate hearth periphery, while only one element was found further north in the stone border. Finally, only the western dump/refuse area received a few vertebral remains disposed outside the occupation area. Since they form two distinct sets, they possibly reflect a succession of disposals. Anyway, it can be observed that these outer disposals are in contrast to those of deer for the same vertebral segment, which took place in the eastern dump/refuse area only.

In our spatial analysis, the elements of the anterior (n = 99) and posterior (n = 100) limbs provide similar numbers, though survival rates indicate that some long posterior bones have better chances of being preserved (% PO; **fig. 9B**). Outside the central area of the hearth, these segments show a distribution that does not overlap with the internal distribution of elements of the cranial segment (including concentrations in the east and south-east). The remains of the anterior limb are well represented at the central hearth, but they are also found in numbers to the north-west and south of it. Logically, at the stone circle, we find this category of remains rather to the south and west, although they are not absent in the east. Although a few elements were recorded in the eastern dump/refuse area, the western one was clearly preferred for bringing horse anterior limb elements outside. There is little difference between the anterior and posterior elements in their respective distributions. Indeed, for the posterior anatomical region, the highest concentrations are within the eastern half of the hearth area and east of its immediate surroundings. These densities are in contrast to the few isolated remains found at the stone border of *locus* 46. As with anterior limb remains, we note that the western dump/refuse area was the preferred one for the disposal of elements from the posterior limb segment of horse.

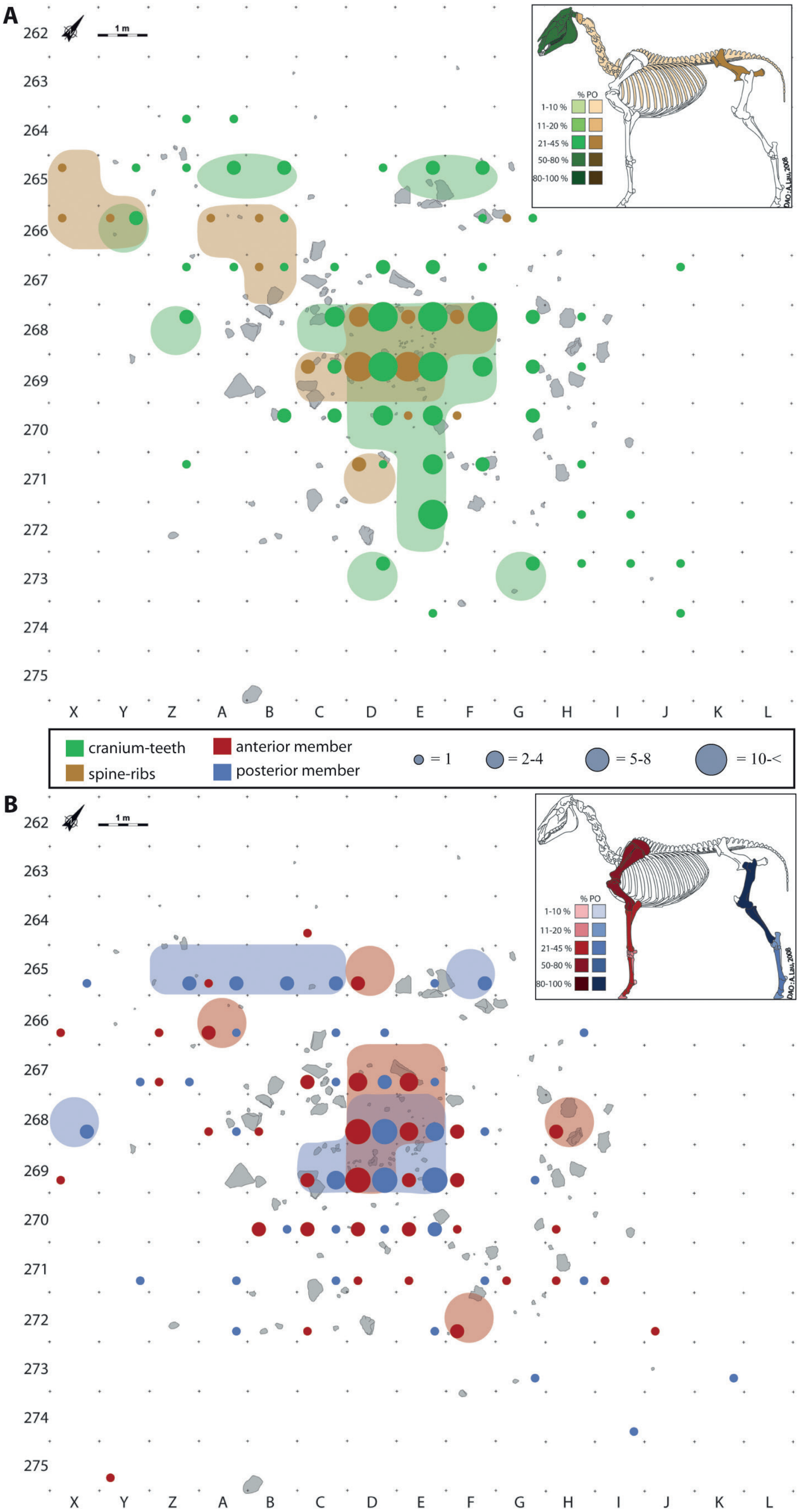


Fig. 9 Distribution of horse remains (*Equus caballus arcelini*, *s.l.*) in *locus* 46 – Le Closeau: **A** sketelal elements of spine and ribs. – **B** skeletal elements of anterior and posterior members. – (CAD Bignon-Lau 2015).

Spatial organization of animal processing in *locus* 46

The different stages of animal processing seem to have taken place in the occupation area: disarticulation, meat removal, fracturing of long bones to retrieve the bone marrow, as well as skin processing (according to traceological studies and the presence of hematite and many scrapers). Our analyses have shown the differential distribution among identified species and a certain variability in the distribution of various anatomic segments by species. While taking into account the destruction caused by the burning of faunal remains, the imbalances in the skeletal representation of taxa are potentially related to various factors (Bemilli 2000; Bignon 2008): leaving some bulky portions (e. g. the vertebral elements) on the hunting site, differential importation (previous consumption), potential exportation (deferred consumption). Whatever the combination of these factors, and even if some rare animals were potentially brought into *locus* 46, what was processed there is related to the more portable fleshy parts: skulls and upper parts of the appendicular skeleton, especially of posterior limbs. The broken bone fragments, which are evidence of the final phase of butchery activities, are concentrated in the central hearth area for most species (and their different segments). Carnivores are the only notable exceptions to this pattern of spatial distribution: lion is rather distributed south of the hearth, while the few remains of dog were found in a marginal position to the east (fig. 7). This distribution provides information on the intermittent operation of the combustion zone as unburned remains were discovered there. This central area appears to have alternately hosted butchery activities, as did the whole interior space, which is attested by the homogeneous distribution of bone remains smaller than 1 cm. This type of tiny remains results from the fracturing phase of the long bones, notably to retrieve the marrow. Before these final steps of butchery processing took place, the distribution of marginally retouched blades to the west of the hearth seems to indicate that most meat removal operations were conducted there (Bodu / Mevel 2008). Evidently, hide working also took place there using retouched blades.

Despite a variable spatial distribution, more noticeable for minority species, the overlapping of horse or red deer segments in the same space is very common. These spatial overlaps highlight the spread over time of different butchery operations, which were alternatively implemented. This is the time of various identified hunting episodes, but also the time when the occupation runs out of domestic space to synchronously process all or part of the animals brought in. In that sense, the distribution of faunal remains is also the product of maintenance strategies that led to movements. We can thus explain the overrepresentation of bone remains in the combustion zone and the presence of elements that were pushed away to the stone borders of the occupied unit. The maintenance strategies also sought to reduce the mass of bone disposals by their recurring use as fuel. Nevertheless, these maintenance operations were neither systematic nor very regular as a major circulation path is still noticeable, and some concentrations or distribution absences (F270; fig. 9A) could hint at the physical location of the occupants. Moreover, we observe that some concentrations of flint are not covered by faunal remains within (C267, D67) or outside (X-Z263-264, H-I274-275) the occupation.

The spatial distribution of remains provides valuable insights into the primary position of animal processing operations, and their partial movement to a secondary position toward the hearth and the structural limit of the unit, but the deposit dynamics reveal a third state. The operation of the central combustion zone produced a rate of 95 % burned remains, a percentage only found in two outer areas in the east and west, which have been interpreted as dumps / refuse areas. The bone remains of these outer areas are the final stage of animal processing, the end of the maintenance strategies employed by the Early Azilians. As the differences between segments or between species have shown (figs 7-9), the constitution of these dumps / refuse areas was the subject of variable choices between selected areas or respective proportions. These observations also hint at a recurrent use of these outer disposal areas in a sequence of several points in time.

FINAL DISCUSSION

Function of the sites, economy and ways of life of Early Azilians

At this point of archaeological discoveries, the occupations at Le Closeau may give the best insights into the function of Early Azilian sites of the Paris Basin. The groups stayed at the site for various occupations the main objectives of which were to prepare hunting episodes and process various animal products for food and technical purposes (skin working). The occupation levels of *loci* 4 or 46 seem to be the result of several short stays, estimated for each at about one month in total based on lithic product quantities (Bodu 1995; 1998; 2000; Bodu/Debout/Bignon 2006; Bignon/Bodu 2006), during around one year (horse hunting episodes occurred at all seasons). This feature contrasts with the intensity of the processing phases of animals which were killed through individual hunting (Bignon 1998; 2000; 2008). However, clues about seasonality regarding horses show that the formation of the large units (*loci* 4 and 46) is the result of regular reoccupation at different times of the year (Bignon 2003; 2008; Bignon/Bodu 2006; Bodu/Debout/Bignon 2006). These short successive but efficient stays are very likely to be connected with small social groups, perhaps family groups, as suggested by the hunting strategy and the observation of different skill levels in flint knapping (Bignon 2003; 2008; Bodu/Debout/Bignon 2006).

The socioeconomic organisation of the Early Azilians relates to an original combination of logistical and residential mobility (**fig. 10**). A series of observations indicates a clear anticipation of needs (compatible with logistical mobility), associated with a succession of short stays of small social groups suggesting a high mobility (typical of residential mobility), highlighted by the exploitation of animal resources and the results of their spatial analysis. The definition of the way of life of these Early Azilians is thus relatively unsatisfactory in terms of Lewis R. Binford's terminology (1978; 1983), which is also a result of the low number of sites discovered in the region. Despite these difficulties, we have suggested that the Le Closeau units were part of a network of similar camps, forming a regular grid in a rather limited territory (Bodu/Debout/Bignon 2006; Bignon 2008). This assumption is based on the fact that despite the repeated hunting episodes and food reserves, the stays were short, and it seems that the intervals between them were brief as well (especially in *locus* 46).

In the Paris Basin, it appears that our glimpse of the Early Azilians' way of life stands in stark contrast to the one observed for Upper Magdalenian groups. The latter implemented a hunting strategy for two preferred prey species, horse and reindeer, a strategy with a high degree of planning, as is also indicated by their other technical sub-systems (Audouze et al. 1988; Bignon 2007a; 2008). These hunting practices determine the mobility and size of hunter-gatherer groups, in relation to the dispersion-aggregation rhythms of key resources (Bignon 2003; 2008; Bignon/Enloe/Bemilli 2006). The high number of hunters, their collective tactics, the simultaneous slaughtering and processing of many carcasses and the storage of food clearly suggest the existence of large social groups during the Magdalenian in the Paris Basin. This socioeconomic system implies a differential participation of society, and therefore, a mobility that is partly logistical (Bignon 2003; 2007a; 2008). But that does not mean that the Magdalenian territorial expansion necessarily encompassed the whole Paris Basin; on the contrary, it seems to have occurred, at least at certain times, in micro-regions such as the Seine-Yonne confluence area where a maximum amount of resources were concentrated (Debout et al. 2012).

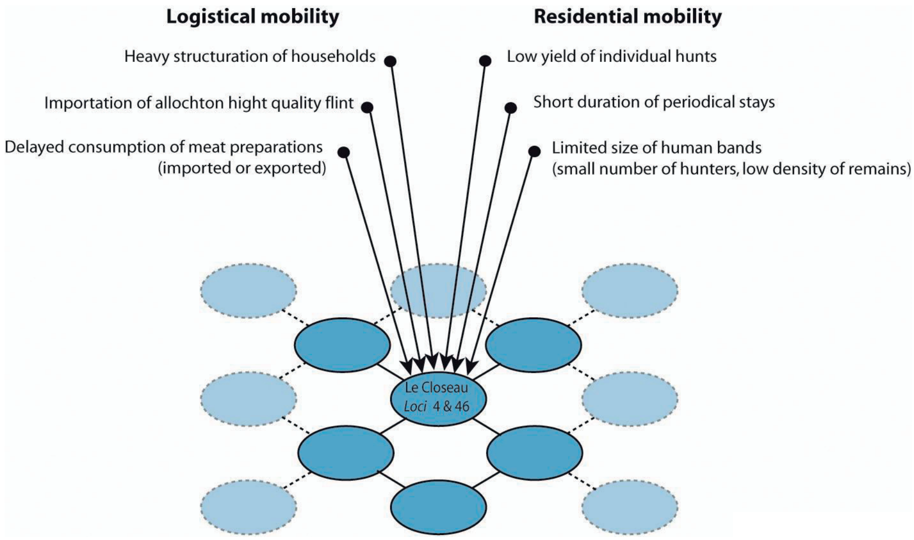


Fig. 10 Mobility and settlement network of Early Azilians in the Paris Basin. – (CAD Bignon-Lau 2015).

From the Magdalenian-Early Azilian transition to their likely co-occurrence

Between the Magdalenians and the Early Azilians of the Paris Basin, there are some shared features in flint knapping, hunting activities, occupation structures. The same applies to supply strategies in lithic raw materials and the production of regular blades resulting from a mode of production with high technical requirements (Bodu 2000; Valentin 2008). Hunting focused on horse harems is also shared by these two cultural entities (Bignon 2003; 2008; Bignon/Bodu 2006). The use of stone borders in dwelling structures of *loci* 4 and 46 was also quickly compared to units P15 and W11 of Étiolles (dép. Essonne/F; Bodu 1998; 2000; Bodu/Debout/Bignon 2006).

However, detailed examination reveals that discrepancies between these Late Glacial entities are predominant and even qualify the shared features. As for the knapped flint, the use of soft stone as hammerstone throughout the production process by the Early Azilians is a highly identifiable trait (Bodu/Valentin 1997; Bodu 1998; 2000; Valentin 2000; 2008). Furthermore, the characteristics of the *bipointe*-shaped axial projectile implements of the Early Azilians do not match those of the regional Magdalenians' points, the forms of which seem closer to Creswellian or Hamburgian points (Schmider 1992; Weber 2003; 2006; Debout et al. 2012; Debout in prep.). Blades with marginal retouches and the retouched blades discovered at Le Closeau are other specificities that do not exist in the regional Magdalenian. Moreover, even if horses were hunted by both prehistoric cultures and despite unbalanced Magdalenian/Early Azilian site frequency, the respective hunters implemented significantly different tactics, and these behaviours were part of different hunting strategies (preferred prey, range of prey; Bignon 2008). As for the use of stone borders in occupation structures, these behaviours seem to be closer to the exception than the rule in the Late Glacial Paris Basin, since the sites and the units mentioned above are the only examples that we know at present. Unlike the Early Azilian, numerous regional sites, some of which have several occupation levels, e.g. Étiolles, failed to provide a link. In addition, it is clear that neither the spatial dynamics highlighted above for the lower level of Le Closeau nor the way of life provide conclusive arguments in bridging the gap between Upper Magdalenian and Early Azilian in this region.

However, some authors have raised the possibility of an affiliation between these cultural entities (Bodu 2000; Valentin 2000; 2008; Weber 2012; Mevel 2013). This affiliation would be part of the »Azilianization« process – a gradual, evolutionary phenomenon of European societies during the Bølling-Allerød Interstadial.

This is according to a Magdalenian-Azilian transition scenario, the main steps of which have been described as follows (Valentin 2000; 2008; Mevel 2013):

1) the very beginning of the phenomenon is dated to the end of the Bølling (12,000 ^{14}C-BP);
2) from that moment on, climate change is causing environmental change;
3) social transformation follows, first in the form of the Cepoy-Marsangy facies (Valentin 1995) and then through the emergence of Early Azilians;
4) Early Azilians spread throughout Europe by a diffusion process, from the oldest emergent settlements such as in the Paris Basin (Mevel 2013), following the ancient trade routes of their Magdalenian ancestors.

An entire article could be devoted to discussing the developed arguments for this model. However, here we will only sketch the outlines of a series of critical remarks that support a plausible »Magdalenian-Azilian« co-occurrence in the Paris Basin:

1) Timeline: As recognised by Ludovic Mevel (2013), many dates from the Magdalenian and Early Azilian are included in the Bølling radiocarbon plateau; the dates of *locus* 46 in Le Closeau (**tab. 1**), which is the most reliable *locus* due to its preservation, are also the oldest dates. In the absence of sufficient chronological resolution, even with the current calibrations, we cannot say more than to acknowledge that there is a temporal overlap between these two prehistoric cultures, from 12,500 ^{14}C-BP to 11,950 ^{14}C-BP.
2) Climate-environment: following a strong global warming that initiates the Bølling, this chronozone is characterised by high instability, marked by large amplitude oscillations, which led to the strong cooling that characterises the Dryas II (Björck et al. 1998; Svensson et al. 2006; Weninger/Jöris 2008; Blockley et al. 2012). With the exception of the initial strong warming signal, no other major triggering event is therefore distinguishable during the Bølling period, especially without fine chronological resolution. As to environmental changes, slight variations in plant communities during the Bølling have been recorded, but the structuring of open, steppe-dominated landscapes showed great stability (Leroyer/Allenet/Chaussé 2005; Leroyer/Allenet de Ribemont 2009). Concerning animal species, we already saw that it was difficult to identify a clear break in the Early Azilian spectra.
3) Transformation of societies: The Magdalenian »Cepoy-Marsangy« facies (Valentin 1995) is characterised from the lithic equipment point of view by substituting backed points for backed bladelets on spear points. This facies, however, raises an issue, as no site where it is present has an impeccable stratigraphic context. Moreover, the presence of bladelets, even if rare, is attested (Valentin et al. 2006). The sites in this facies, seen as a transitional episode, do not have a reliable chronological baseline (Valentin et al. 2006), which leads us to question the very existence of the facies; other options suggest favouring the influence of other northern cultural groups (Debout et al. 2012). Again, insufficient chronological resolution cannot support the hypothesis of a gradual evolution: while the Marsangy dates are indeed around the end of the Bølling (12,120 ± 200 ^{14}C-BP, 12,140 ± 75 ^{14}C-BP), there are no dates for Cepoy (dép. Loiret/F) nor for Tureau des Gardes 7 (dép. Seine-et-Marne/F), and the Étigny-the Brassot date is very similar, perhaps even earlier than *locus* 46 of Le Closeau (Debout et al. 2012). Finally, L. Mevel (2013) comes to the conclusion that it is currently impossible to classify the deposits of the Paris Basin in the timeline.
4) The diffusion of Early Azilians: two »epicentres« are speculated in the diffusion process of the first Azilian societies, Le Closeau (Paris Basin) and Monruz (canton of Neuchâtel/CH). The first challenge to this hypothesis is that the lithic characteristics of these two sites are different (Mevel 2013). Also, if there was indeed a transformation of large social Magdalenian groups, why are there so few sites matching the Early Azilian? Indeed, one would have expected a proliferation of sites with regard to the Early Azilian way of life and high mobility in this case.

We can see many arguments and archaeological facts that may object to key points that underpin the Magdalenian-Azilian transition scenario in the Paris Basin. In the absence of better evidence, it would be better to leave this issue open to all plausible hypotheses until new sites are discovered and/or compelling arguments are developed.

Epistemology and design of cultural change in prehistory

This discussion has not so much to do with the question whether Azilian societies came after the Bølling Magdalenians during the Allerød, since multiple stratigraphic sequences in several regions establish the chronological order of these cultural entities. In our opinion, the real issue is epistemological, namely how the issue of cultural change is understood in prehistory. By tracing its epistemological reflection back to the foundations of the discipline, the enlightening work of Virginie Guillomet-Malmassari (2009; 2012) has shown the opposition between two conceptions of the evolution of prehistoric society, some advocating continuity and others focusing their models on change.

The immediate formulation of the issue of evolution of Magdalenian and Azilian societies from the perspective of a cultural transition exclusively positions the scientific discussion in the model of an evolutionary continuity (Guillomet-Malmassari 2009; 2012). According to this design of phylogenetic continuity, the evolution of societies is linear, driven by slow and gradual processes. The notion of affiliation, rooted in technological discourse, therefore means that each industry is the root from which the following industry grows[1]. The word »transition« expresses the gradual nature of this linear affiliation, and consequently the instability resulting from a mixture of cultural traits, which at both ends of the evolutionary process are distinct and stable. Thus, the transitional model of Late Glacial societies like the Cepoy-Marsangy facies or the Early Azilian can only be conceived of as steps leading to the transformation of Azilian societies during the Allerød. In short, the transitional issue in prehistory aims to primarily follow the initial undertaking of the discipline, which is its own chronological construction.

Such is not the goal of evolutionary discontinuity interpretative models, which insist on the recognition of breaks in which cultural changes are more sudden and radical (Guillomet-Malmassari 2009; 2012). It is in this perspective that we would like to suggest two alternatives that should fuel discussions and broaden the framework for reflection. First, nothing prevented the possibility of a migration of Early Azilian societies from outside the Paris Basin into this territory, whether they co-existed with Magdalenians or not. Indeed, one cannot rule out that the vast geographical area currently corresponding to the Channel could have been a cultural melting pot, where people developed hunting weapons with axial implements in the same manner as other, more northern entities (Creswellian, Hamburgian) did. Secondly, we will formulate a plausible hypothesis in light of current data that is in the perspective of a non-linear (or multi-linear) evolution of the Late Glacial societies. This hypothesis assumes that as the result of fission-fusion events, which are classically recognised among hunters-gatherers (Ingold 1996), some groups from the Upper Magdalenian emancipated themselves to form what we call today the first Azilians. This cultural tipping point can be explained by the interrelations between the hunting methods, the social morphology and the exploited environments, which are all closely linked (Bignon 2008). The image of the kaleidoscope, used by Claude Lévi-Strauss (1990) to describe structural rearrangements, illustrates how changing one parameter leads to a tipping point for the entire system. This model thus moves away from the linear transition since the emergence of the Early Azilian does not imply the disappearance and replacement of Magdalenians, because the ways of life of these cultural entities are so contrasting that they could have coexisted in the Paris Basin. Our parallel evolutionary model of the Magdalenians and the Early Azilians is fuelled by Jacques Pelegrin's (2000) observations, which linked the changeover of flint production (the adoption of soft hammerstones and of backed points) to the loss rates of projectile implements and to the acquisition methods of animal resources. However, our work has shown that the profitability of hunts could be separated from the structural change of the environment, by adopting different hunting tactics, i. e. by economic choices leading to different ways of life.

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Note

1) Prehistoric »cultures« do not have the same meaning as in ethnology; at best, they are technological traditions the attributes of which are appropriately identified and on which names are affixed, without being able to ascertain the cultural characteristics that one confers to the notion of ethnicity (Valentin 2008).

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Summary

This contribution aims at completing the current knowledge concerning the Early Azilian period in the Paris Basin. This area has been densely occupied by the groups of the Upper Magdalenian. By contrast, Early Azilian sites known to date are scarce but show good archaeological preservation. It is particularly the case of the Le Closeau site, located at the bottom of the Seine Valley. It has been possible to carry out a complete palaeo-ethnographic investigation, as it has been done previously on the famous Magdalenian sites of Pincevent and Etiolles, for example. The focus of this paper lies on zooarchaeological studies of hunting practices combined with spatial analyses. Our results enable us to accurately document the Early Azilians' palaeo-ethnography and to highlight the singularity of their way of life.

Keywords

Paris Basin, Early Azilian, zooarchaeology, palaeo-ethnological approach

PHILIPPE CROMBÉ

THE ENVIRONMENTAL SETTING FOR THE LATEGLACIAL RECOLONISATION OF THE SCHELDT BASIN (NORTH-WEST BELGIUM) BY THE FEDERMESSER-GRUPPEN

The area encompassing the valleys of the River Scheldt and its tributaries, situated in North-West Belgium, is very rich in both archaeological and palaeo-environmental archives. Intensive surveys of the past decades have revealed the presence of numerous Lateglacial sites, mostly belonging to the Federmesser-Gruppen (FMG), as well as deep continuous organic soil sequences, from a variety of contexts (dune slacks, palaeo-lakes, river and stream valleys; Crombé 2006), allowing a first analysis of human behaviour against the background of a changing landscape and climate, in particular during the Allerød and the transition towards the Younger Dryas.

GENERAL SETTING

After the River Meuse, the Scheldt is the largest river in Belgium with a total length of 430 km, of which 207 km run on Belgian soils (**fig. 1**). Its headwaters are situated in northern France, its debouchment is located in the south-west of the Netherlands, where it nowadays flows into the Westerscheldt. During the Lateglacial, however, the Scheldt north of Antwerp had a more northern course, joining the estuary of the Rivers Rhine and Meuse in the central western Netherlands. The Scheldt is fed by numerous tributaries, the most important ones being from south to north Rivers Lys, Kale / Durme, Dendre and Rupel. The total catchment area amounts to 21,863 km², subdivided into the Upper Scheldt Basin (from source to Ghent) and the Lower Scheldt Basin (from Ghent to its debouchment).

The area of the Upper Scheldt, called the »Flemish Ardennes«, is a hilly upland, consisting mainly of Tertiary hills with a maximum height of 157 m above present sea-level. The quaternary cover mainly consists of loam and sandy loam deposited during the Pleniglacial, forming thick packets in the valley bottoms and on ancient river terraces. On the hill tops on the other hand the Pleistocene cover is generally thin (< 1 m), partly due to erosion, allowing Tertiary sediments to outcrop. The topography along the northern Lower Scheldt Basin is much less pronounced. This area corresponds to a typical lowland area with numerous relatively small and elongated sand ridges formed by a local reworking of coversands mainly during the late Pleniglacial and Lateglacial cold phases (Heyse 1979). In the northern and western extremes, in the Scheldt Polders and Coastal Polders, respectively, the Pleistocene coversand landscape is covered by Holocene peat and (peri)marine deposits, protecting the prehistoric sites from erosion and destruction (Crombé 2005; 2006).

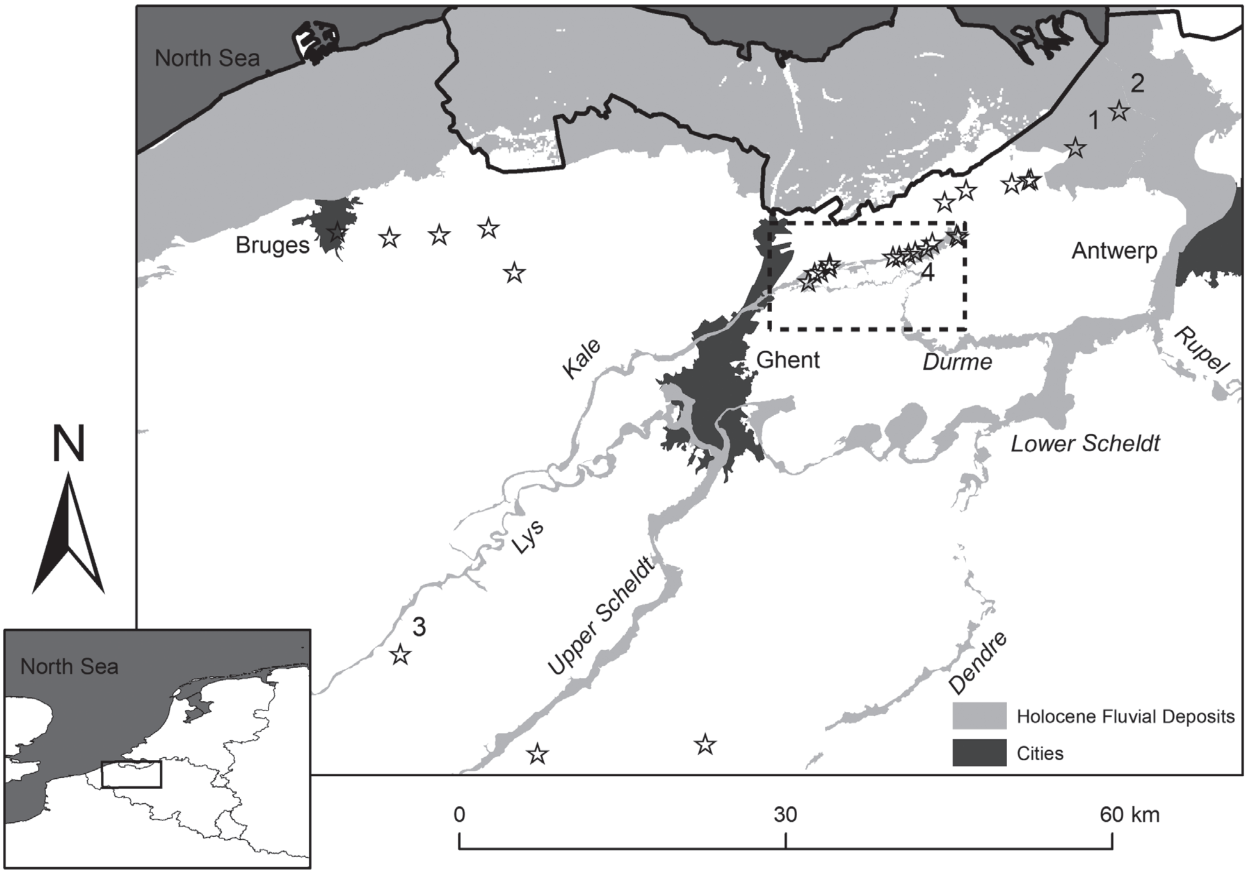


Fig. 1 The River Scheldt and its tributaries with indication of the FMG sites: **1** Verrebroek »Dok 2«. – **2** Doel »Deurganckdok-sector B«. – **3** Harelbeke »Gavermeersen«. – **4** Klein-Sinaai »Boudelo«. The small box (dashed lines) indicates the position of **fig. 4.** – (Map J. Verhegge).

MATERIALS AND METHODS

Palaeo-environmental dataset

The valley of the River Scheldt, in particular its lower course, and some of its tributaries, especially the River Kale/Durme, have been studied intensively in the last decades in the context of both academic and developer-led (»commercial«) research. Different aspects of the Lateglacial and Early Holocene palaeo-landscapes have been intensively investigated, allowing a rather detailed reconstruction of the palaeo-vegetation through the study of pollen and plant macro-remains (Bos et al. 2017; 2018a; Deforce et al. 2005; Deforce 2011; Perdaen et al. 2011a; Storme et al. 2017; Verbruggen 1971; Verbruggen/Denys/Kiden 1996) as well as the geomorphology and palaeo-hydrology (Bogemans et al. 2012; De Moor 1963; Heyse 1979; Kiden 1989; 1991; Tavernier/De Moor 1974; Vanmaercke-Gottigny 1964). In addition, the chronological framework of the Lateglacial and Early Holocene landscape evolution is well documented by means of numerous radiocarbon dates (Crombé et al. 2012; Crombé/Robinson/Van Strydonck 2014; Meylemans et al. 2013) and a limited number of OSL dates from aeolian sediments (Bogemans/Vandenberghe 2011; Derese et al. 2010).

Archaeological dataset

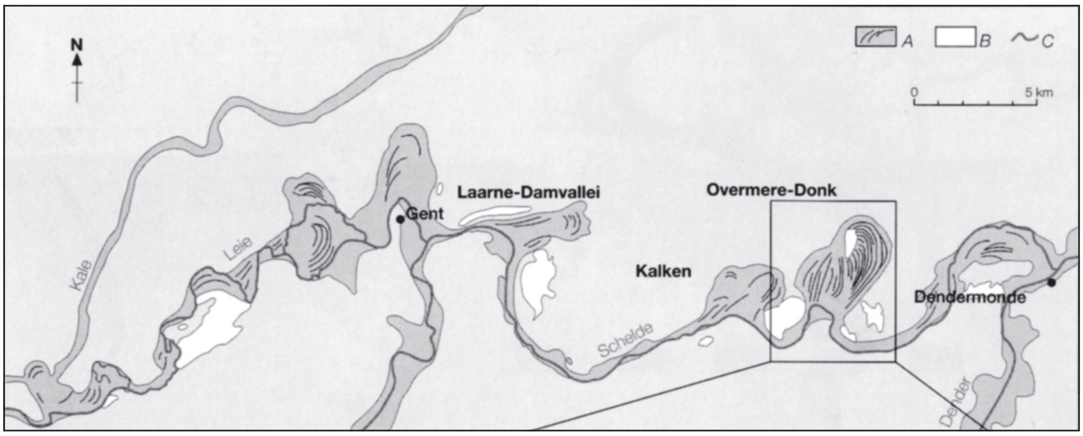
The Scheldt Basin has been the subject of intense archaeological research, including surveys (field-walking, aerial photography, augering, test-pitting) and excavations, some of which covering large surfaces (e.g. Doel »Deurganckdok«, Kerkhove »Stuw«, Oudenaarde »Donk«, Verrebroek »Dok«). However, the research intensity varies considerably among the different subregions of the Scheldt Basin, resulting in somewhat biased distribution maps. Research into the Lateglacial (Final Palaeolithic) and Early Holocene (Mesolithic) archaeology has been most intense in the coversand lowland corresponding to the Lower Scheldt Basin. Systematic field walking in large parts of this area – conducted mainly by amateur archaeologists from the 1980s onwards (Crombé et al. 2011) – has led to the discovery of numerous, albeit mostly destroyed (ploughed) sites located on dry coversand ridges. The survey of the river floodplains, on the other hand, has only started in the late 1990s (Bats 2007; Bats/Bastiaens/Crombé 2006; Crombé 2006; Meylemans et al. 2013), yielding the first covered prehistoric sites in the valley of the River Scheldt and its tributaries. Some of these have been excavated in the framework of large infrastructural works, e.g. harbour expansion (Crombé 2005), water management projects (Meylemans et al. 2013; Perdaen et al. 2011b), and sand extraction (Parent/Van der Plaetsen/Vanmoerkerke 1986/1987). Lateglacial and Early Holocene archaeological research in the southern upland started already in the late 19th century, but focused almost exclusively on dryland locations, with a special interest in the hill tops and plateaus (Crombé 1989). Investigation of the valley bottoms has only been initiated recently and hence remained so far limited to occasional projects, e.g. at Spiere, Kerkhove, Oudenaarde, and Ename.

RESULTS

Late Glacial environment: Palaeo-hydrology, palaeo-topography and palaeo-vegetation

River floodplains

Within the floodplain of the Scheldt and its tributaries, remains of abandoned single-channels of meandering river systems, locally forming large oxbows, have been detected during surveys, some of which have been analysed in detail (**figs 2-3**). In the Scheldt these palaeo-channels locally reach dimensions of 200 m width and 6-9 m depth (Bogemans et al. 2012; Kiden 1989; 1991); in the Kale/Durme tributary channels of c. 30-50 m width and 4-6 m depth have been reported (Crombé et al. 2013; De Smedt et al. 2012). The size of these meandering channels clearly indicates that the Lateglacial rivers had a discharge at least three to five times larger than today (Kiden 1989; 1991). This is also confirmed by the dimensions of the Lateglacial palaeo-meanders, which were much larger compared to present-day oxbows, locally extending 3-4.5 km inland. The higher discharge during the Lateglacial probably is due to higher levels of meltwater in spring and a less dense vegetation which induced more intense run-off (Kiden 1991).
The exact dating of the initial incision of these meandering channel systems is still not well established. The basal infill of sandy gyttja or scroll-bar sediments in two deep channels – one at Kalken in the Lower Scheldt Valley (Meylemans et al. 2013) and another at Vinderhoute in the Upper Kale Valley (Verbruggen 1971) – yielded ages of 12,460 ± 60 years ^{14}C-BP (Beta-245745) and 12,655 ± 70 years ^{14}C-BP (GrN-6062), respectively. These situate the start of the infilling during the Bølling (GI-1e) or even slightly earlier. However, given the presence of numerous reworked pollen, e.g. from several thermophilous (*Corylus*, *Carpinus*) and Tertiary species, as well as the high percentages of *Pinus*, the reliability of these early radiocarbon dates is



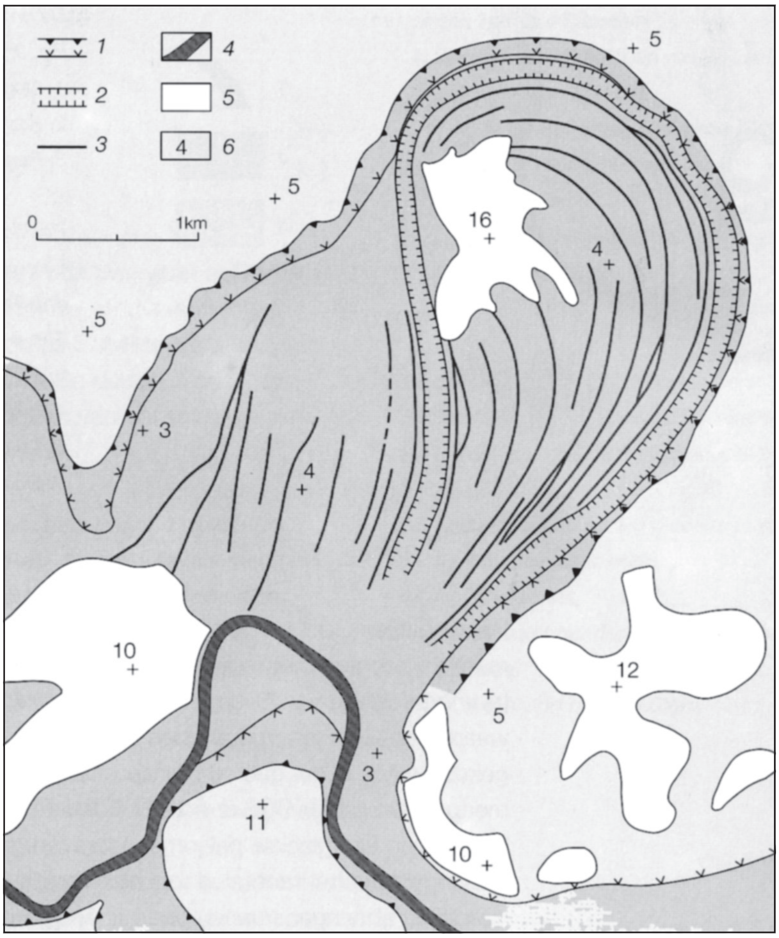


Fig. 2 Above: Lateglacial palaeo-meanders along the Lower Scheldt and Lower Lys Rivers: **A** palaeo-meanders with fossil scroll-bars; **B** river dunes; **C** present-day rivers. – Left: detail of the Lateglacial palaeo-meander of Overmere-Donk: **1** border of the Lateglacial floodplain; **2** fossil Lateglacial river channel; **3** scroll-bars; **4** present-day river bed; **5** river dunes; **6** altitude in m TAW (= mean low water tide level in Oostende). – (After Kiden/Verbruggen 2001, fig. 7).

generally contested (Kiden 1991; Storme et al. 2017; Verbruggen 1971), as they may have been performed on eroded older material.

The first reliable radiocarbon dates all come from calcareous gyttja found in several channels immediately above the sandy basal sediments. In the Lower Scheldt Valley the oldest dates are around 11,120 ± 60 years ^{14}C-BP (Beta 245744) and 10,910 ± 60 years ^{14}C-BP (Beta 245743; Meylemans et al. 2013), corresponding to the final Allerød (GI-1a) and the beginning of the Younger Dryas (GS-1). Similar dates have been obtained from several channel sections in the Kale/Durme Valley (Bos et al. 2018b; Crombé et al. 2013; Crombé/Robinson/Van Strydonck 2014). With the exception of one date from Ename (11,210 ± 50 years ^{14}C-BP; Deforce 2004), no radiocarbon dates are yet available for the Upper Scheldt Valley, but pollen evidence

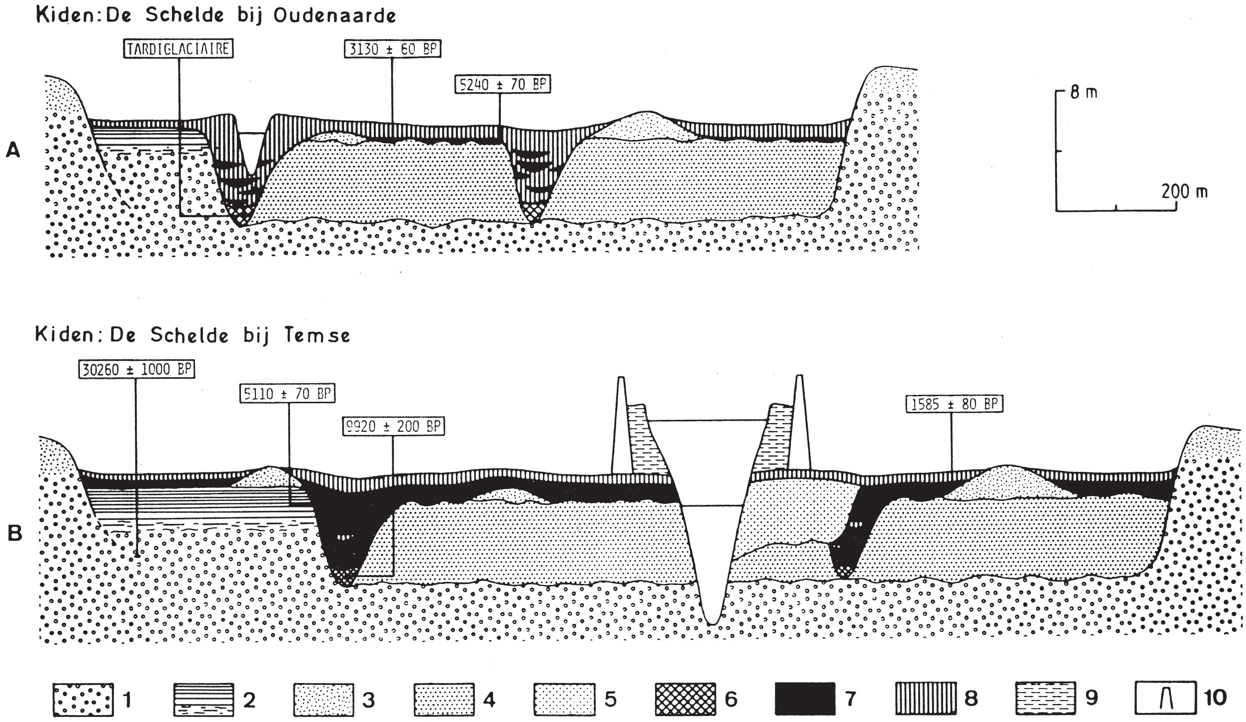


Fig. 3 Schematic cross-sections of the valleys of the Upper Scheldt (**A**) and Lower Scheldt (**B**): **1** braided river channel-fill and bar deposits. – **2** fining upward overbank deposits. – **3** aeolian deposits. – **4** Lateglacial meandering river lateral accretion deposits forming scroll-bars. – **5** Subatlantic meandering river lateral accretion deposits. – **6** gyttja. – **7** peat and clayey peat. – **8** fluviatile clay and silt. – **9** estuarine intertidal deposits. – **10** man-made embankments. – (After Kiden 1991, fig. 12.3).

points to an initial infilling from the start of the Younger Dryas (Parent/Van der Plaetsen/Vanmoerkerke 1986/1987). So although the timing of the incision of the meandering channels is not yet precisely fixed, it is clear that it occurred before the end of the Allerød/start of the Younger Dryas when the final channels started to fill in locally. This is in agreement with data from other river valleys, such as the Somme (Antoine et al. 2000), the Meuse (van Huissteden/Kasse 2001), and the Niers-Rhine Valley (Kasse et al. 2005). In all these valleys the incision of a large single channel meandering system has been dated to the Allerød, while the Bølling is characterised as a transitional phase between a braided and a meandering system. Remains of such a transitional system, characterised by several straight, small, and shallow channels which were active at the same time, have only been found so far within the Moervaart depression along the Kale/Durme River (Crombé et al. 2013; De Smedt et al. 2012) (**fig. 4**). Radiocarbon dates from a series of these anastomosing channels demonstrate that the infilling started at the transition from the GS-2a (Oldest Dryas) to the GI-1e (Bølling) or early in the GI-1e between 12,450 ± 50 years ^{14}C-BP (Beta-302750) and 11,925 ± 55 years ^{14}C-BP (KIA-47009), and continued during the main part of the Allerød (GI-1c) (Crombé/Robinson/Van Strydonck 2014). However, some channels may be younger as indicated by a late Allerød date from the basis of a small anastomosing channel at Wachtebeke (11,345 ± 50 years ^{14}C-BP; KIA-46184; Crombé et al. 2013; Crombé/Robinson/Van Strydonck 2014).

The later evolution of the Scheldt River system, however, deviates considerably from the river valleys in surrounding countries. In the case of the Meuse the cold conditions of the Younger Dryas led to a return to a multi-channel braided system followed by a new deep channel incision at the start of the Holocene (Hoek/Bohncke 2002), while in the case of the Somme the Younger Dryas coincides with a major infilling of the alluvial plain followed also by a new major channel incision at the start of the Preboreal. On the contrary, in the Scheldt Basin the Allerød meandering channel system remained active during the Younger Dryas and

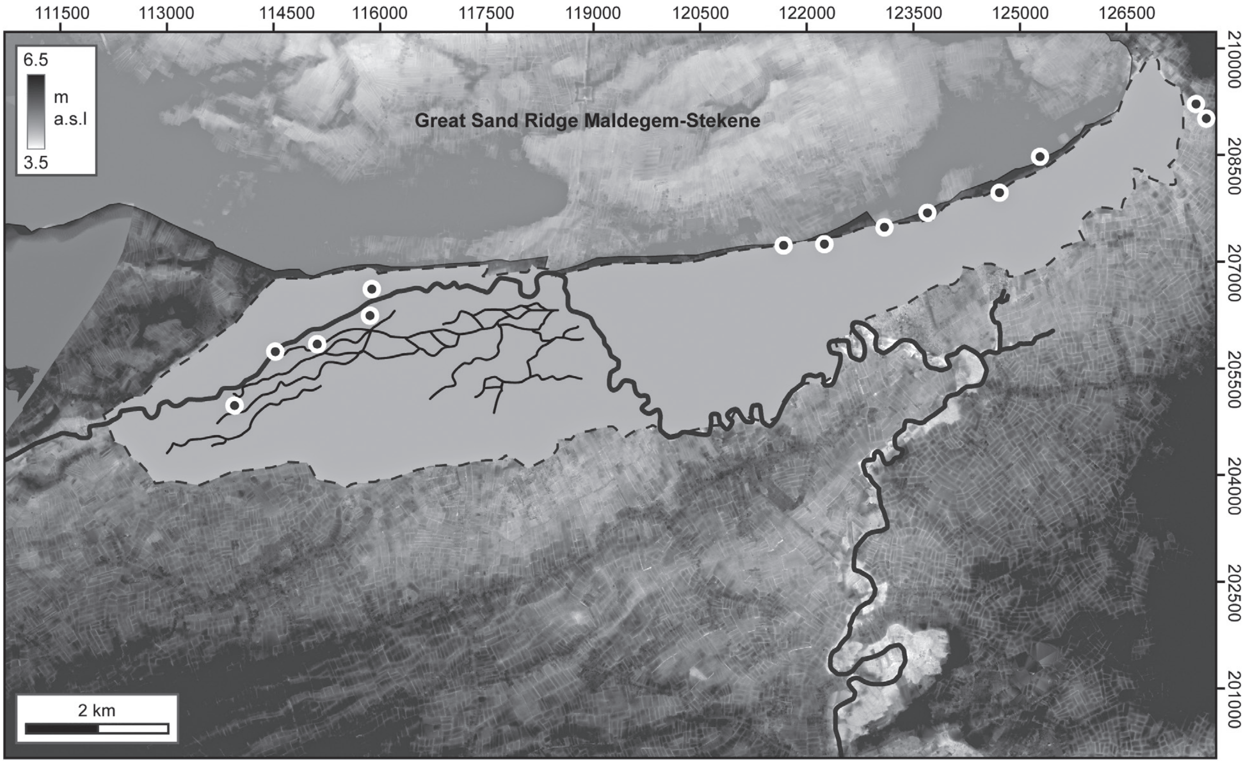


Fig. 4 Map of the Moervaart palaeo-lake through which the single-channel meandering River Kale/Durme runs (underlying map = digital elevation model; Lidar, AGIV 2001-2004). The dots indicate the position of FMG sites. In the west, there are remains of an older, anastomosing river system consisting of several small and shallow channels, reconstructed on the basis of data from augering, electromagnetic interference (EMI) and digital elevation modelling. Most FMG sites along these shallow channels are situated on small levees. In contrast, no sites are known along the lower Kale/Durme River in the east.

into the Holocene (Bogemans et al. 2012; Crombé et al. 2013; Crombé/Robinson/Van Strydonck 2014; Kiden 1991; Storme et al. 2017); however, with a clear change in sedimentation from calcareous gyttja to peat in the course of the Preboreal. The latter was probably the result of a lowering of the water level caused by increased evapotranspiration following the installation of a dense pine (*Pinus*) forest as well as higher temperatures. The sedimentary characteristics indicate an evolution from deep, stagnant, or slow-running water during the late Allerød and early parts of the Younger Dryas to very shallow and marshy conditions during the later Younger Dryas and the beginning of the Holocene. Due to the reduced fluvial activity during the Younger Dryas, river (parabolic) dunes were created within or just outside the Lateglacial floodplain. Some of these were OSL dated to 12,000 ± 900 years (OSL)-BP (n = 5) (Bogemans/Vandenberghe 2011).

Sandy lowland (Lower Scheldt Basin)

The landscape in the northern sandy lowland was very dynamic as a result of a changing climate during the Lateglacial. At the start, local reworking of Pleniglacial (cover)sands triggered the formation of dunes, a process which was reactivated during the subsequent cold Dryas stages (Heyse 1983). Most dunes are rather small, except for one called »the Great Sand Ridge of Maldegem-Stekene«, running over a distance of c. 80 km from west to east across the sandy lowland (Heyse 1979; 1983). According to recent data (Bos et al. 2013; Crombé et al. 2012), this massive dune was formed mainly during the Older Dryas (GI-1d) and Younger Dryas (GS-1) and consists of numerous intersecting and overlapping smaller dunes. In between these

sand dunes hundreds of relatively small- to medium-sized, closed, and shallow depressions were formed by local aeolian erosion, so-called blow-outs. Judging by the presence of humiferous to peaty sediments at their base, it can be concluded that these shallow depressions were temporarily wet, ranging from ponds during the Bølling to shallow dune slacks in the Allerød (Bos et al. 2013; Crombé et al. 2012).
Another type of open-water system within the sandy lowland consisted of shallow freshwater lakes which appeared along the southern steep edge of »the Great Sand Ridge«. Contrary to the dune slacks, these were not formed by wind erosion, but by local accumulation of groundwater and surface water which had become blocked by »the Great Sand Ridge« (De Moor/Heyse 1978; Verbruggen/Denys/Kiden 1996). By far the largest one was Lake Moervaart extending over a surface of approximately 25 km² (Heyse 1983; Crombé et al. 2013) (**fig. 4**). Starting as swampy depressions during the Bølling, they evolved in the course of the Allerød into shallow lakes with fluctuating water levels (3-6 m), probably as a result of increased precipitation and local seepage (Bos et al. 2013; Crombé et al. 2013; Denys/Kiden/Verbrugen 1998). The highest water level in the Moervaart Lake was reached at the transition from the early to the middle Allerød, as indicated by the abundance of aquatic plant species, such as waterlily (*Nymphaea*), Eurasian watermilfoil (*Myriophyllum*), and buckbean (*Menyanthes trifoliata*) (Bos et al. 2017).
The vegetation around these dune slacks and lakes gradually became more closed in the course of the Allerød (Bos et al. 2018a). Initially birch (*Betula*) and willow (*Salix*) were the dominant tree species, although grasses and sedges remained largely present along the banks. From c. 11,300 years ^{14}C-BP onwards Scots pine (*Pinus sylvestris*) increased in importance and finally became the most frequent species. By the end of the Allerød the Arboreal Pollen ratio locally reached 80-90 %, indicating the presence of an almost entirely closed coniferous forest (Bos et al. 2013; 2018a; Deforce et al. 2005; Verbruggen/Denys/Kiden 1996).
Clearly before the onset of the colder Younger Dryas, more precisely during the *Pinus*-stage of the Allerød, a clear decrease of the water level occurred both in the dune slacks and lakes. Dune slacks got filled in with aeolian sands (Bos et al. 2013; Crombé et al. 2012), while in the lakes (Lakes Moervaart and Snellegem) the lacustrine sediments got covered by peat indicating a change to a marshier environment (Denys/Verbruggen/Kiden 1990; Denys/Kiden/Verbrugen 1998). This marked lowering of the water level was recently synchronised with the Intra-Allerød Cold Period (GI-1b) on the basis of a Bayesian modelling of radiocarbon dates (Crombé/Robinson/Van Strydonck 2014), yet the chronological precision still demands further improvement.

Loamy upland (Upper Scheldt Basin)

From the southern upland area no palaeo-environmental information is currently available, except for the Scheldt floodplain (see above). This is mainly due to erosion of Lateglacial levels situated on hill tops and slopes, as well as plateau edges. In addition, so far only little environmental research has been conducted in small stream valleys (Maarkebeek, Zwalmbeek, etc.) that feed the River Scheldt and its tributaries.

FMG occupation

Lithic assemblages

Except for some isolated late Magdalenian/Creswellian finds in the upland area (Crombé 1989; Vandendriessche et al. 2016), there are currently no traces of human occupation in the Scheldt Basin prior to the

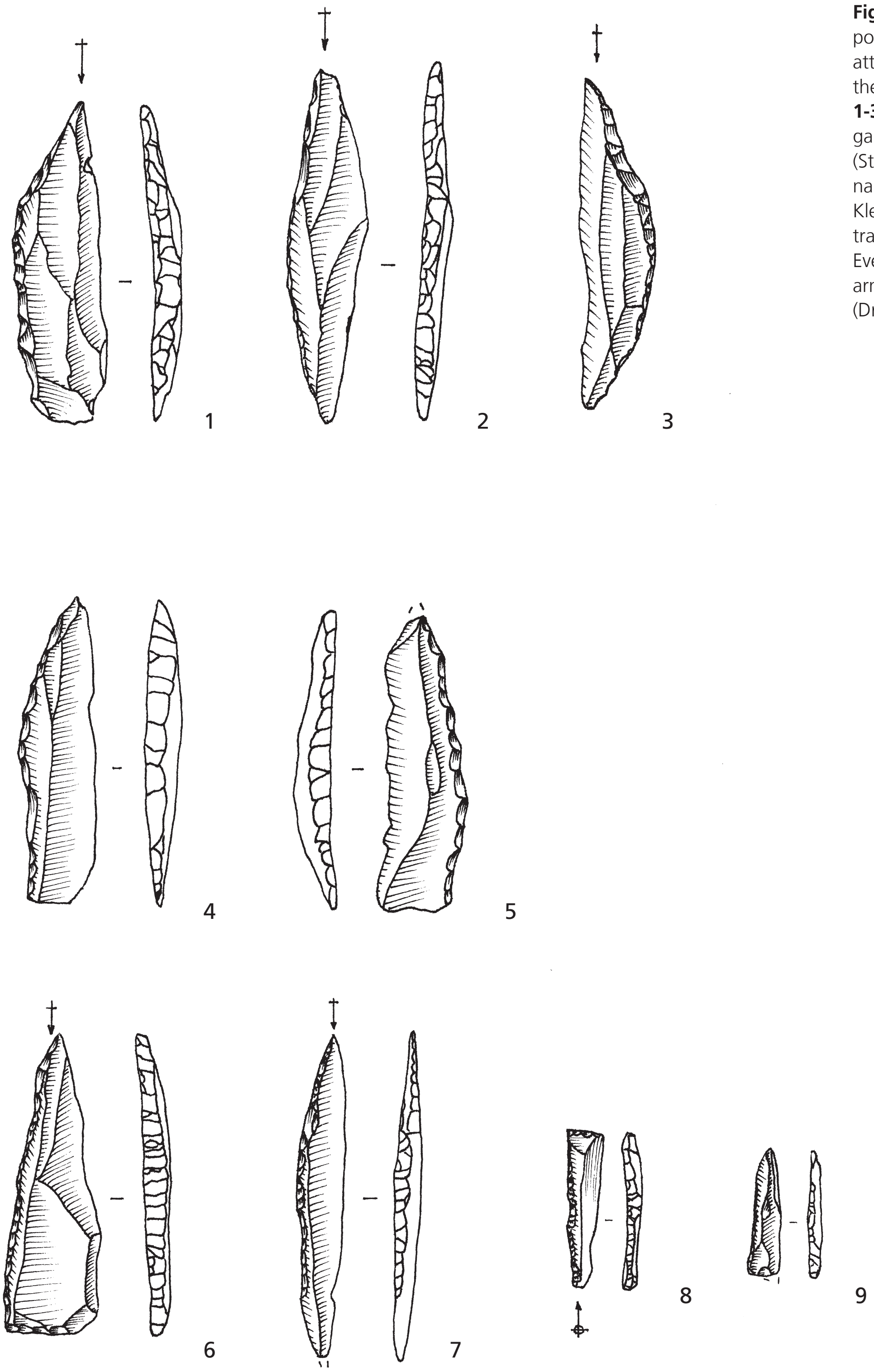


Fig. 5 Selection of backed points from the Scheldt Basin attributed to different stages of the Allerød and Younger Dryas: **1-3** early FMG (Doel »Deurganckdok«). – **4-5** late FMG (Stekene »Heirweg«). – **6-9** final FMG (Malaurie-like point: Klein-Sinaai), and Younger Dryas traditions (Blanchères point: Evergem »De Nest«; microlithic armatures: Ruien »Rosalinde«). – (Drawings J. Sergant).

FMG. A clear explanation for this absence of human occupation during the Bølling has not yet been found, but it could be that the environment was still too unstable for humans to settle. The sand dunes were still in formation and probably not yet well-developed, making the area not well suited for erecting camp sites. In addition, there may have been a problem with the availability of drinking water, certainly in the sandy lowland where the dune slacks and lakes only appeared later during the Allerød (**fig. 5**).

At the moment it looks as if the FMG hunter-gatherers were the first re-colonisers of the Scheldt Basin after the Lateglacial Maximum. At least 30 FMG sites are actually known in the Scheldt Basin (Ameels/Van Vlaenderen 1995; Crombé/Verbruggen 2002; Crombé et al. 2011) (**fig. 1**). Except for a few, these are all eroded plough-layer sites known from field surveys. As a result little is currently known about the chronology and settlement organisation of the FMG in the Scheldt Basin. The lithic assemblages found on these surface sites are generally limited in size, ranging between 500 and 1,000 artefacts. The main raw material consists of local flint of mediocre quality found as relatively small nodules on Tertiary outcrops. The use of better quality, black fine-grained flint of Obourg-type is generally restricted to less than 10 % (Crombé et al. 2011). Besides backed points and blade(let)s the lithic toolkit comprises standardly numerous scrapers and burins, the latter mainly dihedral and made on truncation.

So far just four sites have yielded *in situ* finds. The site of Verrebroek »Dok 2« (Crombé et al. 1999; Crombé 2005) consists of a very small knapping post (< 1 m²) without diagnostic tools, found along a former dune slack on top of a humiferous layer dated by pollen analysis and radiocarbon method to the Older Dryas and/or the start of the Allerød (Crombé et al. 2012; Van Strydonck 2005). A radiocarbon date obtained on a sample of burnt bark found in the same stratigraphical position as the flint artefacts yielded a result of 11,900 ± 90 years ^{14}C-BP (UtC-9434), corresponding to the Older Dryas/Allerød transition (Van Strydonck/Crombé 2005). This date is also corroborated by the knapping characteristics which indicate careful and rather intense core preparation (frequent rejuvenations, high frequency of facetted butts, etc.) and the use of a soft stone hammer (Perdaen/Crombé/Sergant 2004; Perdaen/Ryssaert 2002). These features are typical of early rather than late FMG in Western Europe (Bodu/Valentin 1997; Fagnart 1997). Pollen and charcoal analyses (Deforce et al. 2005) indicate that the occupation took place in an environment with up to 45 % of willow (*Salix*) and a wet vegetation consisting mainly of *Cyperaceae* (sedge family) and *Poaceae* (grass family).

At the site of Doel »Deurganckdok-sector B« (Crombé et al. 2000; Crombé 2005) FMG lithic remains have been found on a coversand ridge covered by Holocene peaty and fluvial deposits. Despite this covering, large parts of the site were disturbed by intense later occupations dated to the Late Mesolithic (> 100 hearth-pits) and Early Neolithic (Swifterbant Culture). In addition – due to advanced bioturbation – the FMG remains were intermixed with lithics from these younger phases. However, based on a combination of attributes, such as raw material, weathering (patination), and morphology, it was possible to select c. 600 artefacts which can be attributed to the FMG with a high degree of certainty. Despite the absence of radiocarbon dates, here too, the knapping characteristics and the presence of some »bipointes« (**fig. 5, 1-3**) seem to point to an early stage of the FMG, although the presence of late FMG artefacts is not excluded (Perdaen/Crombé/Sergant 2004).

A third excavated site is situated within the extensive site-complex along the northern bank of the Moervaart palaeo-lake (see below). At Klein-Sinaai »Boudelo« (Vanmoerkerke/De Belie 1984) at least five lithic scatters were discovered by chance during the excavation of a Medieval abbey. According to a first preliminary excavation report, the FMG remains (1,757 lithic artefacts) were found in a sandy layer with iron nodules, situated c. 10 cm above a layer containing scattered charcoal fragments. The latter might correspond to the well-known Usselo-layer, but this unfortunately cannot be verified since the site is not accessible any longer and the charcoal has not been preserved. No further spatial information is available, but in all scatters some typical FMG tools (backed points and blades, burins) have been reported. Worth mentioning are two »bipointes« and one »Malaurie-like point« (**fig. 5, 6**), which might point to an early and final FMG occupation of the site, respectively.

A last FMG site was excavated at Harelbeke »Gavermeersen« in the context of sand extraction (Vermeersch 1976). Here FMG hunter-gatherers choose to settle on the dry northern bank of a large depression, situated less than 1.5 km from the Lys floodplain, an important tributary of the River Scheldt. This shallow depression was filled with silty to clayey sediments sealed by peat, which unfortunately has neither been studied nor dated. The site itself (c. 2,183 lithic artefacts) is situated on the southern flank of a sandy ridge, which was largely affected by ploughing. Nevertheless, some lithics were still preserved underneath the plough-layer, albeit not allowing a meaningful spatial analysis.

Although the above excavations have revealed the presence of the early stages of FMG, in terms of overall technology the vast majority of lithic assemblages in the Scheldt Basin clearly relates to the classic / late FMG, characterised by uni-pointed backed armatures (**fig. 5, 4-6**) and a much less refined blade technology that focused on the production of irregular unstandardised blade(lets).

Distribution pattern

The distribution pattern of the FMG sites displays a marked concentration in the sandy lowland area (**fig. 1**). In the southern uplands FMG sites are currently hardly known, but this may be partly due to a lesser research intensity and taphonomic factors. Indeed, one needs to consider the possibility that numerous sites in this hilly area are hidden underneath colluvial deposits, as was recently attested at the Younger Dryas site of Ruien »Rosalinde« (Crombé et al. 2014). The few sites known so far in the uplands (e.g. Kluisberg, Pottelberg, Kemmelberg) are located on hill tops, in particular on local outcrops of Tertiary sands (Vandendriessche et al. 2016). A similar observation has been reported by Coudret and Fagnart (2006, 737) for the Somme region of northern France.

Within the sandy lowland region of the Lower Scheldt Basin FMG sites mainly occur along the dry banks of dune slacks and shallow lakes, sometimes forming extensive site-complexes running over several kilometres (Crombé et al. 2011; 2013). This pattern is most apparent along the Moervaart palaeo-lake (**fig. 4**), where a high density of sites has been observed along the relatively steep northern bank and on small sandy ridges, possible levees, within the western lake sector. These dense clusters of sites probably reflect frequent and recurrent visits of FMG hunter-gatherers to these lake areas. Most likely they were attracted by the rich and diversified ecology of these areas, which provided them with drinking water, rich hunting grounds, and plenty of plant material for both consumption and tool production (Crombé et al. 2013).

In contrast to this, the total absence of FMG sites along the floodplains of the River Scheldt and its tributaries is most remarkable and difficult to explain. Despite the intense archaeological research especially along the Lower Scheldt Valley, so far not a single FMG camp-site, except some isolated finds, has been discovered within the Lateglacial floodplains. Apparently the scroll-bars flanking the Allerød palaeo-channels were inhabited only from the Early (Boreal) Holocene onwards, when the rivers were already reduced to shallow slow-running streams (Ameels et al. 2003; Bats 2005; 2007; Bats / Bastiaens / Crombé 2006; Crombé et al. 2013; Meylemans et al. 2013; Parent / Van der Plaetsen / Vanmoerkerke 1986/1987; Perdaen et al. 2011a; 2011b). Even on the dry river dunes situated adjacent to the floodplains not one FMG site is currently known, while the evidence of Mesolithic and Neolithic occupation is overwhelming. This is particularly evident along the very intensively surveyed Durme River (Crombé et al. 2011; 2013; **fig. 4**, eastern section). Here fieldwalking yielded at least twelve Early (Boreal) Mesolithic sites, mostly situated on the left bank, while not a single FMG site, not even an isolated find, has been reported. Similarly, intensive surveys and large-scale excavations on the dry banks along the floodplains along the Upper Scheldt, e.g. at Ename (Ameels et al. 2003), Kerkhove (Crombé 1985; Sergant et al. 2016), Spiere (Vanmoerkerke 1988; Vanmontfort et al. 2001/2002), Gavere (Vanmoerkerke 1986) and Melden (Crombé / Braeckman / Parent 1991), yielded plenty of Mesolithic and extensive Neolithic (Michelsberg Culture) sites, but no evidence of FMG occupation.

DISCUSSION

From the above it is clear that the Lateglacial environment in the Scheldt Basin was very dynamic. At present not all details of the Lateglacial environmental changes are fully understood, but the main trends are yet defined. During the time of occupation of the FMG, i.e. the Allerød, an important network of single-channel meandering rivers, with the Scheldt as the main river, as well as numerous shallow ponds and lakes had developed within an increasingly wooded environment dominated by first birch and later pine. Within this landscape FMG hunter-gatherers clearly preferred to settle along the banks of lakes and ponds, apparently leaving the river valleys aside. This is a very remarkable pattern which considerably differs from surrounding river valleys in Western Europe, where FMG hunter-gatherers intensively occupied the edges of Lateglacial floodplains. In the Dutch Meuse Valley FMG sites occur both along lake banks and the outer banks of Lateglacial oxbows (Deeben 1995). In northern France, the Somme and Seine Valleys have yielded plenty of sealed FMG sites situated along active river channels (Bodu/Debout/Bignon 2006; Coudret/Fagnart 2006). Similarly in the valley of the Rhine and its tributaries FMG sites, such as Andernach, Bad Breisig, Niederbieber and Kettig, are located close to active meandering channels (Street et al. 2006).

Why do the River Scheldt and its tributaries differ from this general pattern? Before addressing this question it needs to be investigated whether the actual distribution pattern is not biased. It has to be considered that some FMG sites may be hidden as a result of later sedimentation. As a matter of fact, most sites in adjacent valleys are covered by later sediments of different origin (alluvial, volcanic, aeolian, anthropogenic). However, it seems highly unlikely that this explains the total lack of FMG sites in the Scheldt floodplains. The small scroll-bars created as a result of the lateral migration of the meandering channels, which constituted the preferred habitats for human occupation during the Mesolithic, are often hardly covered, some are even visible in the present day landscape. So, if FMG sites are present on these small elevations, at least some of them would have been found during the intense surveys of the Scheldt floodplains. FMG remains were also not reported on the numerous drilled and/or excavated scroll-bars which are covered by Holocene fluvial deposits, e.g. at Oudenaarde, Kerkhove, Kalken, Wichelen, Bazel, and Melsele. Still, it cannot be fully excluded that some FMG sites have been missed during archaeological research. The discovery of a humiferous palaeo-sol situated at maximum 30 cm below the top of a scroll-bar at Wichelen »Bergenmeersen« (Perdaen/Meylemans/Vanholme 2013) demonstrates that some scroll-bars might have been covered by aeolian sands during the Younger Dryas. Knowing that archaeological research is often limited to the top of the Pleistocene sediments, it is possible that some covered FMG levels were not explored, but this certainly cannot explain the complete absence of sites in the floodplains. Aeolian sedimentation could also be potentially responsible for the lack of FMG sites on the dry banks along the margins of the floodplains. However, if the river dunes along the Scheldt and its tributaries were created during the Younger Dryas, as suggested by recent OSL research on some of them (Bogemans/Vandenberghe 2011), they did not yet exist at the time of the FMG. So, at present it rather looks as if the banks of the Lateglacial floodplains and oxbows were not yet attractive for settling during the Allerød due to the absence of dry enough settlement locations, comparable to the inland dunes intensively occupied by FMG groups. Some isolated finds of FMG armatures nevertheless indicate that the Scheldt floodplains were visited by FMG hunter-gatherers, possibly in the context of hunting activities.

Alternatively we need also to consider post-Allerød fluvial erosion of former FMG sites in order to explain the lack of sites in the floodplains. However, this explanation too seems rather unlikely as, contrary to other valleys in North-West Europe, the Scheldt Valley remained rather stable and much less dynamic during the subsequent Younger Dryas and Early Holocene. The single-channel systems from the Allerød persisted into the Holocene with a gradual infilling of the deep channels demonstrating a marked decrease of the fluvial activity. In fact the Younger Dryas and Early Holocene rivers were largely reduced to slow running streams. It is only during the early stages of the Subatlantic that a new river channel with associated crevasse gullies was incised in the Scheldt floodplain (Bogemans et al. 2012; Kiden 1991). However, sedimentary properties seem to indicate a rather stable meandering channel with minor lateral migration, so the impact of this renewed fluvial activity on older prehistoric sites will have been rather limited.

So, actually there is little evidence which supports the idea that the distribution pattern of FMG sites at least along the Lower Scheldt Basin is seriously biased. Then how can we explain the absence of interest in the river floodplains? Maybe the river valleys were a too dynamic environment for FMG hunter-gatherers in order to exploit or settle? Large parts of the Allerød coincide with a phase of high discharge and fluvial erosion; river channels were not yet fixed but subject to continuous lateral migration, which ultimately led to the formation of very extensive oxbows. However, this argument does not hold for the later phases of the Allerød. The available radiocarbon evidence clearly indicates that the river systems in the Scheldt Basin stabilised ultimately during the final Allerød (GI-1a) and the transition towards the Younger Dryas (GS-1). At that time the channels started to fill in with organic sediments, indicating more tranquil flow rates. So one would at least expect FMG hunter-gatherer activity along the Scheldt and its tributaries at this late stage, even more so since around the same time the coversand interior faced an abrupt drop of the ground water level, turning most of the inland freshwater lakes and dune slacks into dry or marshy environments. This certainly must have had a considerable impact on the FMG hunter-gatherers who intensively exploited these lake banks. They were confronted with a sudden reduction of the available open water, which provided them with vital drinking water. Also the game populations must have been affected by this abrupt environmental change. The frequent occurrence of animal dung (coprophilous) fungi (*Bombardioidea* type, *Sporormiella* type, *Podospora* type, *Sordaria* type and other Sordariaceae; Bos et al. 2013) as well as high phosphate ratios (Louwagie / Langohr 2005, 103) indirectly demonstrate the presence of numerous large herbivorous mammals along the Allerød lake banks. These too will have suffered from the marked reduction in available drinking water and will have been forced to move to other areas. In this context the total absence of FMG sites along the main river valleys of the Scheldt Basin is very strange. Does it mean that these hunter-gatherers moved to other areas, altogether leaving the Scheldt Basin? Unfortunately, due to the complete absence of radiocarbon dates for the FMG, this hypothesis cannot yet be further explored but nevertheless seems plausible. It seems reasonable to assume that the important environmental changes occurring during the final Allerød and early Younger Dryas altered the settlement system of the contemporaneous hunter-gatherers, but further research is needed in order to fully understand the nature of the human response.

CONCLUSIONS

The most important observation from the above analysis is the so far total absence of FMG camp sites along the river floodplains of the Scheldt Basin. Apparently the first re-colonisers of North-West Belgium were more attracted to the dry banks of former freshwater lakes and ponds in the sandy interior, possible indicating that the latter constituted a more stable and secure environment, contrary to the highly dynamic river valleys – at least until the final Allerød (GI-1a) when a sudden ground water lowering dramatically reduced the available amount of drinking water for both animals and humans. But even then, FMG hunter-gatherers apparently did not shift to the rivers, although these probably had become the only or at least the most important sources of drinking water within the area. However, in absence of faunal remains and well-dated FMG sites it remains difficult to assess the real extent of this hydrological event. Future Lateglacial research in the Scheldt Basin should therefore focus on the detection and excavation of sealed FMG sites, which can still be expected along the banks of the numerous freshwater lakes and dune slacks. Sites such as Verrebroek »Dok 2« and Klein-Sinaai »Boudelo« clearly prove the existence of well-preserved FMG occupation levels underneath Younger Dryas aeolian sediments. Existing survey techniques should be further refined, allowing to map buried palaeo-landscapes on a larger scale and with a higher resolution (Missiaen et al. 2015; Verhegge/Missiaen/Crombé 2016) and to detect even the smaller and less dense sites (Crombé/Verhegge 2015). In addition much more research should be done on the contemporaneous environment in view of a better understanding of the landscape evolution, especially in response to a changing climate. The long and often continuous sedimentary sequences available in the numerous river channels and inland lakes make the Scheldt Basin an ideal context for a high-resolution, multi-proxy investigation of the Lateglacial and Early Holocene environment.

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Summary

In this paper the spatial distribution of Federmesser-Gruppen (FMG) sites in the Scheldt Basin is discussed. A clear pattern of focused occupation and exploitation of the dry banks of former dune slacks and freshwater lakes is observed, while the river floodplains were seemingly avoided. The latter may be due to the highly dynamic environment of the rivers, which were characterised by very high discharges and continuous erosion. During the late Allerød (GI-1a) and the transition towards the Younger Dryas (GS-1) the meandering rivers finally stabilised, gradually turning into slow running and shallow streams. This probably was the result of a general decrease of the ground water table, which also affected the inland lakes and ponds, reducing them to dry or swampy depressions. It is assumed that this marked hydrological event, which may be linked to cooling during the Intra Allerød Cold Period (GI-1b) and the subsequent Younger Dryas (GS-1), had a considerable impact on the settlement system of the FMG hunter-gatherers, who may have been forced to leave the Scheldt Basin.

Keywords

Scheldt Basin, Federmesser-Gruppen, site distribution, hydrological change, climate change

FLORIAN SAUER

LANDFORM-BASED MODELLING OF POTENTIAL BIOLOGICAL DIVERSITY

INFERRING ECOLOGICAL VARIABILITY IN SITE CATCHMENTS FROM DIGITAL ELEVATION DATA

Modelling ecosystems based on topographical attributes is an approach which is employed in environmental conservation to assess biological diversity (a list of case studies underlining the concept is given by Parker/Bendix 1996; Walz 2011; Zimmermann/Thom 1982). This powerful tool allows the generation of data about the biological composition of large areas based on remote sensing data like Digital Elevation Models (DEM). It is based on the assumption that local topography has a profound influence on geomorphic processes which determine the prevailing abiotic framework (Hobohm 2011; MacMillan et al. 2009; Swanson et al. 1988; Walz 2011; Zimmermann/Thom 1982). These conditions determine the presence of biocoenoses that adapted to these specific environmental circumstances. This approach can also be used to model the biological diversity and makeup of prehistoric landscapes, and it can give insight into the potential diversity of biotic resources in prehistoric site catchments. The methodology's benefit is especially prominent when it is used in landscapes where the traditional sources of information, like palynology and faunal assemblages, are absent or at least very scarce.

MATERIALS

The Late Palaeolithic period in north-eastern Bavaria (southern Germany) roughly spans the time from the onset of the Alleröd interstadial to the end of the Younger Dryas (12,000-10,000 years ^{14}C-BP), although this chronological placement is largely based on typological comparisons. Exceptions are the sites of the Sesselfelsgrotte in the Altmühl Valley (chronostratigraphy: Younger Dryas), and a worked antler out of the Main deposits at Bergrheinfeld in Lower Franconia (10,995-10,730 years cal. BC; Weidinger 1996). The influence of the Younger Dryas cooling phase on the vegetation in the study area seems to have been only very limited (Frenzel 1983, 147; Knipping 1989, 107). Thus, the biological background of the Late Palaeolithic in this area is considered to be quite uniform. The sites in the study area are assigned to the Arch-backed Point (ABP) technocomplex (Valde-Nowak/Kraszewska/Stefański 2012) due to the frequent presence of backed points in the assemblages. Traditionally, sites in the study area were also dated based on a supposedly »typical« raw-material utilisation (Cretaceous flint, Abensberg-Arnhofen chert, and lydite; Schönweiß 1992), but due to the obvious flaws of this approach these sites will not be used here. Accordingly, a total of 91 sites are present (**fig. 1**).
The study area was set based on the ecological classification of Germany. It subdivides Germany into units of great ecological, geomorphological, and hydrological homogeneity and therefore provides the best basis for delimitation. Accordingly, five units were chosen: the Keuper-Lias-Land, the Franconian Alb, the Franconian-Thuringian Mountain Range, the Upper Palatinate Valley, and the Upper Palatinate Forest (**fig. 1**). This article focusses mainly on the sites situated in the Upper Palatinate Forest.

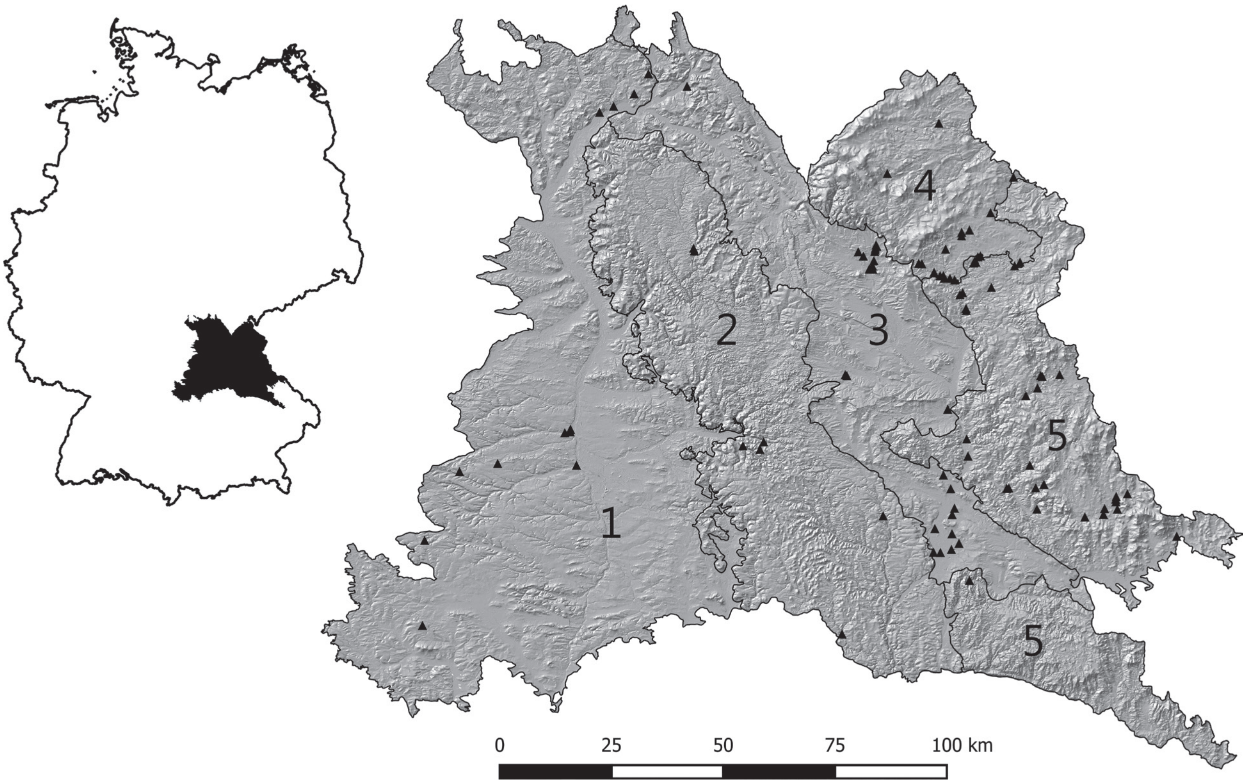

Fig. 1 Location of the study area in Germany (left) with subdivision into ecological landscape units (right): **1** Keuper-Lias-Land. – **2** Franconian Alb. – **3** Franconian-Thuringian Mountain Range. – **4** Upper Palatinate Valley. – **5** Upper Palatinate Forest. – Black triangles represent sites used in this study.

Information on Lateglacial fauna and vegetation is very limited in the study area. Though there is a small number of publications on Lateglacial vegetation history, they only present very selective information (Frenzel 1983; Hahne 1991; 1993; Knipping 1989; Kortfunke 1992; Stalling 1987). This way it is difficult to examine the biotic factors that may have led to the placement of a campsite in the landscape. This situation is amplified by the fact that nearly all of the sites known in the application area are represented by surface collections. These yielded no supplementary information concerning the use of organic resources. One of the few excavated locations is the site of Steinbergwand at Ensdorf, which could provide limited information on fauna and vegetation (Gumpert 1933). The methodology presented here aims towards providing an alternative approach to assess environmental conditions in the landscape. Based on the assumption that the location of a campsite is not selected randomly, but very much based on economic criteria of its immediate environment (Jochim 1976), the biotic factors, among others, in the catchment of the site could be linked to different adaptive strategies (Brouwer Burg 2012), and to intrasite activities. These activities are represented by the lithic assemblages, provided that the extraction of biotic resources was the dominant activity. However, it is obvious that other criteria like lithic raw material procurement or water availability are not covered by this approach, but can be equally important. They will be covered in the underlying PhD project this methodology is a part of.

The calculations were conducted using the digital ground model DGM25 for Bavaria with a resolution of 25 m and a Root Mean Square Error (RMSE) of ± 0.3 m. The DEM, generated by photogrammetry and airborne laserscanning, was provided by the Bavarian Geodesic Administration (Bayerische Vermessungsverwaltung).

This approach is part of the PhD project »Late Palaeolithic Land Use Patterns in Northern Bavaria« at the Friedrich-Alexander-University Erlangen-Nuremberg. The project also covers the typological analysis of lithic assemblages in the study area and the raw material procurement patterns. However, this line of investigation is not discussed in this paper. As this is only a presentation of the methodology, no statements will be made as to whether the connection between assemblage and catchment is visible on this scale.

METHODS AND THEORY

The approach is based on the interrelation of phytocoenosis composition and topography. The morphology of the landscape influences the environmental factors that limit or promote plant growth on many levels. Energy and mass flux, moisture, nutrition, precipitation and solar radiation rates, propagule transport and non-geomorphically induced disturbance factors, such as fires and floods, affect the pattern of phytocoenoses in the landscape in relation to their specific needs (Swanson et al. 1988). Plants are not randomly scattered throughout the landscape, but rather are related to its suitability (Zimmermann/Thom 1982, 50). Thus, certain topographic conditions are more suitable for specific plants and plant communities than others. A landscape providing a very heterogeneous morphology would consequently show a relatively high level of diversity in environmental conditions, and therefore in plant communities.
Geomorphic heterogeneity can be expressed in many different ways. Here, landforms were selected as units of measurement. They allow, on the one hand, the measurement of topographic diversity in any given area, and on the other hand, the measurement of regularities and irregularities in the composition of the specific areas. This way, different areas can easily be compared to one another.
Landforms are components of the landscape that separate themselves from the surrounding areas by their distinct geomorphologic characteristics (Bates/Jackson 1987). Another definition emphasises the links of the landforms to physical processes that take place within their boundaries: »a terrain unit created by natural processes in such a way that it may be recognised and described in terms of typical attributes wherever it may occur« (MacMillan/Shary 2009, 228). These different units, »valleys«, »plains«, »ridges«, or »slopes«, are the components that make up the landscape. They are also the scale on which physical processes are the dominant factor determining the spatial pattern of plant societies in the landscape (Zimmermann/Thom 1982, 52). The second definition shows that specific geomorphic and geophysical processes can be linked to specific landforms. This way, hypothetical plant communities can be assigned to these units. A high diversity of landforms therefore correlates with a high level of biological diversity.
In this archaeological approach to Predictive Ecosystem Mapping (PEM), biodiversity is understood as it was defined by the Convention on Biological Diversity: »Biological diversity means the variability among living organisms from all sources including, *inter alia* terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part« (United Nations 2014). This includes, but is not limited to, the flora and fauna that are understood as typical resources for prehistoric humans. Diversity therefore cannot be understood as a proxy that shows the availability of prehistorically important resources, but rather describes their potential variability, whether exploitable by prehistoric humans or not.
A plethora of different methods is available for landform classification (Barka/Vladovic/Malis 2011). In this case the Topographic Position Index (TPI) Based Landform Classification Algorithm, as it was developed by Jennes (2005; 2006) and Weiss (2001), was used. It compares the TPI on two different scales to classify the landscape into discrete geomorphological features (**figs 2-3**). The algorithm is part of the SAGA software and is capable of classifying any given DEM raster (Department of Physical Geography Göttingen/Department of Physical Geography Hamburg/SAGA User Group Association 2014). The benefit of using landforms

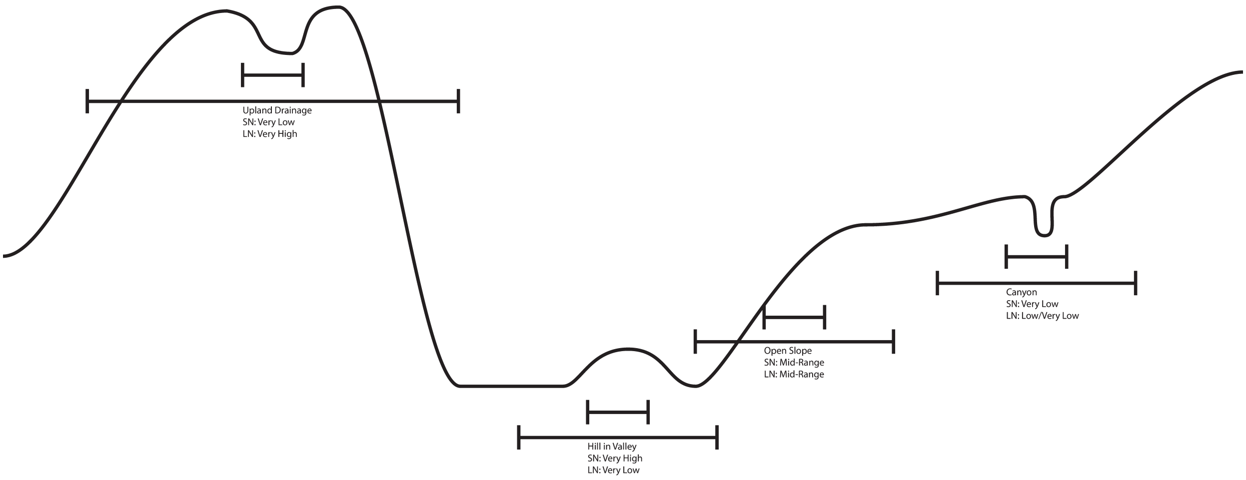

Fig. 2 Model of the landform classification using the Topographic Position Index (TPI). – SN: Small Neighbourhood; LN: Large Neighbourhood. – (After Jennes 2006).

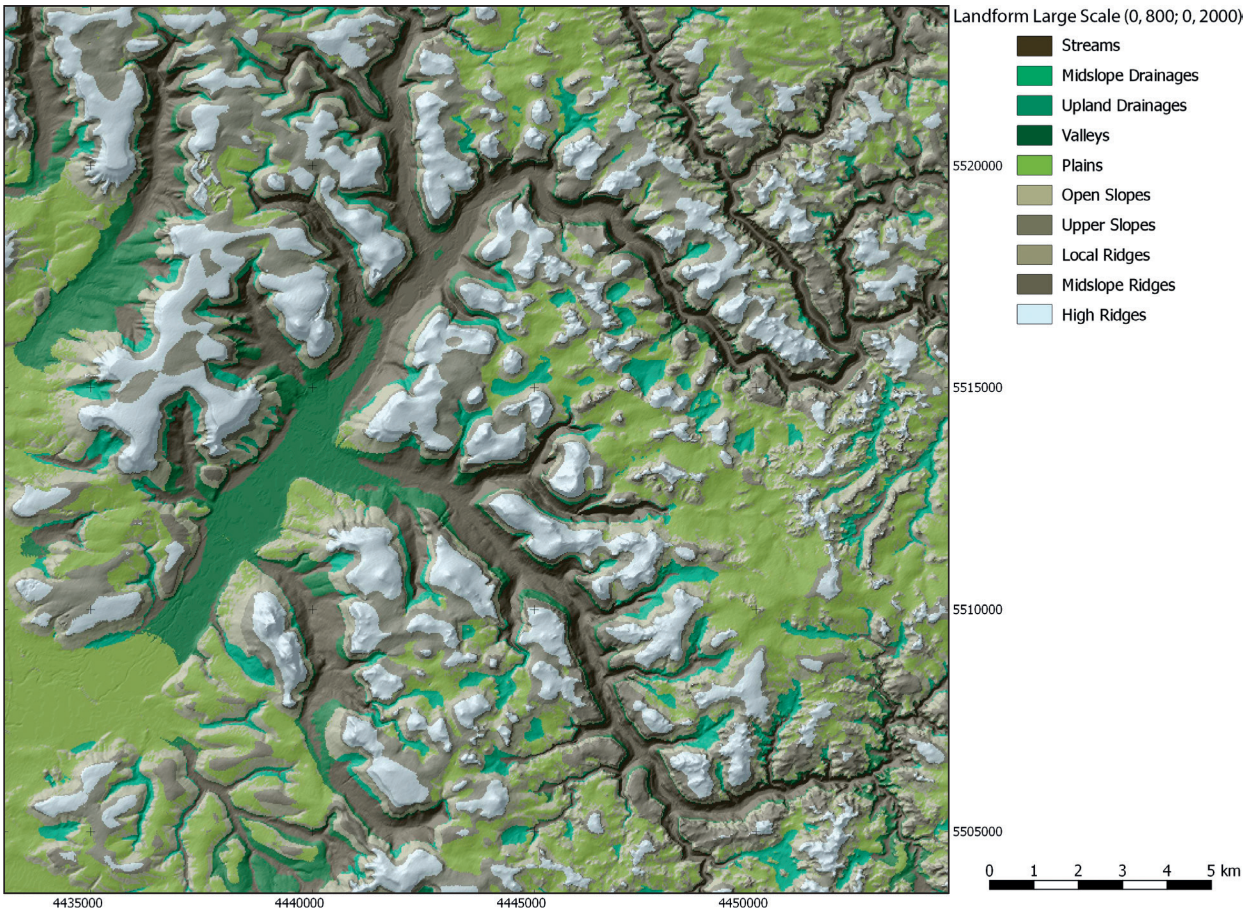

Fig. 3 Exemplary result of the landform modelling process (TPIs used for classification: SN [Small Neighbourhood] – 0 m, 800 m; LN [Large Neighbourhood] – 0 m, 2,000 m); Wiesent Valley and tributaries, Franconian Alb.

for classifying the landscape is the fact that they show a specific makeup of geomorphological and geophysical processes, which determine plant growth within their boundaries (Swanson et al. 1988). It allows to correlate hypothetical ecotypes with the landforms modelled using GIS software because of the plants' specific needs and limitations.

Landform	Wetness	Erosion/deposition	Disturbance	TPI
Canyon/V-shaped valley	very high wetness high flow rates	seasonal flooding and erosion events	intense seasonal disturbance	SN: low LN: low
Midslope drainages/shallow, local valleys in plains	medium wetness	seasonal erosion events or seasonal flooding	landslides	SN: moderate LN: low
Upslope drainages/headwaters	medium to high wetness	seasonal erosion or flooding events with moderate or intense deposition	storm damage	SN: low LN: high
Valley/U-shaped valleys	high wetness low flow rates	seasonal flooding events with intense deposition	landslides	SN: moderate LN: low
Plains	moderate wetness to dry	low to none	seasonal fire storm damage	SN: moderate LN: moderately low slope = 0
Broad open slope	dry	low erosion or low deposition rates	storm damage	SN: moderate LN: moderately high slope > 0
Upper slopes/mesas/flat ridge tops	dry to very dry	low to medium erosion rates	landslide storm damage	SN: moderate LN: high
Local ridges/hills in valleys	dry to very dry	low to moderate erosion rates	landslide storm damage flooding protection	SN: high LN: low
Midslope ridges/small hills in plains	very dry	low to moderate erosion rates	landslide storm damage	SN: high LN: moderate
High ridges/mountain tops	very dry	high erosion rates	storm damage	SN: high LN: high

Tab. 1 Landform units provided by the classification algorithm and related properties. – TPI: relation of Small (SN) and Large Neighbourhoods (LN) for classification.

By using the TPI, which calculates the relative position of a pixel in relation to the elevation of the surrounding pixels in a given radius on two different scales (SN: Small Neighbourhood; LN: Large Neighbourhood), the landform classification algorithm produces a thematic raster with ten different landform classes, ranging from »canyons« to »high ridges« (**tab. 1**). Based on the radii, which are entered for calculation, different classification scales can be obtained. Very small radii result in a very high resolution of the resulting map; small features in a very local context will be pronounced. A large scale will extract features on a more regional level, resulting in more extensive landform units. The use of different scales has a direct influence on the topographic diversity of the landscape. Small TPIs would result in a greater number of pixels that are classified as »plains«. The »plains«-landform represents areas where there is hardly any change in elevation. By expanding the scale, areas that are classified as something other than »plains« are expanded as well, because a change in elevation is more likely.

Therefore, choosing the right scale for analysing the landscape composition is paramount. In the case of this approach, three different scales, ranging from small to large will be employed. This allows for the examination of potential influences of topography on biodiversity in relation to scale.

Since prehistoric biological diversity is inferred from modern topographical information it has to be kept in mind that topography is not a constant through time, but, at least in some cases, subject to substantial change. In this case, though, the modelling is done on a relatively large scale, and therefore changes in relief may have only limited influence on the results of the examination of the Lateglacial landscape. Landforms exist over a relatively long time, compared to other geomorphological units (Ahnert 2009, fig. 1.3). However, there are cases in which there may be a significant influence on the results. These instances are, on the one hand, areas that show a high degree of geomorphological activity, and, on the other hand, time phases that date back a particularly long time. These changes should always be considered when examining a working area. A possibility to reduce the influence of geomorphological change on the results is to choose a relatively large scale of modelling. This way the modelling focus lies on larger landscape features, and spatially limited change in topography has only little influence on the results. However, this will also lead to relatively coarse modelling results.

For comparing the catchments of the different sites in respect to their potential biological composition, the catchments were modelled using a cost distance calculation (Uthmeier / Ickler / Kurbjuhn 2008). It examines the accessibility of the landscape based on the topography in relation to a point of origin. Tobler's »Hiking Function« (Tobler 1993) gives back an estimation of the time required to cross a raster pixel depending on its slope. A basic speed of 0.89 m / s was used for calculation, as it was measured for trail hikers in the Yosemite National Park (van Wagtendonk / Benedict 1980). By adding up the values to a threshold value, for example the maximum foraging distance, as it is known from ethnological comparison, it is possible to calculate the size of the foraging radius (Binford 1982; 2001). Within the boundaries of the catchment-radii the landforms are then sampled and form the basis for further analysis (fig. 4). The sampling was done using the ArcGIS Plugin GME 0.7.2.0 (Geospatial Modelling Environment for ArcGIS).

The benefit of cost distance calculation as a tool for catchment modelling is the fact that the sampling results are weighted by their accessibility. Local landform features that can be reached quite easily will play a much more important role than features which are situated further away from the site in an environment that shows a bad accessibility. To examine this change by distance, the catchment was divided into circular isochrone rings with a width of one hour each. This way it is possible to examine whether specific conditions were favoured in a specific distance to the site. These could be a favourable ecological diversity or a specific composition of ecotypes.

Many different models of interpretation could arise, looking at the distribution of diversities throughout the landscape. Sites that reflect a very low ecological diversity in their vicinity and a very high diversity further away could reflect a preference of a specific set of resources close to the camp. A very good accessibility of these specific resources could have been an important factor for site placement (Jochim 1976, 50-51). Furthermore, characteristics of a special task camp could be prominent in the site's lithic assemblage, reflecting the economic focus. In turn, if the situation was inverted, a broad resource basis could have provided a high level of economic security (Jochim 1976, 16). Characteristics reflecting a base camp could be prominent in these cases. Anyway, the site / catchment relationships probably are much more complex than these examples suggest.

As it was already stated at the beginning of this article, the landforms could be correlated with hypothetical ecotypes due to their specific environmental conditions and the individual needs of the vegetation. Therefore, the combination of ecotypes in the catchments of the sites could provide an insight into preferred combinations of ecological entities. Again, the subdivision of the catchment into circular rings could show the change of the ecological makeup in relation to distance.

PRELIMINARY RESULTS

Analysing the results of the modelling process, sites in the landscape can be categorised into three different sets of potential biological diversity in regard to their catchment radii and the transportation cost. The sites of Lindenloh (Lkr. Tirschenreuth), Schönthal (Lkr. Cham; fig. 4D) or Oberweiherhaus (Lkr. Schwandorf; fig. 4B), for example, show a very low level of diversity in close range. With increasing distance to the centre of the catchment it rises to a relatively high level. On the other hand, the sites of Schlattein (Lkr. Neustadt

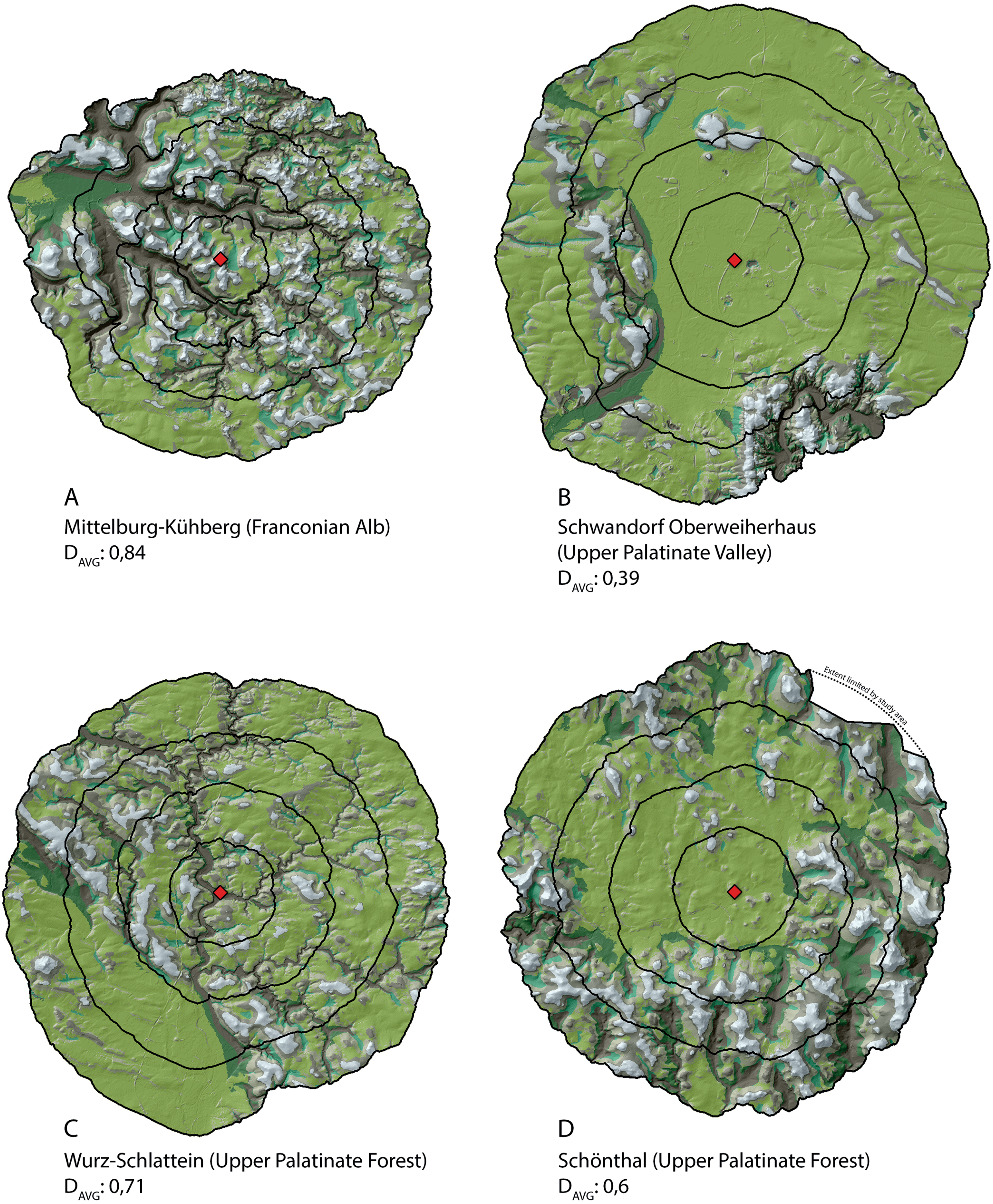

Fig. 4 Catchment-discs for the four sites mentioned in **tab. 1**. Subdivision: 1 h; landform classification: SN – 0 m, 800 m, LN – 0 m, 2,000 m.

a. d. Waldnaab; **fig. 4C**) and Weißenhof (Lkr. Schwandorf) show a decrease in potential diversity. The sites of Mittelburg-Kühberg (Lkr. Nürnberger Land; **fig. 4A**), Atzenhof (Fürth), Ritzmannshof (Fürth), and Zangenstein (Lkr. Schwandorf) show a consistent level of high or low diversity.

Site	1 h radius D_i	2 h radius D_i	3 h radius D_i	4 h radius D_i	D_{AVG}
Lindenloh	0.05-0.07	0.32-0.41	0.55-0.59	0.61-0.71	0.42
Oberweiherhaus	0.1-0.14	0.35-0.38	0.51-0.63	0.46-0.52	0.39
Schönthal	0.25-0.27	0.56-0.66	0.66-0.80	0.73-0.85	0.6
Schlattein	0.76-0.8	0.74-0.77	0.65-0.68	0.60-0.63	0.71
Weißenhof	0.78-0.8	0.77-0.81	0.53-0.55	0.60-0.66	0.7
Kühberg	0.84-0.87	0.84-0.88	0.83-0.87	0.78-0.82	0.84
Atzenhof	0.23-0.3	0.16-0.21	0.2-0.24	0.24-0.26	0.23
Ritzmannshof	0.25-0.33	0.18-0.24	0.24-0.28	0.25-0.27	0.26
Zangenstein	0.78-0.84	0.79-0.84	0.8-0.84	0.74-0.80	0.81

Tab. 2 Selection of changes of potential ecological diversity in relation to distance; the variance is due to the different scales in landform modelling (D_i: Diversity index of the individual circular ring; D_{AVG}: Diversity average).

Activities related to the sites of the first group would have to focus on the availability of a more or less limited set of biotic resources in the vicinity of the site and a greater bandwidth of resources further away from the camp. The ecological potential of the sites' catchment would allow only a limited range of different bioresource-exploitation tasks to be carried out, and the low transportation distance would suggest that the camp was placed in a convenient distance to the resource so that transportation costs to move the yield back to the camp would be relatively low (fig. 4B. D; tab. 2).
In contrast, tasks related to spots of the second category would focus on a great variety of potential organic resources close to the site and a more specific set in a greater distance. If one considers transportation costs, the possibility to easily exploit a great variety of nearby resources would have been the dominating factor in the decision making process that led to site placement. Furthermore, the great number of different organic resources would have permitted to carry out a great number of different tasks (fig. 4C; tab. 2).
The third group of sites does not seem to focus on the distance in which specific sets or diversities of biogenic resources are available, but rather on their general availability. Viewed from a logistical point of view, it would not have been necessary to travel far from the site to access a different variety of resources, because the biological potential is distributed more or less evenly throughout the catchment. In a sense, these sites could very well reflect the first two categories presented before, with a difference in the way resources placed in the hinterland contributed to the sites' economy (fig. 4A; tab. 2).
Another way to work with the results of the modelling process would be to look at the specific composition of different landform types in the varying catchments. This approach is based on the idea that the geomorphic processes that correlate with a specific landform type determine the ecotype that is placed within the boundaries of the geomorphic unit. Therefore, one can assume that throughout the landscape the same landform usually produces a more or less identical set of biotic resources. A preference for a specific landform by prehistoric humans thus would suggest a focus on the related organic resources, whatever they may be. Although this part of the methodology is still under development, and furthermore is aimed on the comparison of lithic assemblages and catchment composition, a brief example will be given here.
The sites analysed in this example all are situated in the ecological landscape unit of the Upper Palatinate Forest (fig. 5). It is an area that is composed of a very heterogeneous geomorphology. Landforms reflecting this topography, like »canyons«, »ridges«, and »slopes«, are prominent. A total of 37 sites were analysed using cluster analysis (1 h catchment; large landform modelling scale SN: 800 m; LN: 2,000 m). By using the

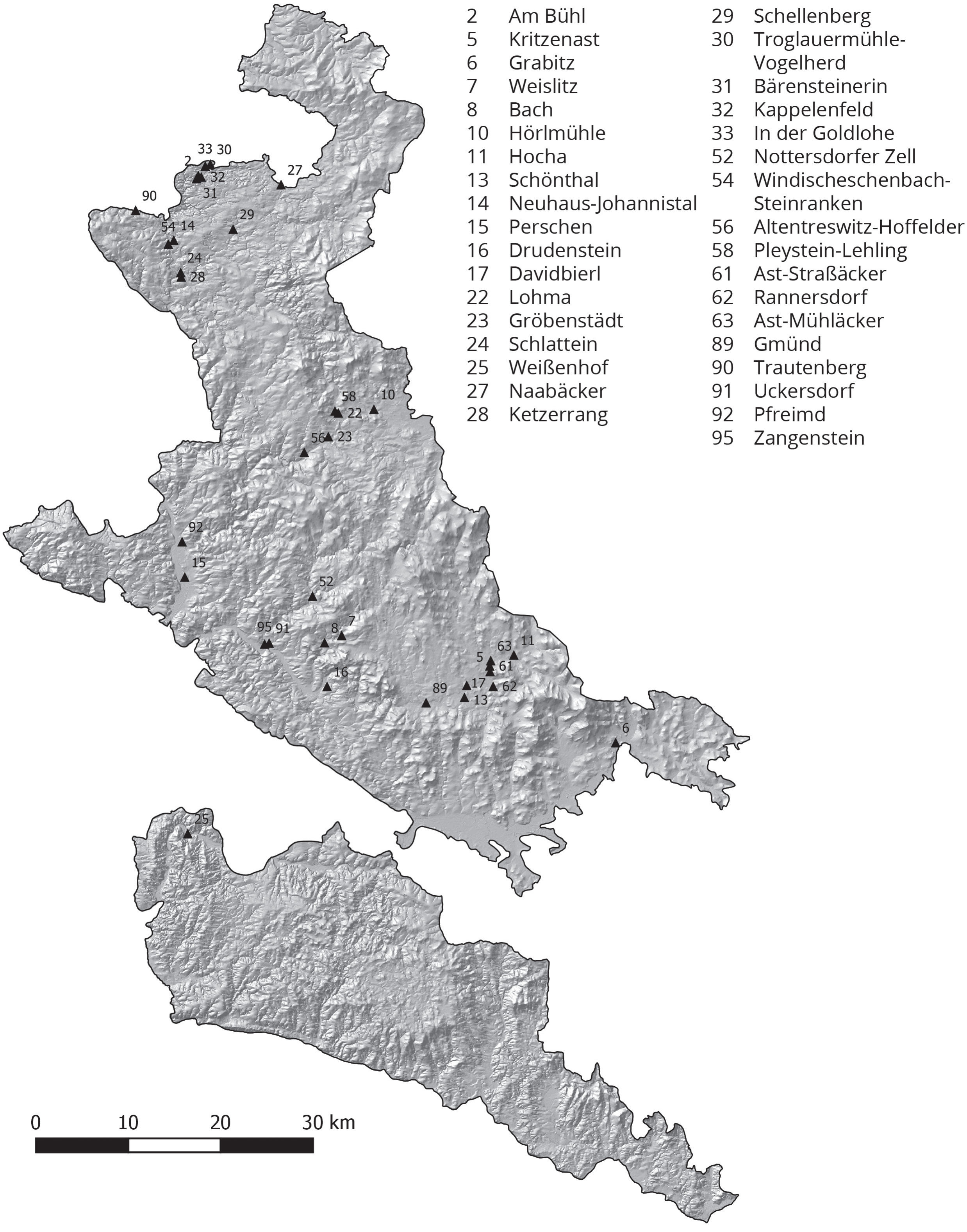

Fig. 5 Landscape unit and sites of the Upper Palatinate Forest. – Black triangles: sites used for cluster-analysis presented in **fig. 6**.

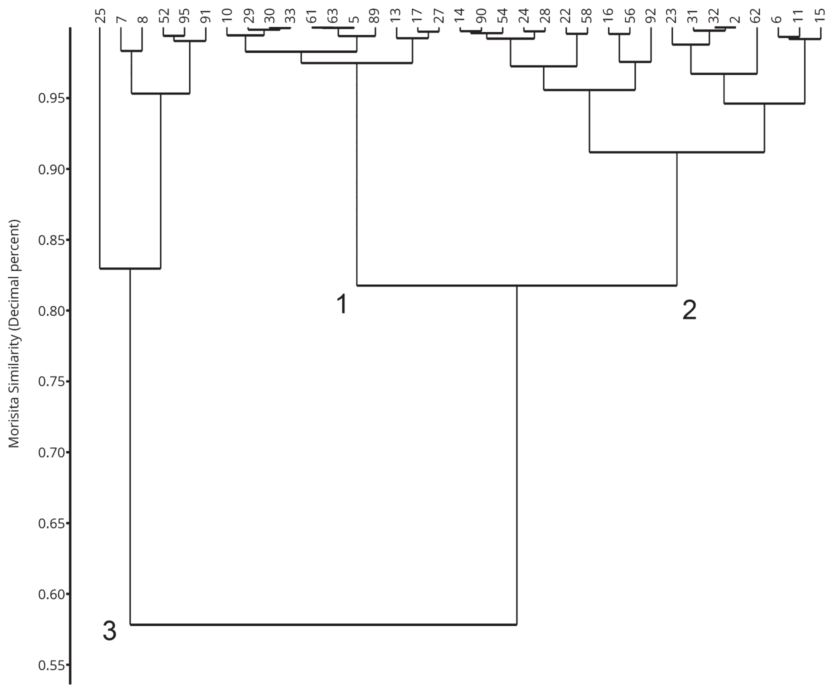

Fig. 6 Cluster analysis of 37 sites in the Upper Palatinate Forest; 1 h catchment radius, TPIs used for landform classification: SN – 0 m, 800 m; LN – 0 m, 2,000 m (Cluster analysis: PAST 3.04).

	LFT 1	LFT 2	LFT 3	LFT 4	LFT 5	LFT 6	LFT 7	LFT 8	LFT 9	LFT 10
	canyons	midslope drainages	upland drainages	valleys	plains	open slopes	upper slopes	local ridges	midslope ridges	high ridges
Cluster 1	2 %	2 %	0 %	4 %	70 %	16 %	1 %	0 %	2 %	3 %
Cluster 2	10 %	4 %	0 %	7 %	39 %	28 %	2 %	0 %	6 %	5 %
Cluster 3	24 %	5 %	0 %	13 %	10 %	24 %	5 %	0 %	9 %	11 %

Tab. 3 Arithmetic mean values of the different clusters' landform types (LFT).

»Morisita Similarity Index« (Hammer / Harper / Ryan 2001) for abundance data, the sites could be grouped into three main clusters. They suggest a division of the camps into three basic types in respect to their catchments' landform composition (**fig. 6; tab. 3**).

The first cluster reflects sites which are placed in a relatively flat landscape. »Plains« and moderately sloping areas make up the greatest percentage of the catchment. The second group is still dominated by flat surface landform types, but also shows a limited shift towards other units. The third group seems to be completely different to the other two. Here, »ridges« and »canyons« are the most important features. If one assumed the correlation and causation of landforms and ecotypes, this would show three types of sites that would have to focus on three different sets of resources.

The next step of this approach would be to analyse a possible correlation of the catchments' landform composition and diversity, and the accompanying lithic assemblages. The greatest problem probably will be the question whether the variations of the modelled biological composition of the landscape really translate to the lithic assemblages at the different sites. The resolution of both the assemblages and the modelling results could be too low to see correlations. Also different foci of the sites, for example on non-organic resources, as well as a small net production, which is not limited by specific compositions, could disturb the picture. This step, though, cannot yet be presented in this article, because it is part of the PhD project mentioned above.

CONCLUSIONS

The benefit of this methodology is not only to gain information about environmental conditions in areas where there is no other or only scarce information, but also the possibility to analyse the prehistoric use of organic resources throughout the landscape. Typical sources of environmental information, like palynology and fauna, can still be used in this approach to calibrate and compare the results of the modelling processes. Other information levels, like soil information or wetness indices, could also improve the resolution as well as the predictive capacities of this modelling approach. The basic question that will be tested in the PhD project mentioned earlier will be whether the differences in ecological makeup that can be modelled by PEM can be traced back to the lithic assemblages. It is possible, however, that this scale of changes in biological composition throughout the landscape does not translate to the level of the lithic assemblages. The approach is not limited to the Palaeolithic, but is usable in any case where insight into the interaction between site and environment is important.

Acknowledgements

This paper represents the state of work in 2014. Since then the project has been finished and a comprehensive analysis can be found with the published PhD (Sauer 2018). Many thanks for the support for my participation in the UISPP Congress in Burgos to the UISPP organisers and the reviewers of this article for their helpful comments.

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Summary

Insights into the ecological composition of a site's catchment are rarely possible in many cases. Usually, no information is available on the vegetational makeup of the surrounding landscape. In this article a methodology is presented which uses topographic information to model the potential biodiversity in the landscape. It is based on geomorphic processes that coincide with different geomorphological units, the so-called landforms. Furthermore, these processes influence the composition of the vegetation that yields important resources for hunter-gatherers. Hence, the geomorphic processes have a direct influence on the bio-economic potential of a site's catchment.

Keywords

Predictive Ecosystem Mapping, Catchment Analysis, Late Palaeolithic, Bavaria

MARTIN MONÍK · ANNA PANKOWSKÁ

SETTLEMENT PATTERNS OF THE LATE PALAEOLITHIC IN BOHEMIA AND MORAVIA

Similarly to other territories in Central and Western Europe, what is today Bohemia and Moravia (CZ) saw significant cultural change at the beginning of or during the Allerød period when Magdalenian sites disappeared from the archaeological record and typologically less pronounced Late Palaeolithic (LP) assemblages started to appear (Vencl 2013). The task of this study is to statistically evaluate whether, complementary to changing artefact types, areas of a different topographical type were exploited during the LP period, broadly identified with the Allerød and Younger Dryas climatic phases in the Bohemian and Moravian territory (Valoch 2001; Vencl 2013). A similar approach was applied recently in northern Spain where differences in site preferences between distinct Palaeolithic periods were identified (Turrero et al. 2013). The assumption is that selected topographical categories of archaeological sites can be quantified, and that they, responding to a certain settlement pattern, change in time together with changing climate or even archaeological cultures. The principal questions to be answered are whether there is a certain settlement pattern, if this pattern changes between the two analysed periods, and what are the topographical features that most likely influenced Late Pleistocene people.

Bohemia and Moravia are two parts of what is today the Czech Republic (the third one, Silesia, is considered here together with Moravia). They are both well known for their rich Upper Palaeolithic settlement evidence (Oliva 2005; Vencl 2013). Whereas Magdalenian sites, above all caves, were excavated primarily at the end of the 19th and the beginning of the 20th century (Valoch 2001), LP sites were recognised only in the 1960s (Klíma 1962; Vencl 1964). Although nowadays more numerous than Magdalenian sites, LP sites usually consist just of chipped stone assemblages acquired through field-walking. Stratified LP sites are rather exceptional in the area and have not provided a clear stratigraphy as Allerød and Younger Dryas strata are either mixed with (e.g. in Kůlna Cave at Sloup; Nerudová/Neruda 2014), or are difficult to distinguish from (e.g. in Tmaň, Tři voli Cave; Prošek 1958) Holocene soil, or are otherwise disturbed by post-depositional processes (e.g. Voletiny, Plzeň-Roudná; Vencl 1978; 1988). This has also resulted in very few reliable radiocarbon dates from local LP sites.

MATERIAL AND METHODS

Mapping and GIS analysis

A characteristic element of Magdalenian settlement in Bohemia and Moravia (Svoboda 2002; Valoch 2001; Vencl 1995a) is the elevated number of cave sites, a situation that changed in the following LP. Cave sites concentrate predominantly in two karst areas – the Bohemian and Moravian Karsts – although Bohemian open-air sites are relatively frequent as well (Vencl 2013). LP sites, on the other hand, are known throughout the country, with clear concentrations in South-West Bohemia and North-East Moravia, i.e. areas of intensive professional or amateur surface prospection. Analysed sites are presented on the map (**fig. 1**) and, in the case of LP sites (n = 152), are practically identical to those mentioned in Moník/Eigner (2019), with the

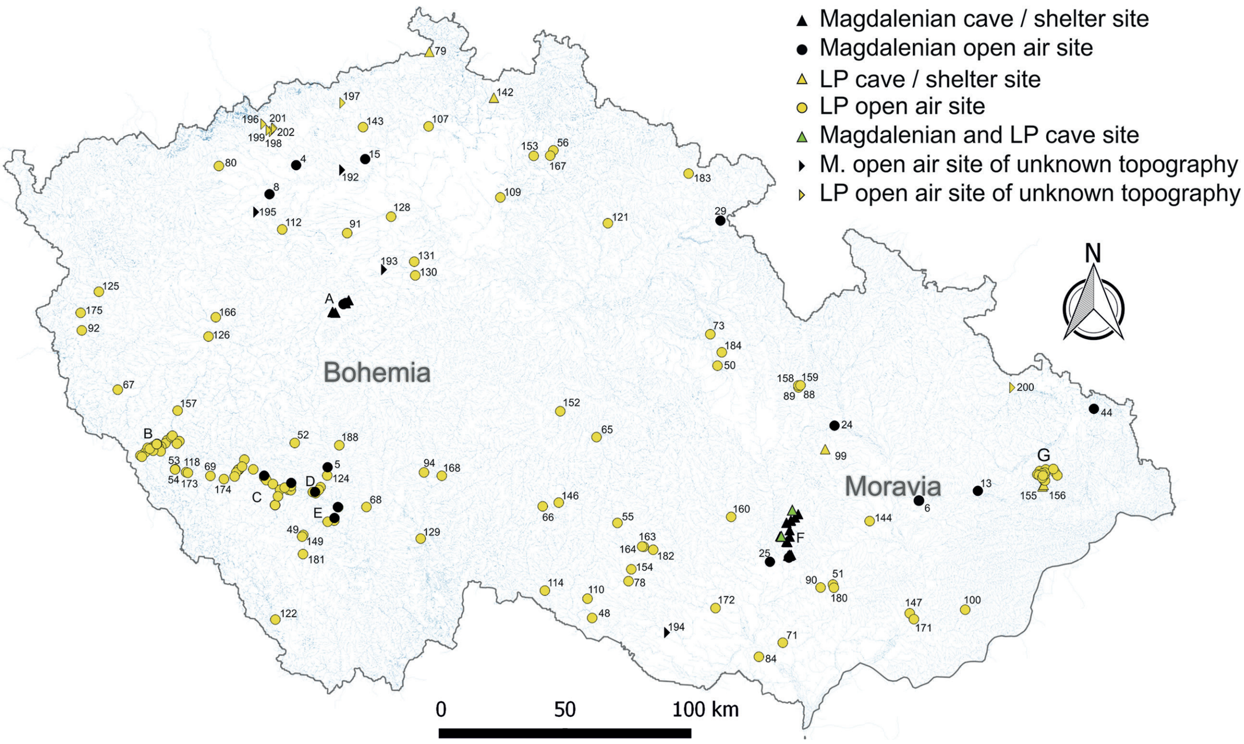

Fig. 1 Magdalenian and LP settlement in Bohemia and Moravia.
Magdalenian and LP sites: **F** Moravian Karst area: **3** Habrůvka, Barová Cave. – **21** Sloup, Kůlna Cave.
Magdalenian sites: **A** Bohemian Karst area: **11** Hostim. – **12** Hostim-Krápníková Cave. – **18** Koněprusy Caves. – **37** Sv. Jan-Na průchodě Cave. – **39** Tetín-Ve stráni. – **40** Tmaň-Děravá Cave. – **C** Otava River area: **9** Dolní Poříčí 8. – **35** Slaník 1. – **D** Putim area: **33** Putim. – **E** Blanice River area: **27** Milenovice 1. – **45** Žďár 1. – **F** Moravian Karst area: **1** Ochoz, Adlerova jeskyně Cave. – **2** Ostrov, Balcarova skála Cave. – **7** Habrůvka, Býčí skála Cave. – **10** Mokrá, Hadí jeskyně Cave. – **14** Habrůvka, Jáchymka Cave. – **16** Ochoz, Klímova jeskyně Cave. – **17** Jedovnice, Kolíbky Cave. – **19** Suchdol, Koňská jáma Cave. – **20** Ochoz, Křížova jeskyně Cave. – **22** Mokrá, Kůlnička Cave. – **23** Ochoz, Liščí jeskyně Cave. – **26** Lipovec, Michalova skála Cave. – **28** Mokrá I and V. – **30** Březina, Nová Drátenická Cave. – **31** Ochoz, Ochozská jeskyně Cave. – **32** Mokrá, Pekárna Cave. – **34** Lažánky, Rytířská jeskyně Cave. – **36** Vilémovice, Srnčí Cave. – **38** Ochoz, Švédův stůl Cave. – **41** Vilémovice, Verunčina Cave. – **42** Habrůvka, Vinckova jeskyně Cave. – **43** Březina, Výpustek Cave. – **46** Habrůvka, Žitného Cave. – **Sites in other areas**: **4** Bečov. – **5** Borečnice 2. – **6** Přerov. – **8** Dobříčany. – **13** Hranice-Velká Kobylanka. – **15** Keblice. – **24** Loštice I. – **25** Brno, Maloměřice-Borky I. – **29** Náchod. – **44** Záblatí. – **Sites of uncertain location**: **192** Klapý. – **193** Praha 6-Dolní Liboc. – **194** Tvořihráz. – **195** Želeč.
Late Palaeolithic sites: **A** Bohemian Karst area: **161** Tmaň-Dolní jeskyně Cave. – **162** Tmaň-»Tři voli« Cave. – **B** Úhlava River area: **47** Běhařov. – **57** Dolní Lhota. – **60** Dubová Lhota 1. – **61** Dubová Lhota 2. – **62** Hadrava. – **72** Hvízdalka. – **74** Chudenín. – **75** Janovice nad Úhlavou 1. – **76** Janovice nad Úhlavou 10. – **77** Janovice nad Úhlavou 9. – **82** Klatovy 3. – **83** Klatovy 4. – **98** Luby u Klatov 1A. – **101** Malá Víska. – **119** Nýrsko. – **120** Ondřejovice. – **123** Petrovice nad Úhlavou. – **127** Pocinovice. – **170** Úborsko. – **176** Veselí 1. – **177** Veselí 4. – **178** Veselí 6. – **179** Veselí 7. – **C** Otava River area: **58** Dolní Poříčí 1. – **59** Dolní Poříčí 7. – **64** Hájská 2. – **81** Katovice 3. – **102** Malé Hydčice 1. – **103** Malé Hydčice 2. – **104** Malé Hydčice 4. – **105** Malé Hydčice 5. – **106** Malé Hydčice 6. – **111** Modlešovice 6. – **113** Mutěnice 2. – **115** Němětice 1. – **116** Němětice 2. – **117** Němětice 3. – **133** Přední Zborovice 1. – **140** Rabí 1. – **145** Slaník 1. – **148** Strakonice 4. – **150** Střela 2. – **151** Střelské Hoštice 4. – **165** Třebomyslice 1. – **169** Týnec 4. – **191** Žichovice 6. – **D** Putim area: **70** Hradiště 1. – **93** Lhota u Kestřan 1. – **138** Putim, eastern bank. – **139** Putim, plot no. 422. – **E** Blanice River area: **108** Milenovice 2. – **141** Radčice 1. – **189** Žďár 1. – **190** Žďár 3. – **G** Příbor area: **63** Hájov 3. – **85** Kopřivnice 1. – **86** Kopřivnice 2. – **87** Kopřivnice 3. – **95** Lihošť-Borovec. – **96** Libhošť-road. – **97** Lubina. – **132** Prchalov. – **134** Příbor-homestead. – **135** Příbor-Jánský sloup. – **136** Příbor-Klokočov. – **137** Příbor-Sedlnička. – **185** Závišice-»Peklo«. – **186** Závišice graveyard. – **187** Závišice-north. – **Sites in other areas**: **48** Bítov. – **49** Blanice 6. – **50** Bohuňovice 6. – **51** Bučovice. – **52** Buzice. – **53** Čachrov 1. – **54** Čachrov 2. – **55** Číchov. – **56** Daliměřice. – **65** Herlify. – **66** Horní Cerekev. – **67** Horšovský Týn. – **68** Hosty 1. – **69** Hrádek 1. – **71** Hustopeče. – **73** Choceň. – **78** Jaroměřice nad Rokytnou II. – **79** Jetřichovice, Janova zátoka rockshelter. – **80** Kadaň. – **84** Klentnice-»Soutěsky«. – **88** Krasíkov1. – **89** Krasíkov 2. – **90** Křižanovice. – **91** Kvíc. – **92** Labuť. – **94** Lhota Samoty 1. – **99** Ludmírov, Průchodnice Cave. – **100** Luhačovice. – **107** Malý Bor (Stvolínky II). – **109** Mladá Boleslav. – **110** Mladoňovice. – **112** Mutějovice. – **114** Mutná. – **118** Nemilkov 1. – **121** Ostroměř. – **122** Pernek 3. – **124** Písek 3. – **125** Planá u Mariánských Lázní. – **126** Plzeň-Roudná. – **128** Podhořany. – **129** Ponědrážka, Švarcenberk 7. – **130** Praha 10-Malešice. – **131** Praha 8-Ládví. – **142** Radvanec, Údolí Samoty rockshelter. – **143** Sebuzín. – **144** Skalka u Prostějova. – **146** Spělov. – **147** Staré Město. – **149** Strunkovice nad Blanicí 2. – **152** Světlá nad Sázavou. – **153** Svijany. – **154** Štěpánovice. – **155** Štramberk, Čertova díra Cave. – **156** Štramberk, Šipka Cave. – **157** Švihov. – **158** Tatenice 1. – **159** Tatenice 4. – **160** Tišnov. – **163** Třebíč I. – **164** Třebíč II. – **166** Třemošná 1. – **167** Turnov. – **168** Turovec. – **171** Uherské Hradiště. – **172** Vedrovice XII. – **173** Velhartice 4. – **174** Velká Chmelná 3. – **175** Velký Rapotín. – **180** Vícemilice. – **181** Vítějovice 1. – **182** Vladislav. – **183** Voletiny. – **184** Vračovice 1. – **188** Zvíkovské Podhradí 1. – **Sites of uncertain location**: **196** Dolní Jiřetín. – **197** Chabařovice. – **198** Komořany A1. – **199** Komořany A2. – **200** Opava-Kylešovice. – **201** Souš (A). – **202** Souš (B). M. = Magdalenian.

exception of two cave sites with both LP and Magdalenian settlement (Barová and Kůlna Caves). These were considered separately for each period in all performed statistics (see below), but are presented as one site on the map (**fig. 1**). Seven LP sites could not be precisely located due to their destruction by quarrying (specifically, the Federmesser-Gruppen sites in North-West Bohemia, and the Opava-Kylešovice site; see Klíma 1951; Vencl 1970). Precise topographical data could not be reconstructed here, and these sites were not used for our analysis though we also present them on the map (**fig. 1**). Similarly, 46 Magdalenian sites have been analysed, leaving aside further four sites of uncertain or unknown topographical data mentioned by Vencl (1962; 2013), Woldřich (1900), and Kovárník (2001). As most LP finds in Bohemia and Moravia consist just of chipped stone assemblages acquired through surface prospection, a limit was set at ten artefacts when distinguishing single finds (not considered in this study) from sites *sensu stricto*.
The settlement pattern of archaeological sites is characterised by their altitude, aspect, distance to freshwater source and steepness of slope (cf. Turrero et al. 2013). In this study, moreover, the area visible from each site was considered as a complementary variable, important for example in the tracking of game in the Palaeolithic.
Coordinates of different sites were obtained from literature (Moník 2014; Neruda/Kostrhun 2002; Neruda/Nerudová/Čulíková 2009; Nerudová 2010; Svoboda 2002; Škrdla/Schenk/Zapletal 2008; Valoch 2001; Vencl 1995a; 2006; 2013). If not stated by the authors, the positions of sites were located on mapping servers (Google Earth) on the basis of their description. The coordinates were then used to acquire necessary variables from a Digital Elevation Model (DEM) in the QGIS Desktop 2.4.0 software. As the resolution of the available pixel DEM for the Czech Republic is rather poor (100 m × 100 m), altitude and distance to freshwater were usually copied from the literature or read off the map (mapy.cz 2015) manually. Possible errors in topographical analyses (see below) may have originated here as present-day water courses are often different from those of the Late Pleistocene as is the whole landscape. Aspect, slope and visible area values had to be obtained through interpolation of DEM map and vector data (**fig. 2**). When considering areas visible from every Magdalenian and LP site, the height of the observer was set at 1.6 m, and the range (radius) of vision at 10 km. The reliability of this method is rather restricted by the fact that vegetation cover is not taken into account, and also by the rather poor DEM resolution which affects the slope analysis as well. Nonetheless, the general strategic importance of sites is, in our opinion, discernible.

Statistics

Principal Component Analysis (PCA) is a statistical technique used to reduce the dimensionality of interrelated variables of a certain dataset (Salkind 2007) and detect their mutual relationships. Similarly to the study of Turrero et al. (2013), it was conducted here for topographical variables of different periods (Magdalenian and LP), first for cave/shelter and open-air sites together, and then for these two site types separately. If any of the variables characterising the sites were correlated (e. g. the higher the position of the settlement, the better the vision range), the correlation would be identified using this technique. If there were significant changes in site preferences, correlation of variables would differ between the Magdalenian and LP.
The Mann-Whitney U test is a non-parametrical test to verify whether there is a difference between two or more populations (Dodge 2008). It was performed here to determine whether the settlement pattern of the two periods in question is significant as regards four of the considered variables (altitude, aspect, slope, distance to freshwater source) or not, i. e. whether sites were chosen randomly or according to specific criteria. For every LP and Magdalenian site the identical amount of »Expected random samples« (points on the map) was created in the QGIS software and compared with the existing sites.

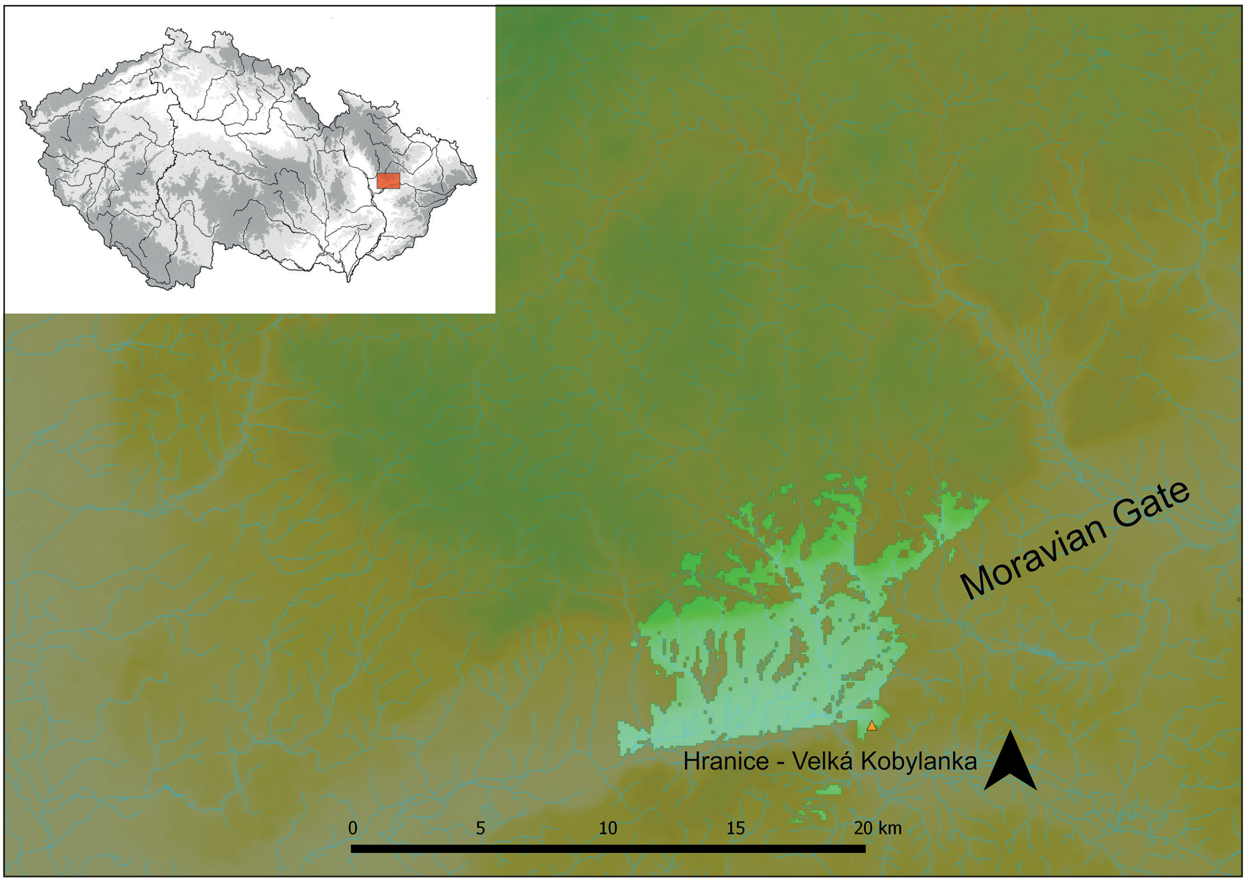

Fig. 2 Vectorised area (bright green) visible from a selected Magdalenian site and calculated as regards the extent of visibility. Analogous calculations were conducted for all Magdalenian and LP sites.

Secondarily, a Mann-Whitney U test was conducted for testing the significance of topographical differences between Magdalenian and LP sites. In this case, five variables were taken into account (altitude, aspect, slope, distance to freshwater source, visible area).

RESULTS

Topography of sites

Variable means and medians of selected topographical variables are summarised in **table 1**. When considering cave/shelter and open-air sites together, a number of trends are observable at the end of the Magdalenian and the onset of the LP, especially the settlement of higher altitudes. Typical altitudes (i. e. the mean 50 % of all altitudes) exploited during the Magdalenian were situated between 315 and 396 m with no maximum outliers and a non-outlying maximum at 476 m. This pattern changed in the LP when mean values increased to 331-450 m, with a non-outlying maximum at 613 m and a maximum outlier at 770 m.
Probably related to this change are larger areas visible from LP sites, increasing from units of square kilometres (when median values are considered) visible from all types of Magdalenian sites to tens of square kilometres visible from LP sites (**tab. 1**). The general aspect of sites does not change much between the two periods, the south-west orientation being preferable, whereas the distance to freshwater sources rises slightly in the LP (**fig. 3**). Magdalenian sites used to be situated on steeper slopes than LP ones, a fact prob-

Means and medians for	Altitude (m a.s.l.)	Aspect (degrees from N)	Slope (degrees)	Distance to freshwater (meters)	Visible area (km²)	Open-air sites (n)	Cave and shelter sites (n)
Magdalenian sites						**18**	**28**
Open-air sites							
mean	314.56	187.59	5.25	342.22	27.38		
median	325.5	202.98	4.03	140	19.4		
Cave and shelter sites							
mean	373.93	196.99	11.19	210.14	4.26		
median	367	207.05	11.68	122.5	2.03		
All sites							
mean	353.34	193.31	8.87	256.68	13.31		
median	361	207.05	8.12	130	4.33		
Late Palaeolithic sites						**139**	**8**
Open-air sites							
mean	397.9	199.6	4	239.9	24.79		
median	413.5	204	3.3	165	18.25		
Cave and shelter sites							
mean	396.8	203	11.1	177.2	14.75		
median	357.0	207.5	12.1	140	11.73		
All sites							
mean	397.86	199.78	4.46	236.11	24.25		
median	413	204.44	3.44	160	16.6		

Tab. 1 Descriptive statistics of topographical variables of Magdalenian and LP sites in Bohemia and Moravia.

ably influenced by the preference of cave settlements often situated under steep precipices (frequent in the Moravian Karst area) in the former period (**fig. 1**).
The »steepness« of karst areas becomes evident when comparing Magdalenian cave/shelter sites and open-air sites. Magdalenian open-air sites are situated on gentle slopes, similarly to LP ones, and grant a larger visible area than cave/shelter sites. They also tend to be situated in lower altitudes than cave/shelter sites in either period, and slightly closer to streams.

Principal Component Analysis

Looking at the results for cave/shelter and open-air sites together, both similar and different trends are observable in the Magdalenian and the LP (**tab. 2**). A similar variability is observed in visible area and distance to freshwater. In other words, Magdalenian and LP hunters exploited sites close to water or farther from it, overviewing a large area or just a single valley. The aspect varied little in the two periods, probably in relation to the preferable south or south-west orientation of sites. Slope steepness seems to have been more variable in the Magdalenian, meaning that chipped stone assemblages can be encountered on rather steep slopes as well. Lower loading values for the LP indicate a growing trend for preferring gentle slopes at the sites (the role of karst areas in this matter has been mentioned above). Altitude, again, shows a higher variability in the Magdalenian and a more restricted one in the LP.
When considering cave/shelter and open-air sites separately (**tab. 3**), a slightly higher variability is evident in areas visible from Magdalenian caves when compared to open-air sites. When compared with data in **table 1**, it seems probable that the range of vision was not the most important factor when settling a cave

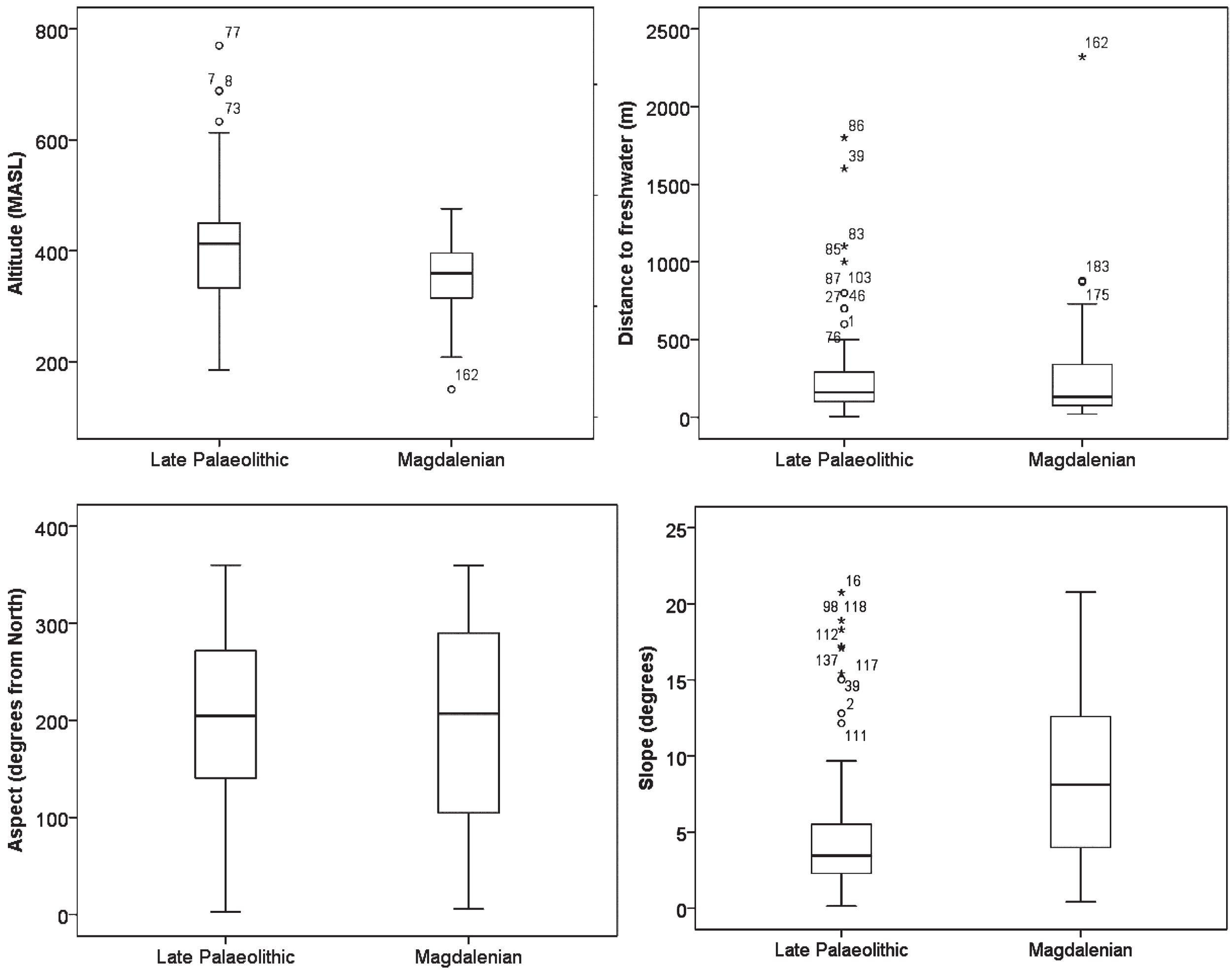

Fig. 3 Box plots of topographic variable distribution in the Magdalenian and LP. The box plots illustrate the spread and differences of samples, they show a 95 % confidence interval and standard deviation for the mean. Numbers represent sites mapped in **fig. 1**.

in the Magdalenian as the values, apart from being variable, are on average low. Greater variance could be observed in the mean distance to freshwater sources in Magdalenian open-air sites, whereas Magdalenian caves are more uniform in this matter and tend to be situated closer to water (**tab. 1**). A third major difference is the greater variability in slope steepness in Magdalenian caves/shelter sites. This may be due to the rugged relief in karst areas where Magdalenian caves in both Bohemia and Moravia are situated. The aspect of Magdalenian cave/shelter sites was highly varied (as already mentioned by Oliva 2005), and therefore obviously not too important when choosing a cave for settlement. This situation changes in open-air sites, where the southern aspect was more preferable (**tabs 1. 3**).

As for LP cave/shelter sites, the informative value of the statistics is limited by their restricted number. Major uniformity is observed in slope steepness and altitude here (**tab. 3**). Most variable are the aspect of cave sites, distance to freshwater and the area visible from them. LP open-air sites are also highly variable as regards distance to freshwater and visible area, but are more restricted when altitude, aspect and slope are considered.

Comparing Magdalenian and LP cave/shelter sites is difficult due to the restricted number of cave settlements in the latter period, reflected in the high variability in LP cave/shelter sites' topography. As for open-air sites, there is a higher variability in altitude, aspect and slope in the Magdalenian when compared to the LP, with the LP sites situated on flatter grounds, though in higher altitudes (**tab. 1**). Distances to freshwater

Magdalenian				
Principal component	Eigenvalue	% Variance		Loading (component 1)
1	1.877	37.540	altitude	-0.585
2	1.096	21.914	aspect	0.072
3	0.896	17.921	slope	-0.485
4	0.690	13.980	distance to freshwater	0.652
			visible area	0.859
Late Palaeolithic				
Principal component	Eigenvalue	% Variance		Loading (component 1)
1	1.454	29.085	altitude	-0.198
2	1.216	24.319	aspect	-0.188
3	1.031	20.612	slope	-0.017
4	0.784	15.671	distance to freshwater	0.855
			visible area	0.802

Tab. 2 PCA of topographical variables of Magdalenian and LP sites. Cave/shelter and open-air sites are considered together. Most variable during the Magdalenian was the area visible from different sites, followed by distance to freshwater, slope steepness and altitude. Visible area and distance to freshwater were most variable in the LP.

Magdalenian cave/shelter sites				
Principal component	Eigenvalue	% Total variance		Loading (component 1)
1	1.7093	34.1854	altitude	0.0572
2	1.1728	23.4562	aspect	-0.7986
3	1.0462	20.9231	slope	-0.7194
4	0.6369	12.7388	distance to freshwater	0.3898
			visible area	0.6314
Magdalenian open-air sites				
Principal component	Eigenvalue	% Total variance		Loading (component 1)
1	1.9066	38.1328	altitude	-0.6991
2	1.3036	26.0722	aspect	-0.4189
3	0.9367	18.7330	slope	-0.4831
4	0.5564	11.1275	distance to freshwater	0.8993
			visible area	0.4437
Late Palaeolithic cave/shelter sites				
Principal components	Eigenvalue	% Total variance		Loading (component 1)
1	2.782	55.632	altitude	0.412
2	1.411	28.228	aspect	-0.988
3	0.591	11.823	slope	0.303
4	0.184	3.677	distance to freshwater	0.920
			visible area	0.828
Late Palaeolithic open-air sites				
Principal components	Eigenvalue	% Total variance		Loading (Component 1)
1	1.445	28.906	altitude	-0.186
2	1.217	24.334	aspect	-0.158
3	1.045	20.896	slope	-0.018
4	0.795	15.888	distance to freshwater	0.856
			visible area	0.803

Tab. 3 PCA of topographical variables of Magdalenian and LP sites. Cave/shelter and open-air sites are considered separately. Most variable in Magdalenian cave/shelter sites were aspect, slope steepness and visible area, but altitude and distance to freshwater in Magdalenian open-air sites. LP cave/shelter sites were variable in all categories except slope steepness, whereas LP open-air sites were variable in distance to freshwater and visible area.

	Magdalenian vs. Late Palaeolithic			
Topographic variable	n(1)	M-W U test	SE	p value
altitude	193	2,323.5	330.0	0.001*
distance to freshwater	193	3,151.0	330.4	0.486
aspect	193	3,310.0	330.6	0.831
slope	193	4,983.5	330.6	0.001*
visible area	193	1,845.0	330.6	0.001*
	Late Palaeolithic vs. Expected random sample			
Topographic variable	n(2)	M-W U test	SE	p value
altitude	294	8,135.0	728.8	0.001*
distance to freshwater	294	9,102.5	728.7	0.020*
aspect	294	11,576.0	728.8	0.290
slope	294	12,006.5	728.8	0.099**
visible area				
	Magdalenian vs. Expected random sample			
Topographic variable	n(2)	M-W U test	SE	p value
altitude	193	1,935.0	330.6	0.001*
distance to freshwater	193	3,198.5	330.6	0.581
aspect	193	2,750.5	330.6	0.057**
slope	193	4,960.0	330.6	0.001*
visible area				

Tab. 4 Comparison of topographical values between Magdalenian and LP sites, LP sites and »Expected random samples« and Magdalenian sites and »Expected random samples«.
(1) 147 LP sites and 46 Magdalenian sites; (2) 147 LP sites and 147 »Expected random samples«; * observed variable is not the same concerning Magdalenian vs. LP, or LP vs. »Expected random sample«; ** is significant at the 0.10 level (slope differs between LP sites and »Expected random sample«, and aspect differs between Magdalenian sites and »Expected random sample«); n = number of sites; M-W U test = Mann-Whitney U test; SE = standard error; p value = statistical significance; if less than 0.05 (or 0.10**), there is no significant difference between two means; (3) 46 Magdalenian sites and 147 »Expected random samples«.

are comparable between the two considered periods, whereas the area visible from Magdalenian open-air sites is more uniform than that from LP sites. This latter fact, however, may be due to the restricted number of Magdalenian open-air sites as median values of visible areas are comparable in both periods.

Comparison between Magdalenian, Late Palaeolithic and identical number of »Expected random samples«

Comparing frequency distributions of »Expected random samples« and existing LP sites, significant differences of topographical values were identified in the case of altitude and distance to freshwater on a 0.05 significance level (**tab. 4**). The differences were caused by lower altitudes and lesser distances to freshwater sources in the case of existing sites. The aspect of sites might have predominantly been south (**tab. 1**), but the advantages of this orientation were probably not sufficient to be statistically significant. Slope steepness of existing sites is significantly different from »Expected random values« only on a 0.1 significance level. As for Magdalenian sites, these were preferentially situated in lower altitudes and on steeper slopes than »Expected random samples« on a 0.05 significance level. Preferential aspect (southward) is significant on a 0.1 significance level when open-air sites probably play a major role, as cave/shelter sites do not show a preferred aspect (see above).

When Magdalenian and LP sites were compared topographically, values of altitude and slope were different on a 0.05 significance level. Slope values were higher for the Magdalenian, whereas altitude was higher in

LP sites. Also the area visible from different LP sites was larger than in the Magdalenian period. Aspect of sites and distance to freshwater remained similar in the observed area throughout the Magdalenian and the LP.

DISCUSSION

Our analysis has shown that Magdalenian sites are not situated randomly in the landscape as regards altitude, aspect and slope steepness. Magdalenian hunters preferred lower altitudes on south-facing slopes (when not living in caves) when the considerable steepness of the slopes was caused by the position of cave/shelter sites in karst areas. LP sites, on the other hand, differ from »Expected random samples« in altitude and distance to freshwater source, and, if 0.1 significance level is considered, in slope steepness. The altitude remained below the »Expected values«, although LP hunters moved slightly off water streams (when median values are considered) compared to Magdalenian ones (**tab. 1**). Exceptionally, LP sites lie over 1 km or even 2 km away from the nearest water source (**fig. 3**). When sites of the two periods are compared, topographical differences are statistically significant in the settlement of higher altitudes on gentler slopes with a greater area visible (disregarding vegetation cover) from sites in the LP. Similarly, the »elevation hypothesis« (Jones 2007) of hunter-gatherers' movements to higher altitudes with a warming climate was tested for the Dordogne area at the Pleistocene/Holocene transition, where, nonetheless, this trend could not be (altogether) demonstrated. Reasons for this changing pattern in Bohemian and Moravian territory are difficult to determine, not least because most LP sites in the area are preserved as mere surface chipped stone assemblages without sufficient information on chronology, season of occupation, game species or surrounding vegetation. Warming during the Allerød period, a possible propagation of tree cover or bogs in the lowlands, with animals and people moving to more open areas, and human population density increase are possible hypotheses, and will remain so until more stratified LP sites are located and excavated to grant us more quantifiable data. Climate change, nonetheless, seems to have played a major role in the abandonment of caves at the beginning of the Allerød.

That being said, we have to stress once again the low quality of data regarding the LP of Bohemia and Moravia. Assemblages of chipped stone artefacts can be termed sites only with a significant amount of uncertainty, whereas the original position of finds is beyond reconstruction due their continuous redeposition or poor preservation conditions (Schiffer 1987; Vencl 1995b). This problem is inherent to LP sites in other parts of Europe as well (e. g. Sorokin 2006; Sulgostowska 2006). Performed statistics are also undoubtedly biased by an uneven prospection intensity in different parts of Bohemian and Moravian territory. LP research in the Czech Republic should thus focus not only on prospection in less explored areas (e. g. Ore Mountains, Slavkov Forest, Hostýn-Vsetín Highlands, High Ash Mountains), but also on the realisation of excavations in places with an increased density of surface finds. Without stratified finds, local LP research will remain a quest for stratified typological analogies in neighbouring countries.

An effort was also made to divide Bohemian and Moravian LP sites into more (106) and less (48) reliable assemblages (Moník/Eigner 2019) on the basis of the amount of preserved chipped stone industries, the presence of »fossiles directeurs«, the reliability of a publishing author or journal, and the quality of the original research. Leaving aside six sites of unknown topography, just 100 reliable LP sites would be at our disposal. The Mann-Whitney U test then comes out differently in the non-random aspect of LP sites, being of 190º, meaning a preferred south-west orientation of most sites. A comparison with Magdalenian sites, however, shows the same results for all 154 sites, i. e. significant differences in altitude, slope steepness and visibility between the sites of the two periods. If predictive analyses were to be conducted in the future,

however, it would be preferable to use just those 100 LP sites to eliminate (if ever possible) a high uncertainty of imbalanced datasets.
So far it looks most promising to look for LP sites on gentle slopes or in flat areas in higher altitudes, relatively close to water and with good control of the surrounding area. In a certain sense, this partially corroborates the often stated (though not statistically evaluated) presumption (e. g. Vencl 2013) that LP sites were situated in elevated places above valleys and confluences. As many Magdalenian cave sites in the region were (completely) excavated in the past, prospection for Magdalenian open-air sites seems more promising. These should be situated close to streams in low altitudes (about 315 m above sea level) as indicated by our analysis. Though open-air areas might seem to have been all but ignored during the Magdalenian of Moravia (Oliva 2005), recent intensive prospection identified Magdalenian sites in areas (e. g. southern Bohemia; Vencl 2013) traditionally considered empty during most of the Pleistocene (Pleiner / Rybová 1978).
The settlement of higher altitudes and a major density of sites in the LP were perhaps responsible for a more intensive exploitation of the landscape and raw material sources. That is probably why a more variable scale of chipped stone materials was now used when compared to the previous Magdalenian (Valoch 2001; Vencl 2013), and why territories (»provinces«) with a specific raw material preference appeared (Moník / Eigner 2019). A different perception of the landscape, on the other hand, led to the scarcity of long-range raw material imports in the LP (Moník / Eigner 2019).

CONCLUSIONS

A quantification of topographical variables of Magdalenian and LP sites in Bohemia and Moravia along with GIS analyses and a statistical evaluation of the data have indicated the following:

1) There was a specialised settlement pattern in both periods. This involved altitude, slope steepness, and aspect of sites in the Magdalenian, and distance to freshwater sources, slope steepness, and altitude of sites in the LP. These patterns differentiate existing sites from randomly chosen points on the map.
2) LP sites differed from Magdalenian ones not only in the almost complete abandonment of caves, but were also preferably established higher up in the landscape. This was possibly driven by the movement of game to more open areas, and the need for greater visible areas from sites, controlling surrounding landscape. The difference in altitude is evident even when just open-air sites are considered.
3) Distance to freshwater and aspect of sites did not change much in the two considered periods, although a greater variability can be observed in the LP.

At least part of the mentioned topographical differences was probably caused by changing climate during the Allerød and Younger Dryas. The significance of this change in Bohemian and Moravian territory is yet to be quantified and correlated with archaeological finds as reliable stratified LP sites are all but missing here. Although the quality of LP data from the territory in question is relatively low, the used method is promising as shown by past research (e. g. Turrero et al. 2013). We thus suggest comparing our data with topographical data of other Upper Palaeolithic cultures in the region, especially the Pavlovian and the Aurignacian.

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Summary

A quantification of topographical data of Magdalenian and Late Palaeolithic (LP) sites in the Bohemian and Moravian territory (Czech Republic) was conducted in order to analyse settlement patterns in the two periods. To achieve this, GIS analyses along with descriptive statistics, Principal Component Analysis and Mann-Whitney U test were conducted. The results have shown that there were non-random settlement patterns in both periods, different from each other. Apart from the almost complete abandonment of caves in the Bohemian and Moravian LP, the major difference of LP sites from those of the local Magdalenian is the settlement of gentler slopes in higher altitudes, and larger areas visible from LP sites. Aspect of sites and their distance to freshwater did not change significantly in the two periods.

Keywords

Magdalenian, Late Palaeolithic, Bohemia, Moravia, topography

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ALEKSANDRA RAKOCA

TWO METHODS OF BLADE PRODUCTION AMONG ARCH-BACKED POINT GROUPS – A CASE STUDY FROM THE WESTERN POLISH LOWLAND

The purpose of the paper is to investigate the lithic technology of the Arch-Backed Point (ABP) groups. The research consisted of analyses of reduction processes and morphological features of debitage. Until recently, Polish archaeology was dominated by studies which employed the dynamic technological classification, infrequently accompanied by the results of application of refitting methods, mostly related to spatial analyses. Having obtained data on the »chaîne opératoire« of two ABP assemblages by dint of the refitting method, we compared them with each other in order to demonstrate two variants of reduction sequences for blade production.

MATERIALS

The Late Palaeolithic inventories of the ABP technocomplex (*sensu* Burdukiewicz 2011; Schild 1996) that will be compared in this study came from two excavation sites: Święty Wojciech 7 (Międzyrzecz commune) and Rogalinek 1 (Mosina commune), which are located in the western part of the Polish Lowland (**fig. 1**). The principal toolkits of these assemblages consist of more or less curved backed pieces – the retouch is from one side or may be crossed – and less distinctive tools like truncated blades, end-scrapers, or burins. Unfortunately, there are no hard data to support a detailed identification of the beginning of the settlement. It should be noted that the geomorphological situation resembles those registered at most sites related to ABP groups on the Polish Lowland, in as much as these sites are typically located on sands that rarely provide stratigraphy or context for absolute dating.

The first site, i.e. Święty Wojciech, is situated on the Zbąszyń Furrow, in the eastern part of the Lubuskie Lake District (Kondracki 2009, 136-137). As regards the micro-regional scale, it is located on a dune strongly elevated above the valley of the Obra River. The slopes of the dune falls lightly toward the east and west. During the years 1997-2006 an area of 1,444 m² was excavated. Rescue excavations produced 930 features and almost 40,000 artefacts, including about 11,500 lithic materials. A preliminary analysis has revealed that this area was occupied from the Late Palaeolithic until the medieval period

Fig. 1 Location of Rogalinek 1 and Święty Wojciech 7 sites. – (Map J. Pyżewicz).

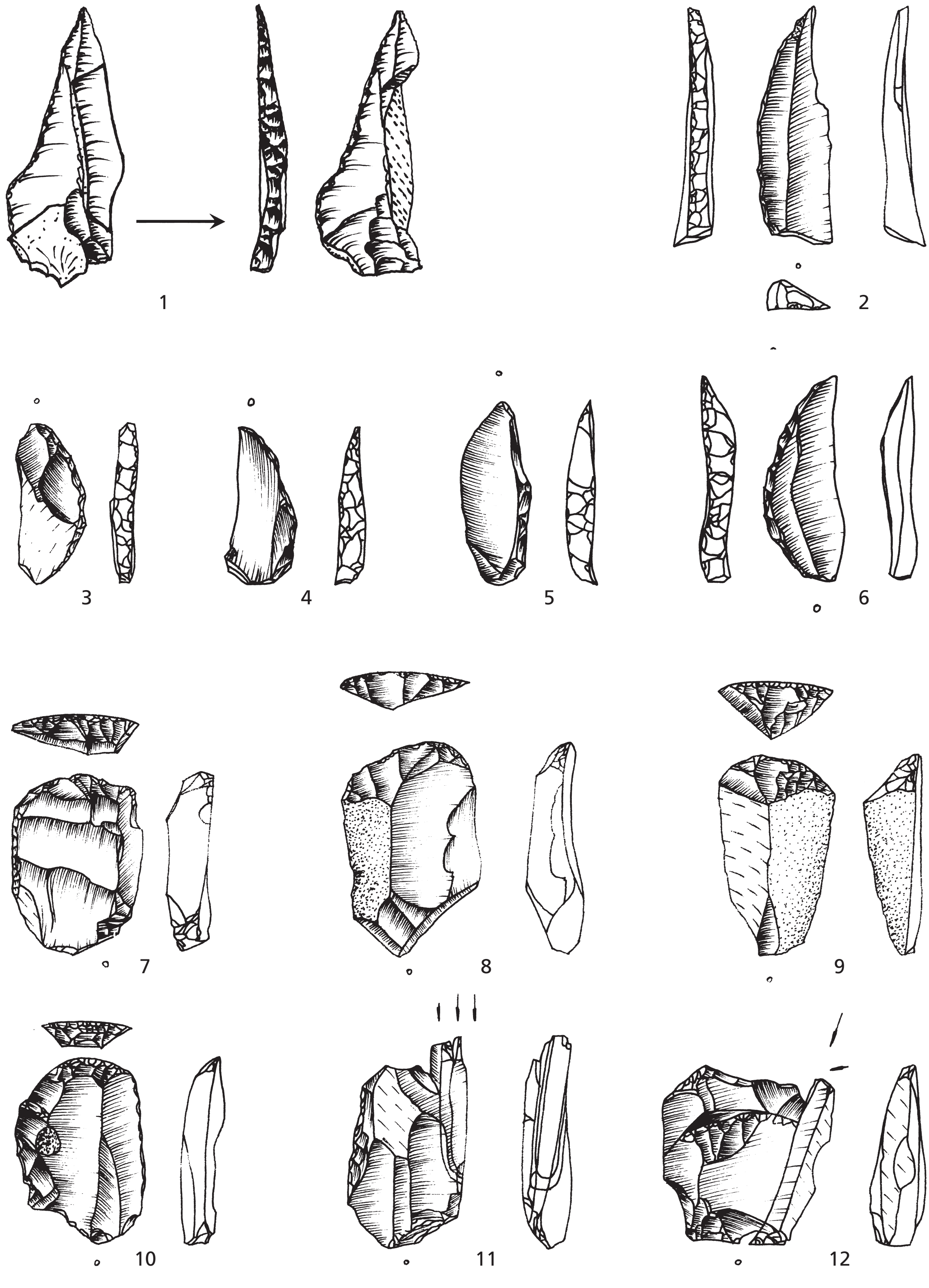

Fig. 2 Lithic tools from Rogalinek 1 (**1**) and Święty Wojciech 7 (**2-12**): **1-6** arch-backed points. – **7-10** end-scrapers. – **11-12** refitted burins. – (Drawings K. Pyżewicz, after P. Dmochowski and A. Rakoca). – Scale 1:1.

(Indycka/Łaszkiewicz 2006). The lithic assemblage related to the ABP consists of numerous slender or short arch-backed pieces, short end-scrapers, and dihedral burins, or burins on a truncation (**fig. 2, 2-12**). Debitage pieces, i.e. blades, flakes, crested blades, and cores are the most numerous group in the assemblage.

Rogalinek 1, the second site to be discussed here, is located on one of the terraces of the Warta River near Poznań, which is part of the Wielkopolska Lake District on a macro-regional scale (Kondracki 2009, 141-142). Over 800 lithic artefacts were collected during field surveys carried out in the early 20th century. The inventory of lithic materials is dominated by flakes, blades, chips, and cores. Almost all the specimens are similar in terms of technology. A few registered tool forms were limited to a backed blade (**fig. 2, 1**), truncated blade and single retouched blades. The refitting process was performed by Piotr Dmochowski, and the results of these studies were published in a separate paper (Dmochowski 2003). In order to better understand the methods of blade production among the ABP groups and to compare them, we endeavoured to reinterpret the refittings.

METHODS

In order to interpret the stages of the »chaîne opératoire«, we combined the refitting method with a morphological analysis of flint materials. We examined the morphological characteristics and macroscopic features associated with the applied technology. We analysed all refitted cores and blades along with artefacts that were similar to refitted pieces in their form and raw material variety. This group comprises almost all flint artefacts collected from Rogalinek 1 (the assemblage being fairly homogeneous) and some lithic materials from Święty Wojciech 7. Since technological and typological analyses of the assemblage from Święty Wojciech have shown that a number of artefacts were related to the Swiderian or post-Palaeolithic groups like Komornica (according to Kozłowski 2009, 354-361), these were excluded from our studies. Our exclusion of Swiderian lithics was based on technological features described in the literature (i.e. Dziewanowski 2006; Fiedorczuk 1992; Grużdź et al. 2012; Klimek 2006; Migal 2007; Przeździecki 2006; Schild 1969). More problematic was the distinction between the debitage of ABP and Komornica assemblages. Although ABP materials were present in different lithic scatters, we were able to refit some of the Late Palaeolithic tools to the blade reduction sequences. We compared the results to the lithic production strategies identified at other sites related to ABP groups.

RESULTS

The characteristics of the lithic materials from both sites clearly show them to be the remains of flint workshops, where flint knappers were focused on the detachment of blades and the production of tools. All phases, starting from preparing cores, through detaching blades and repairing processes, to the production of tools are confirmed by the refitted blocks.

All flint artefacts collected from the two mentioned sites were made from local varieties of Baltic erratic flint. The most common raw material in the Polish Lowland, erratic flint occurs in secondary deposits of the postglacial formations and is characterised by a relatively poor quality compared with the mined raw material from the south of Poland (Dmochowski 2006; Król/Migaszewski 2009). It seems that the similarities in the location of both flint workshops might have resulted from the potential lithic raw materials sources located in the vicinity.

Technological features		Rogalinek 1 number of analysed blades = 100 (100 %)	Święty Wojciech 7 number of analysed blades = 182 (100 %)
Dorsal blade faces	cortex	3 (3.0 %)	1 (0.5 %)
	two (one cortex)	20 (20.0 %)	4 (2.2 %)
	three (one cortex)	27 (27 %)	3 (1.6 %)
	two	12 (12 %)	24 (13.2 %)
	three	8 (8 %)	25 (13.2 %)
	multiplied	27 (27 %)	117 (64.3 %)
	bilaterally crested blade	0 (0 %)	2 (1.1 %)
	two (one with scars of previous crest)	3 (3 %)	4 (2.2 %)
	three (one with scars of previous crest)	0 (0 %)	2 (1.1 %)
	two (one-sided cortex, one-sided cresting)	0 (0 %)	0 (0.0 %)
	two (one-sided cresting and trimming)	0 (0 %)	1 (0.5 %)
Blade termination	straight	45 (45 %)	104 (57.1 %)
	feathered	20 (20 %)	41 (22.5 %)
	plunging	6 (6 %)	5 (2.7 %)
	hinged	18 (18 %)	28 (15.4 %)
	lack of	11 (11 %)	4 (2.2 %)
Blade profile	straight	56 (56 %)	60 (33.0 %)
	slightly curved	34 (34 %)	115 (63.2 %)
	heavily curved	6 (6 %)	2 (1.1 %)
	lack of	4 (4 %)	5 (2.7 %)
Regularity	slightly regular	100 (100 %)	100 (100 %)
	extremely regular	0 (0 %)	0 (0.0 %)
Butt	cortical/natural	14 (14 %)	9 (4.9 %)
	plain	11 (11 %)	112 (61.5 %)
	dihedral	1 (1 %)	6 (3.3 %)
	facetted	46 (46 %)	27 (14.8 %)
	winged	0 (0 %)	6 (3.3 %)
	spur/»en éperon«	0 (0 %)	0 (0.0 %)
	linear	8 (8 %)	11 (6.0 %)
	punctiform	12 (12 %)	10 (5.5 %)
	none	8 (8 %)	1 (0.5 %)
Bulb	diffuse	32 (32 %)	54 (29.7 %)
	slightly marked	21 (21 %)	32 (17.6 %)
	pronounced	34 (34 %)	92 (50.5 %)
	double	3 (3 %)	4 (2.2 %)
	»esquillements du bulbe«	11 (11 %)	13 (7.1 %)
	»éraillure«/bulb scar	75 (75 %)	125 (68.7 %)
Lip	slightly pronounced	50 (50 %)	172 (94.5 %)
	pronounced	50 (50 %)	0 (0.0 %)
Flaking angle	>90°	2 (2 %)	5 (2.7 %)
	90°	24 (24 %)	19 (10.4 %)
	71-89°	17 (17 %)	134 (73.6 %)
	<70°	51 (51 %)	8 (4.4 %)
	lack of	6 (6 %)	16 (8.8 %)
Blade preparation	unprepared	16 (16 %)	26 (14.2 %)
	abrasion/trimming	81 (81 %)	156 (85.7 %)
	lack of	3 (3 %)	0 (0.0 %)

Tab. 1 Rogalinek 1 and Święty Wojciech 7. Technological characteristics of the blades.

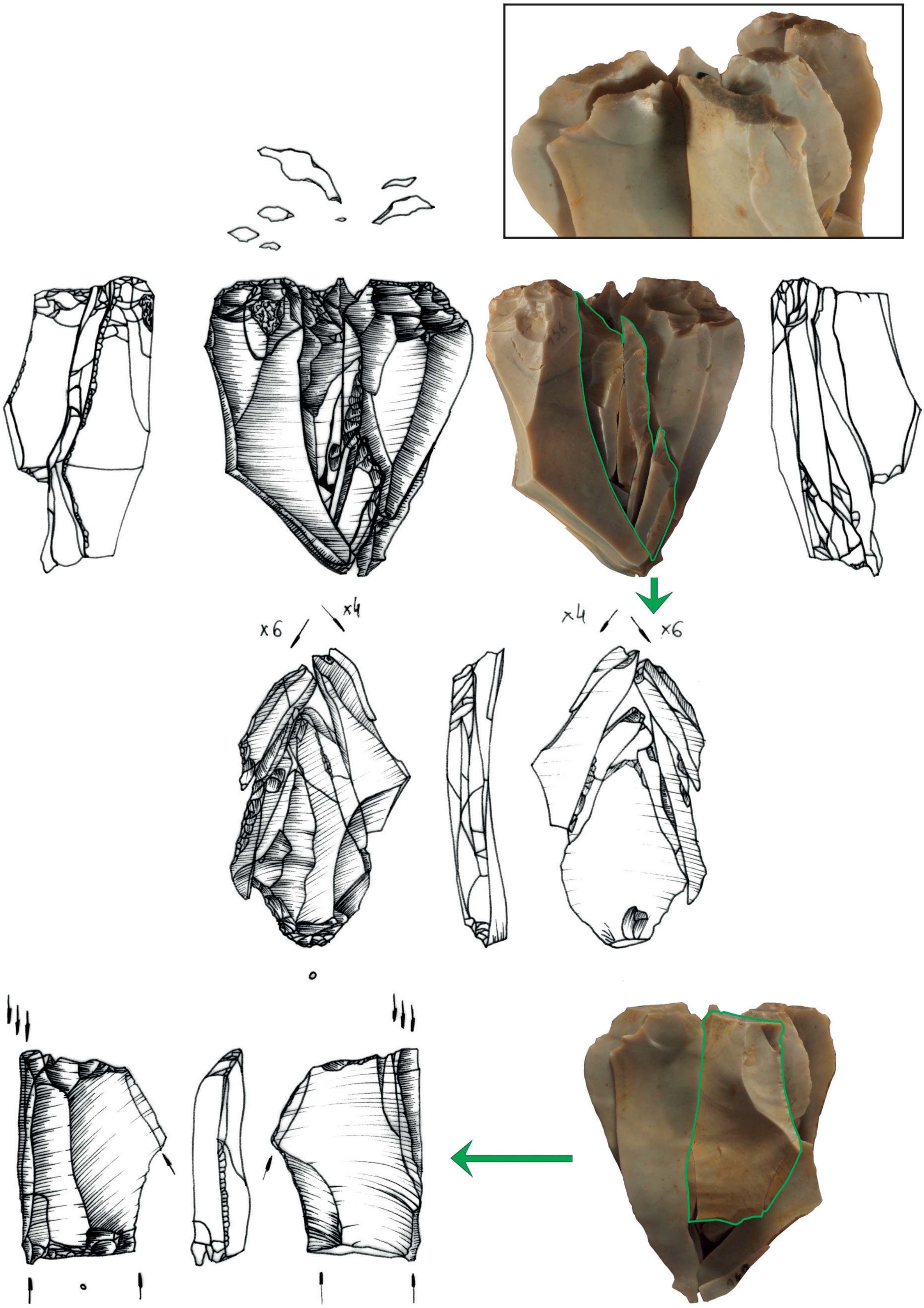

Fig. 3 Święty Wojciech 7. Refitted block, representing the first method of blade reduction (with plain butts). – (Drawings K. Pyżewicz, after P. Dmochowski; photos W. Grużdź). – Scale 1:1.

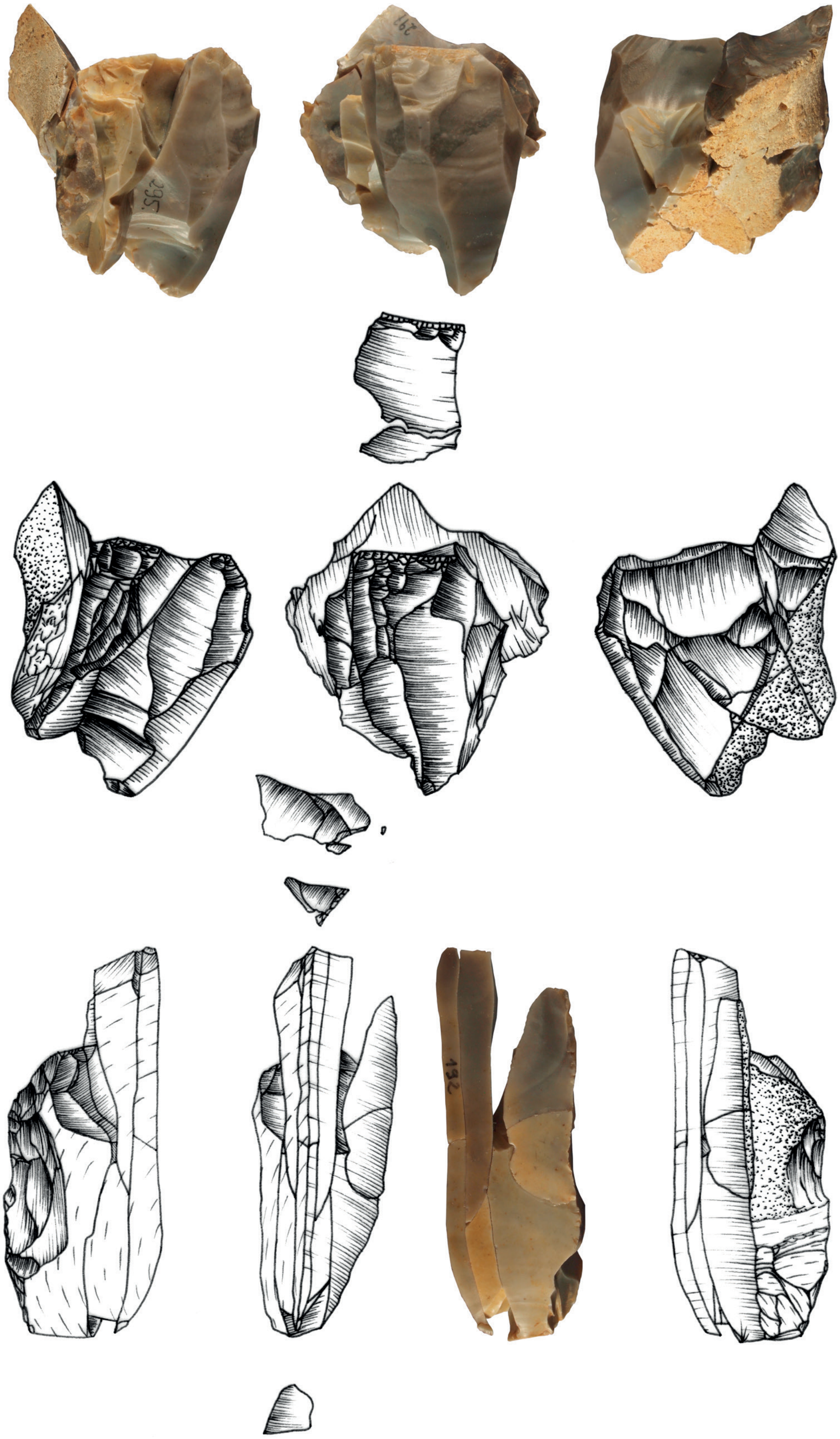

Fig. 4 Święty Wojciech 7. Refitted block, representing the first method of blade reduction (with plain butts). – (Drawings K. Pyżewicz, after P. Dmochowski; photos W. Grużdź). – Scale 1:1.

Our technological studies (**tab. 1**) have identified two methods of blade reduction in the analysed lithic assemblages. The strategies were based on direct percussion techniques with a soft or hard hammer stone and blade detachment from single platform cores or cores with changed orientation.

The first method is represented by lithics from Święty Wojciech 7 (**figs 3-4**). Characteristic features here include amorphous and massive cores and debitage products, but no advanced core preparation – this is mostly limited to the preparation of one or two striking platforms, with traces of reorientation. Occasionally, the core platform was isolated by facetting. Most of the blades' butts are plain, and striking platforms are covered by negatives of one or two flakes – facetting scars were rarely observed. Usually big butts, well pronounced bulbs with a frequent appearance of bulbar scars, lips, »esquillements du bulbe«, and radial striations demonstrate a preference for direct percussion with a hammer stone. The features mentioned above, especially the frequency of blades with »esquillements du bulbe« and lip, may also suggest use of a soft stone hammer. What seems also to be characteristic of this method is obtaining blades by applying a flaking angle of 80° or even c. 90°. These types of products were removed in both the early and advanced phases of debitage.

The method of blade production employed at Święty Wojciech can be considered as relatively simple, i. e. undemanding in terms of a high level of knapping skills and know-how. The first flakes detached from the nodules were massive and formed a platform with an acute flaking angle. Next, the cortex blades were removed from the working face of the core. There are some crested blades in the materials, albeit not many; it therefore seems reasonable to conjecture that the cresting procedure was not frequently used. Most of the blades from the advanced stage of debitage were massive and thick. We refitted some of the blades with blanks from the Święty Wojciech site that were reshaped into burins. These burins were probably extensively used at the campsite, a lot of them having been reshaped on site. In the last stage of detachment, blade cores were typically turned into flake cores.

The second method was aimed at producing blanks by soft stone percussion. Lithic artefacts indicating the use of this method were noticed in the inventory of Rogalinek 1 (**figs 5-6**). The blades from this assemblage are more regular and slender in comparison with the artefacts from Święty Wojciech. Typical for the analysed blades is the frequent occurrence of the facetting procedure. The traces of this special isolation of a platform can be noticed in both the initial and advanced stages of reduction. However, single pieces show no traces of this procedure (natural, punctiform, or linear butts). Bulbs of the analysed blanks are not as well pronounced as in the case of the assemblage from Święty Wojciech 7. We have also noticed a higher frequency of more pronounced lips and a more acute flaking angle. At the same time the presence of bulb scars, »esquillements du bulbe«, and radial striations may indicate the same type of toolkit as in the production of blanks at the Święty Wojciech 7 site.

Based on the refitted blocks from Rogalinek 1, we can conclude that the first stage of the »chaîne opératoire« was heavily dependent on the natural shape of the nodule. We have not noticed any special procedures related to cresting. Only in some cases was a rejuvenation of striking platforms carried out. It should be noted that the frequently applied facetting procedure resulted in a precise application of force. Thereby the obtained products of debitage from Rogalinek are slender and not as massive as blanks from the Święty Wojciech 7 assemblage. Although the first cortex blades in the analysed assemblage are massive and frequently exhibit a plunging termination, we believe it to have been a possibly intentional procedure applied in order to cope with a nodule's natural irregularity and at the same time aimed at shaping a more acute angle between the negative of a plunging blade and the core platform. On the level of advanced blade detachment, the blanks removed were sometimes similar to flakes – their morphology was still determined by the shape of the individual nodules. The last stages of the »chaîne opératoire« could have ended with the change of core orientation, once further detachment from one striking platform became impossible.

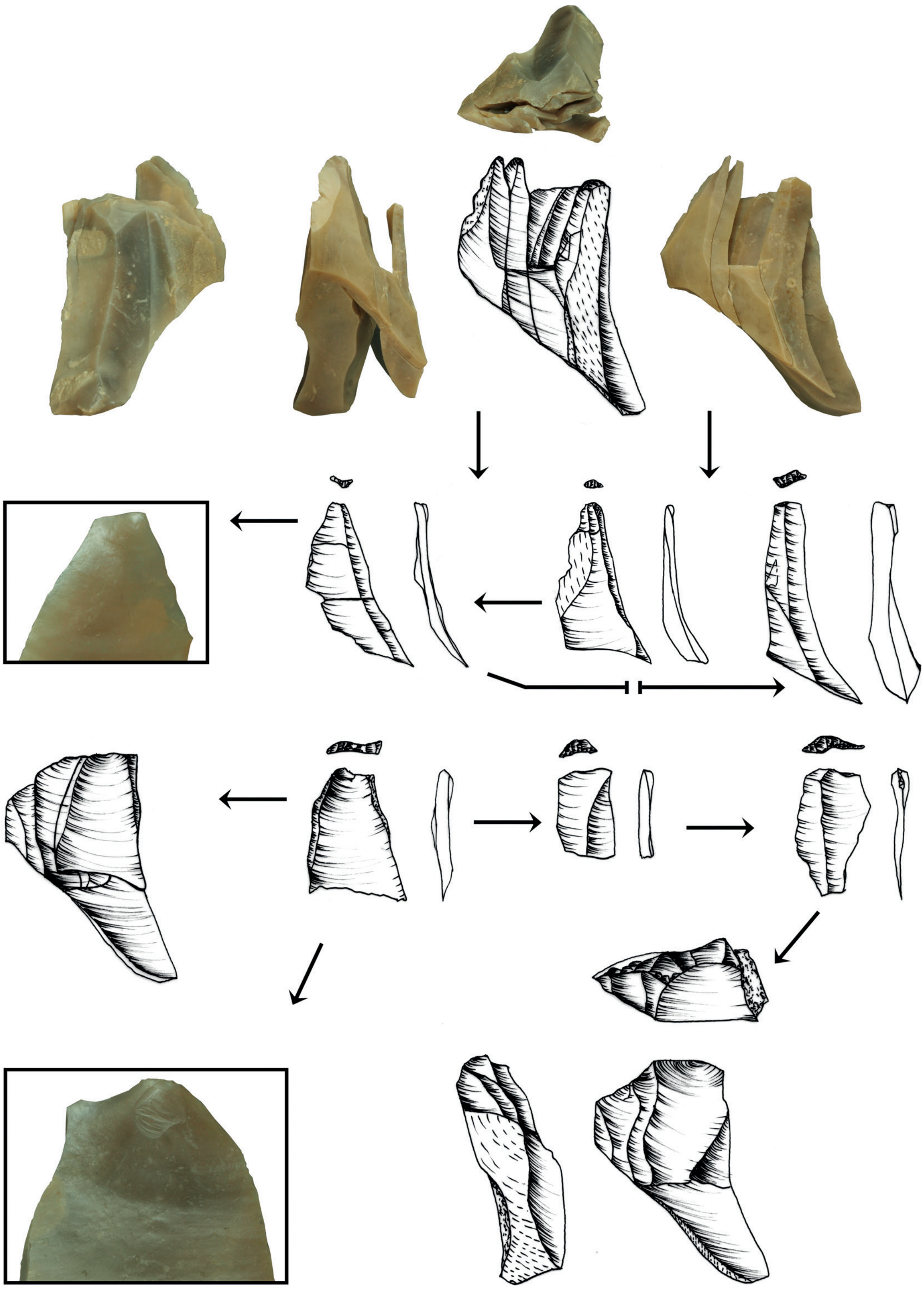

Fig. 5 Rogalinek 1. Refitted block, representing the second method of blade reduction (with facetted butts). – (Drawings A. Rakoca; photos W. Grużdź). – Scale 1:2.

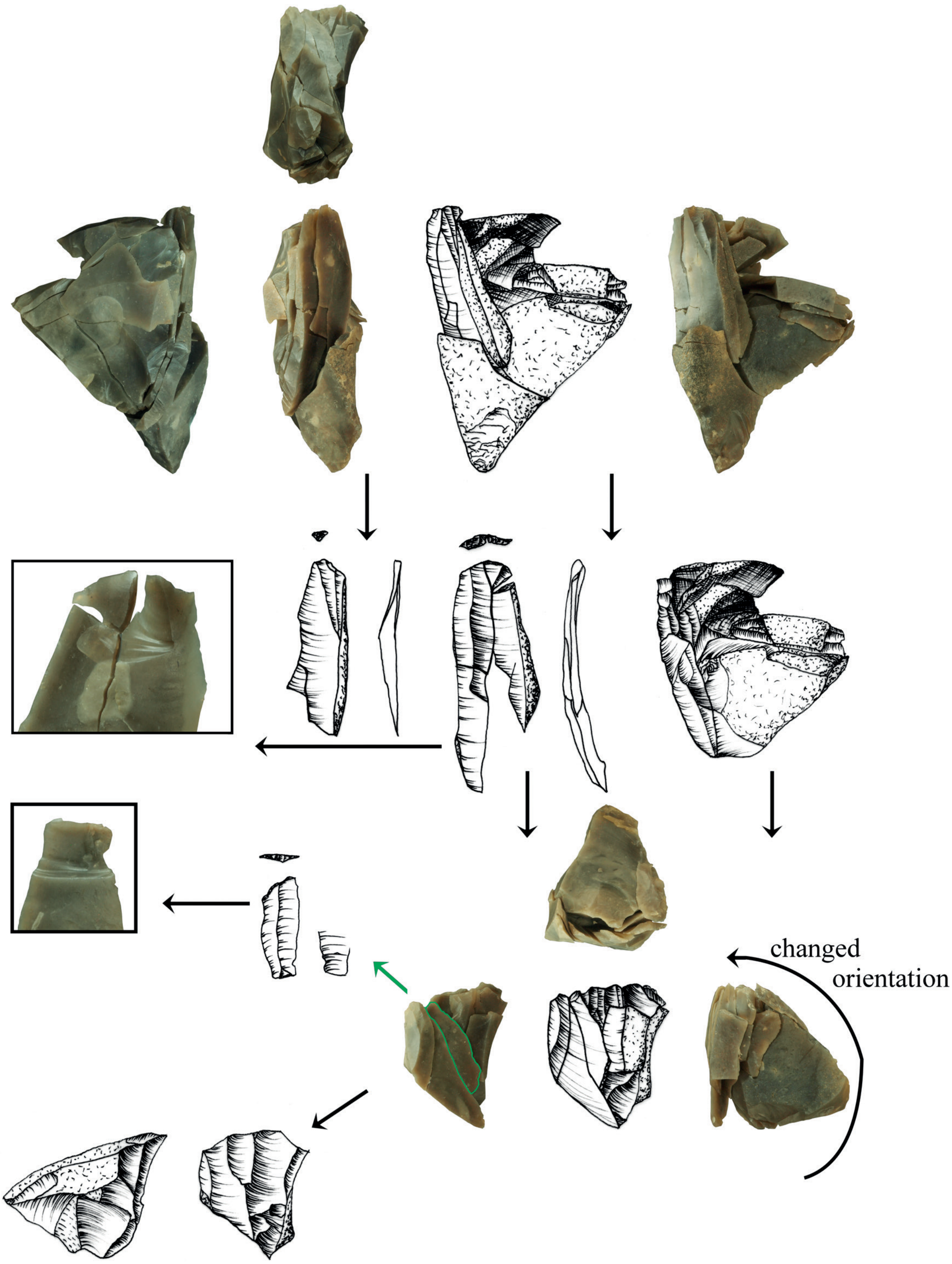

Fig. 6 Rogalinek 1. Refitted block, representing the second method of blade reduction (with facetted butts). – (Drawings A. Rakoca; photos W. Grużdź). – Scale 1:2.

DISCUSSION

The issue of the lithic technology used by groups with arch-backed points from the Polish Lowland is still not well recognised and requires further study. Thus far, the data presented in the literature regarding the methods of lithic treatment is usually limited to a few basic statements. The characteristics of this method (as presented by other researchers) include amorphous and massive cores and debitage products, a simple initial preparation mainly limited to the preparation of a striking platform by detaching one or a few flakes, the presence of single platform cores or cores with changed orientation, and the occurrence of facetting in some cases. The authors emphasise the use of a technique of direct percussion, usually with a hard hammer (i. e. Kabaciński / Sobkowiak-Tabaka 2010; Kwiatkowski / Masojć 2011; Migal 2007; Sobkowiak-Tabaka 2011, 86).

At the same time, a duality in the approach to the lithic treatment has been recently noted among the groups with arch-backed points (i. e. Pyżewicz et al. 2008). The blanks are obtained in both cases mainly from blade and flake cores with simple core preparation or the lack thereof. The recorded reorientation procedure noted in both assemblages may be interpreted in two ways – as a planned stage of the reduction, or the result of core maintenance by the reorientation of the flaking surface to the most optimal side of the nodule. The differences are visible in the preparation of core platforms. This is reflected in the morphology of blanks, which are characterised by »hard« or »soft« features of direct percussion (according to Odell 2004, 59). At the present stage of research we believe that the mentioned duality does not stem from the use of different stone hammers, but results from the application of the facetting procedure, marked by a more precise point of impact located near the edge of the core and the special kind of gesture. The detached blanks are accordingly characterised by »soft« features.

The underlying reasons for this kind of duality might include the characteristics of individual preferences of flintknappers, coupled with their experience. Alternatively, the duality might reflect two different traditions. During the studies of Late Palaeolithic flint artefacts, we noticed that the Witovian assemblages (Całowanie, lev. III and IV [Karczew commune], Witów 1 [Piątek commune], Katarzynów 1 [Zgierz commune]: Chmielewska 1978; Schild 1975; Schild et al. 2014) are typified by a less advanced lithic technology. The lithic strategy there used mainly the simplest modes of detachment; no sophisticated and well planned technological procedures were employed, and the applied technique was hard hammer direct percussion. The result of such a technology is the production of short arch-backed pieces, which are linked by some researchers to the Witovian industry situated between the Rivers Vistula and Oder. These tools are classified as curve-backed points of class II according to S. K. Kozłowski (1987). Some researchers treat Witovian assemblages as a separate cultural unit, which originated from the South European Epigravettian (Kozłowski 1987; Szymczak 2000). This interpretation could be linked to a different tradition in lithic production. It seems that the lithic materials from Święty Wojciech 7 appear to be similar to the Witovian assemblages.

Among the assemblages from Święty Wojciech 7 and Rogalinek 1 we also registered more slender and longer forms, with slightly arched backs, formed by abrupt retouch. This type of backed points is classified by S. K. Kozłowski as class I – Federmesser-type backed points, related to the local Federmesser-Gruppen (Tarnovian assemblages) in the Polish Lowland (Kozłowski 1987). These backed pieces are known mainly in the Oder Basin and only rarely in the Vistula Basin. However, the oldest analogies can be found among Magdalenian assemblages. Most researchers see the origins of the local Federmesser-Gruppen (on Polish territories) in this unit (Kobusiewicz 1999, 51; Kozłowski 1987; Schild 2014; Szymczak 2000). Usually, the presence of slender backed pieces is coupled with the occurrence of a more advanced lithic technology, associated with e. g. a facetting procedure, a phenomenon also registered in the western part of the distribution area of the Federmesser-Gruppen (e. g. De Bie / Caspar 2000; Hartz 1987; Vollbrecht 2005).

It is worth noting another ABP assemblage from Pawłów 4 (Zawichost commune), where two techniques of lithic detachment were noted on the basis of the refitting method. The site is located in the Sandomierz Upland in eastern Poland (Libera/Wąs/Zakościelna 2008). This region is characterised by the presence of rich high quality lithic raw materials derived from primary and secondary deposits, which probably, among others, affected the lithic strategy recorded at Pawłów. Almost all artefacts were made of chocolate flint. These materials are somewhat similar to those recovered from Święty Wojciech 7. However, the applied refitting method indicates a much more intense core preparation than the one registered in the assemblages from the Polish Lowland, which is perhaps related to the availability and quality of the lithic raw material. The process of blade detachment, including toolkits, and a lack of facetting to isolate the striking platform, was similar to features of the analysed materials from Święty Wojciech 7. It is worth noting that the authors of the article also recorded numerous examples of »esquillements du bulbe«, which they nevertheless interpreted as resulting from direct percussion with a hard hammer stone (Libera/Wąs/Zakościelna 2008), while we believe that a soft stone hammer was used (cf. Pelegrin 2000; Weber 2012, 39-40). Additionally, some other researchers interpret knapping characteristics of lithic materials from Pawłów 4 as an effect of direct percussion with an antler hammer applied for obtaining the blades (Migal 2007).

As we mentioned above, most of the sites located in the Polish Lowland, including those presented in this paper, are marked by a lack of preserved stratigraphy. Hence, the assemblages of ABP groups usually overlap with other settlement episodes. The identification of their lithic technology is therefore beset with difficulties. In the case of coexistence with various Late Palaeolithic lithic scatters – related to Swiderian or Hamburgian settlement – it is possible to distinguish the remains of particular lithic technologies, because the applied methods of core preparation, the techniques of blade detachment, or the use of additional procedures differ from one another (see Dziewanowski 2006; Fiedorczuk 1992; Grużdź et al. 2012; Klimek 2006; Migal 2007; Przeździecki 2006; Schild 1969; Sobkowiak-Tabaka 2011, 64. 86. 110-111; Weber 2012). However, as is for example the case with flint materials from Święty Wojciech 7, the coexistence of Mesolithic artefacts (especially those associated with the Komornica Culture) renders it difficult to identify and analyse the Late Palaeolithic blade production. The Early Holocene technology was observed in some Komornica assemblages recovered from the western Polish Lowland, i. e. sites Żuławka 13 (Wyrzysk commune), Pięczkowo 3 (Krzykosy commune), Borowo 2 (Krzykosy commune), Młodzikowo 1 (Krzykosy commune; Dmochowski 2002; 2005), Rosko 4 (Wieleń commune; Jankowska/Pyżewicz 2006), or Santocko 54 (Kłodawa commune; Pyżewicz/Rejchert/Rozbiegalski 2010). Blade production was based on single platform cores or – less frequently – on cores with changed orientation or double platform cores. The technique applied was identified as direct percussion with a stone hammer. The debitage is also marked by a not very advanced core preparation, limited mainly to the preparation of the striking platform, formed by detaching one or few flakes. This brief description indicates that in many cases the elements of both technologies can overlap. Therefore, we decided to find some differentiating characteristics of both groups (apart from the obvious differences in the typology of backed pieces and microliths). Without doubt, one of the differences is the facetting procedure, which also results in a different morphology of butts. Mesolithic blanks are typified by small, punctiform, or linear butts. We think that traces of other procedures, such as cresting and trimming, should also be taken into account while distinguishing these two chronological groups. In both analysed assemblages with arch-backed points these procedures were only marginally used, and they were not as common as in case of Mesolithic inventories. In addition, the Mesolithic artefacts are not so massive, which is evident when we have the whole series of blanks and cores from the lithic assemblage.

CONCLUSIONS

In our studies we sought to identify the characteristics of the ABP lithic technology, which differentiate this method of debitage from those used among other Late Palaeolithic and Early Mesolithic societies in the western Polish Lowland. We should note that various Late Palaeolithic and Early Mesolithic groups differed both in terms of the technology and the structure of production and distribution of blade debitage. This comment applies, *inter alia*, to the Swiderian and ABP groups, settlement remains of which usually overlap. We can observe that Swiderian flint workshops contain retouched forms and debitage products made of different types of raw materials. The group of tools includes some examples of tanged points and burins made on blanks probably produced at other sites. This is in contrast to the debitage products – these types of artefacts, even if they were deposited in the same place as the tools, were derived from another production sequence, and probably were used as replacements for a worn-out toolkit. In this case, the model of the »chaîne opératoire« involves taking lithic blades out of a workshop and using them in another place, which is confirmed by numerous refittings, i.e. from Całowanie (Karczew commune; Fiedorczuk 2006; 2014), Rydno (Skarżysko-Kamiennacommune; Fiedorczuk 1992; 2006; Schild et al. 2011), Suchodółka (Ożarów commune; Grużdź et al. 2012), Kijewo (Środa Wielkopolska commune; Rakoca 2013). Tools were not usually associated with the debitage sequences and were often made from different lithic raw material. The presented strategy involves the use of the toolkit, which was supplemented in the case of a lack of blades and retouched forms. Among the ABP groups the structure of production and distribution of blanks was quite different, typically based on the exploitation of the local raw material (i.e. Sulgostowska 2005, 57-63). More frequently we could record used tools within refitted blocks, e.g. from Rogalinek and Święty Wojciech, or from other sites located further away (e.g. Rydno: Fiedorczuk 1992; Schild et al. 2011; Tomaszewski et al. 2008), and it seems that the debitage was an effect of the strategy that focused on *ad hoc* production (in the case of burins and end-scrapers; backed blades were probably taken out from the site). We can assume that these groups either occupied one place for a longer time, or, alternatively, that they produced blanks and formed tools each time right before a given activity. Both strategies of Swiderian and ABP groups represent two totally different models of the »chaîne opératoire« and can be related to different adaptations of these societies in the Pleistocene (such as the environment, tradition, different levels of skills and knowledge, etc.). Last but not least, we should also refer to the issues of the Early Mesolithic groups. The structure of production and distribution of blank debitage in the Early Mesolithic could have been to some extent similar to that of the ABP groups, and therefore we observe similar lithic scatters. There are nevertheless differences between them as regards some elements of the applied technology and the morphology of retouched forms.

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Summary

This paper seeks to characterise the technological processes of lithic production of Arch-Backed Point (ABP) groups. The studied Late Palaeolithic inventories come from two sites, i. e. Święty Wojciech 7 and Rogalinek 1 (western part of the Polish Lowland). During the detailed interpretation of particular stages of the »chaîne opératoire« we applied a combination of refitting method and morphological analysis of flint materials. Special attention was paid to the aspect of duality in the approach to the lithic technology, as noted in the preparation of cores as well as blade production and the toolkit used for debitage. Our studies have allowed us to characterise the ABP groups' lithic technology, which makes it possible to differentiate this method of debitage from others used among other Late Palaeolithic and Early Mesolithic societies in the western Polish Lowland.

Keywords

Lithic technology, refitting method, Polish Lowland, Arch-Backed Point groups

PAWEŁ VALDE-NOWAK · ANNA KRASZEWSKA

TWO LATE PALAEOLITHIC ARCH-BACKED POINTS VARIETIES IN THE NORTHERN CARPATHIANS

The intensification of archeological research in the northern Carpathian Mountains has led to the discovery of two relatively large sites containing Arch-Backed Points (ABP) technocomplexes: Sromowce Niżne, site 1, and Nowa Biała, site 1 – both Nowy Targ district, southern Poland (**fig. 1**). Both sites are situated within small areas of radiolarite occurence, and this raw material is seen in the two assemblages, proving that it was exploited. We will present some elements differentiating backed points as well as different ways of stone processing. In view of the proposal of a classification of the ABP complexes, it may be concluded that one of those sites represents the Witow group (Sromowce Niżne), while the other indicates a link with some north-western sites of the Federmesser-Gruppen (Nowa Biała). The stratigraphy of both open-air sites is clear with artefacts gathered in eolian sediments right below the plowing layer. The sites are comparable in terms of their topographic positions: both are situated in a prominent gorge of a big mountainous river, close to the terrace's edge. This could suggest that fishing played a big role in the everyday life and diet of the inhabitants of these campsites.

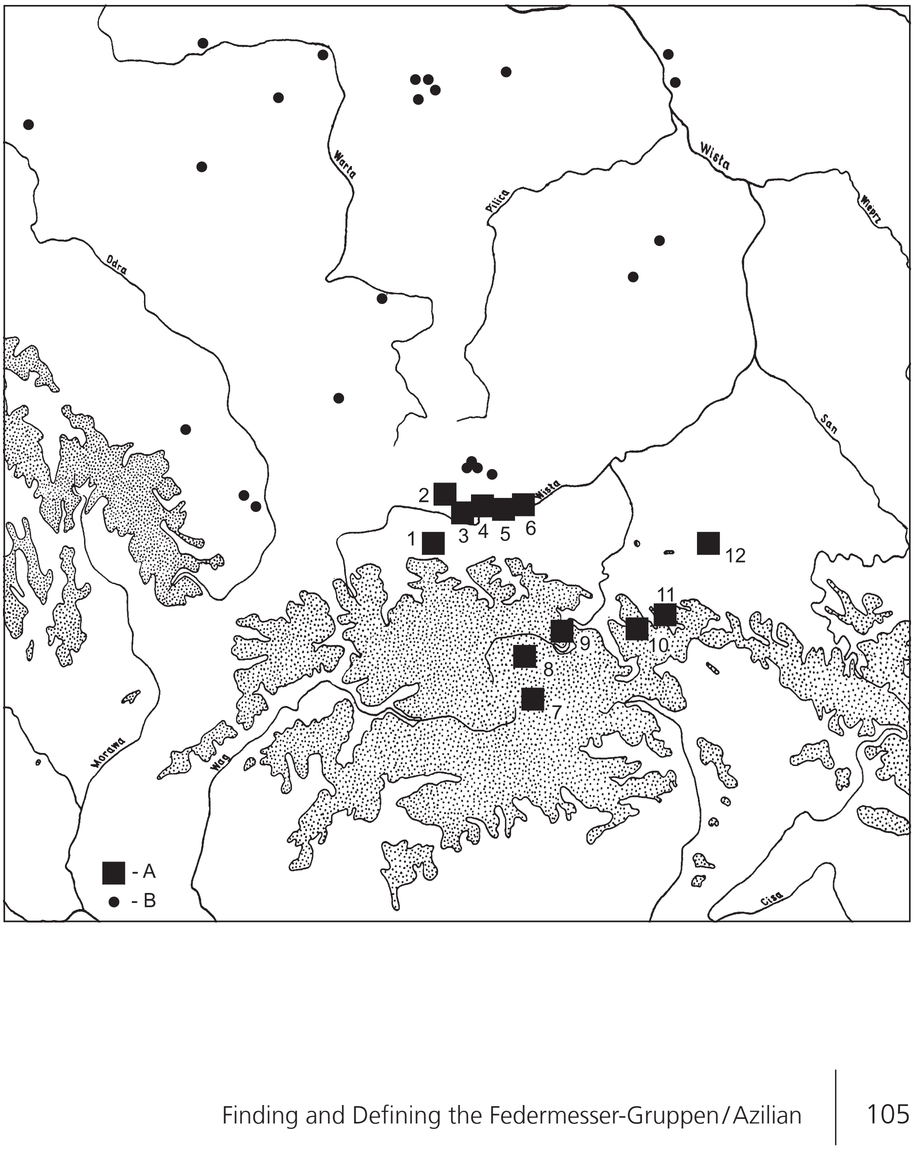

Fig. 1 ABP sites in southern Poland (after Schild 1975, with additions): **1** Zagórze. – **2** Zalas. – **3** Dąbrowa Szlachecka. – **4** Kraków-Kobierzyn, Kraków-Borek Fałęcki. – **5** Kraków-Bieżanów. – **6** Zakrzów. – **7** Sucha Diera. – **8** Nowa Biała. – **9** Sromowce Niżne. – **10** Tylicz. – **11** Skwirtne. – **12** Glinnik Górny. – **A** Carpathian and sub-Carpathian sites; **B** other sites.

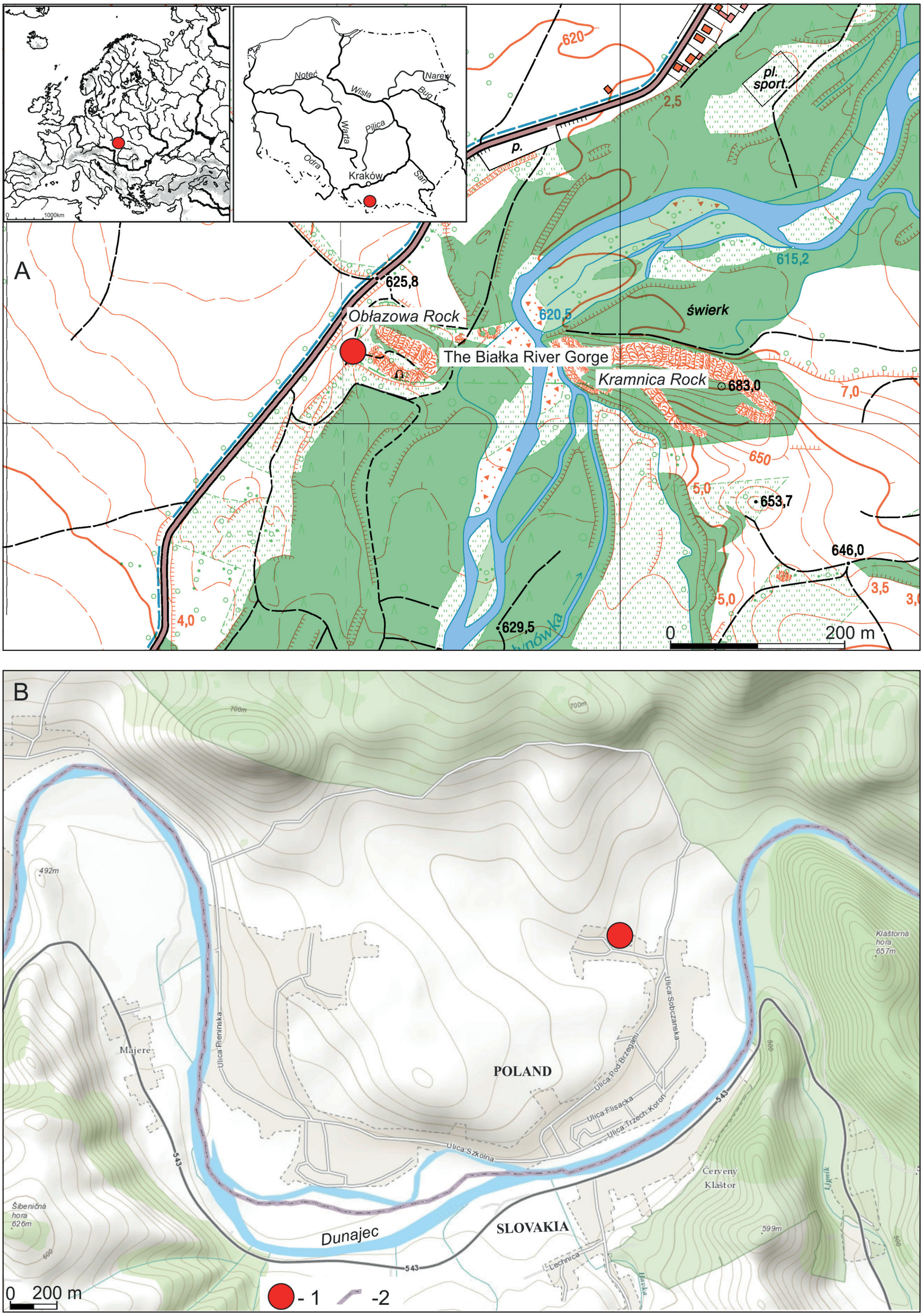

Fig. 2 Topography of ABP sites in the upper Dunajec River Basin: **A** Nowa Biała, distr. Nowy Targ, site 1. – **B** Sromowce Niżne, distr. Nowy Targ, site 1. – **1** archaeological site; **2** state border.

Fig. 3 General view of ABP sites in the upper Dunajec River Basin: **A** Nowa Biała, site 1 (arrow) with the Obłazowa Rock (670 m a.s.l.) and the Gorce Mountains (1,310 m a.s.l.) in the background. – **B** Sromowce Niżne, site 1 (arrow) seen from the Trzy Korony Peak (982 m a.s.l.), with the Slovakian river bank visible in the left upper corner. – (Photos P. Valde-Nowak).

The archaeological assemblage of Sromowce Niżne was first discovered in autumn of 1976 when radiolarite specimens needed for carrying out mineralogical and geochemical research were collected. Approximately a dozen radialorite artefacts were found then in an area of about 50 m². Their location on a high Pleistocene terrace of erosion of the Dunajec River between the mouth of the Sobczański gorge and the estuary of Macelowy Potok in the gorge of the river (figs 2B; 3B) suggested a relationship with a Late Palaeolithic hunting and fishing settlement. After some years of excavation the inventory now consists of 2,437 artefacts. The site was used for stone processing, utilising the local beds of radiolarite. The raw material spectrum of the Sromowce assemblage indicates a predominance of the red radiolarite. Among other raw materials found are Cracow-Jurassic flint, and obsidian from the territory of contemporary Slovakia or northern Hungary. The discovery of this site changed the widely held view that the mountains to the north of the Tatras were not settled until the Late Middle Ages.

The second site – Nowa Biała – was discovered in May 1985 during a local inspection of caves in the Obłazowa Rock (670 m a.s.l.) (figs 2A; 3A). More than 20 flint and radiolarite artefacts were found in Andrzej Bednarczyk's farmland during these activities.

Both sites were excavated shortly after having been discovered.

THE STRATIGRAPHY OF THE SITES

In Sromowce the artefacts lay in scattered positions in layer II, which was of a clay-dusty character and yellow-brown colour. Single artefacts were found both in arable soil and below this, in traces of root systems. The analysis of sections of the excavation trenches and geomorphological characteristics indicate a dislocation of the artefacts and change of their original arrangement, which was caused by a colluvium formation process.
The stratigraphy of the site in Nowa Biała could be identified and the following layers distinguished: I – plough soil, II – soil of a clayey-silty character, III – clay base and rock scree in the north-eastern part of the excavation. The stratigraphy of the excavations documented in 2012 partially agreed with observations made during the initial seasons of the research (1985-1986), however, layer II in the western part of the excavation area was by now completely destroyed by plowing.

A POSSIBLE DWELLING STRUCTURE AT NOWA BIAŁA

In the north-eastern corner of the excavation the remains of an oval feature with a diameter of 3 m were found. The western part of the feature had been destroyed. The outline of the feature was regular, and its maximum depth was 40-45 cm below the contemporary agricultural surface. In the eastern part a root hole was visible; in its central part traces of a hearth were observed (**fig. 4**). An AMS dating of charcoals from this fireplace was performed (see below). Few stone artefacts occurred in the fill. A concentration of stone artefacts was found in the sectors adjacent to the feature to the south. A large number of anvils, hammerstones and debitage found there allow us to interpret this place as a domestic stone-processing workshop. An accumulation of charcoals discovered there, too, has been understood as the second, outdoor fireplace.
The relationship between the flint distribution and the possible hut space represented by the feature described above is uncommon, and it is hard to find something similar among the classic dwelling structures from e. g. the Rhine or Paris Basin (Gelhausen / Kegler / Wenzel 2004). The feature recognised at Nowa Biała cannot be interpreted as a windthrow structure because of a lack of characteristic elements, e. g. two clearly distinctive parts in the profiles (Langohr 1993). Therefore, the dwelling function cannot be excluded in this case.
As it is commonly known Late Palaeolithic dwelling structures differ when compared by outline, dimensions and various other details (Leesch / Bullinger 2012; Vencl 2009).

CHRONOLOGICAL ESTIMATION OF NOWA BIAŁA

Radiocarbon dates are reported as radiocarbon years before present (^{14}C-BP) and converted to calibrated years before present (cal. BP) by the IntCal13 curve (Reimer et al. 2013) and OxCal4.2 software (Bronk Ramsey 2009). Calibrated dates are reported at their 95 % highest probability density function (pdf) unless otherwise noted.
The result of the AMS dating of charcoals from the fireplace is as follows: 11,270 ± 60 years ^{14}C-BP (Poz-53553), 11,368 cal. BC.
A series of OSL dates (courtesy of J. Kusiak and K. Standzikowski from the Faculty of Earth Sciences and Spatial Management, Maria Curie-Skłodowska University in Lublin [Łanczont et al. 2015]) were carried out for the above-mentioned root hole: 8,930 ± 540 (Lub-5500), for the filling of the dwelling structure: 11,030 ± 640 (Lub-5499), and for the geological background: 14,730 ± 850 (Lub-5502). Moreover, archaeo-

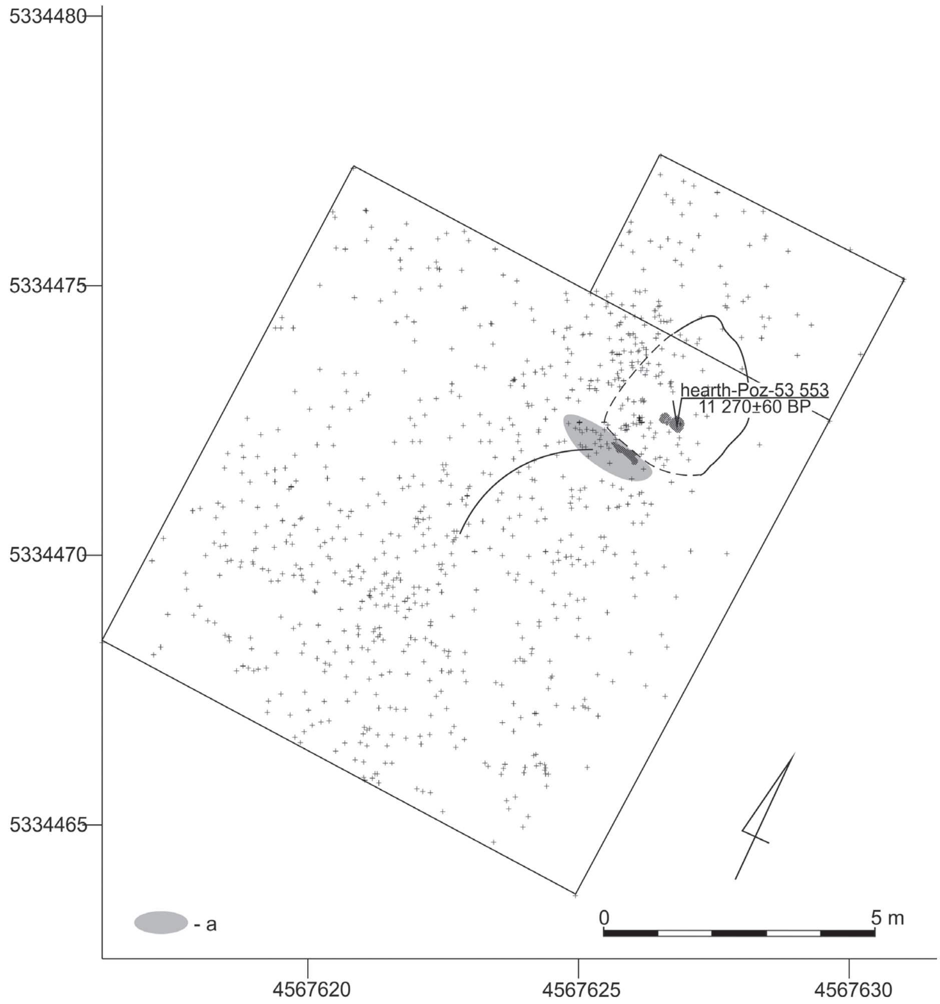

Fig. 4 Nowa Biała, distr. Nowy Targ, site 1. Plan of the archaeological trench I/2012 with marked flint artefacts (crosses) and possible dwelling structure with charcoal concentrations. – **a** small workshop.

botanical samples were taken from those sections. They confirm the presence of coniferous forests with an admixture of deciduous trees such as *alnus*, *salix*, and *betula* (Komar/Łanczont/Madeyska 2015, 503-504).

DESCRIPTION OF THE ARTEFACT INVENTORIES

The assemblage from the site Sromowce Niżne consists of 2,437 artefacts, with 1,016 items found in the years 1977-1978 (Valde-Nowak 1979), and the next 1,421 items in 1980 (Rydlewski/Valde-Nowak 1978; 1979; 1981a; 1981b; Valde-Nowak/Kraszewska 2015).

The raw materials structure can be presented as follows: Pieniny radiolarite predominates (96 %), only a few artefacts are made of other kinds of stone material (Cracow-Jurassic flint: 36 pieces; obsidian: two pieces; undetermined: six pieces).

The group of precores and cores is represented by 70 items (2.9 %), 33 of which were comprehensively analysed. The artefacts found in the years 1977-1978 were thoroughly studied. The original intention of the knappers is represented by single-platform flake cores. Among 29 complete cores found in the first two research seasons, as many as 15 are single-platform cores (fig. 5, 14-19), eleven show traces of orientation change, three are in double-platform stage. Most common are either small or microlithic irregular items or not well-used ones. The variability of shape and proportion is clear; different characteristics were somehow

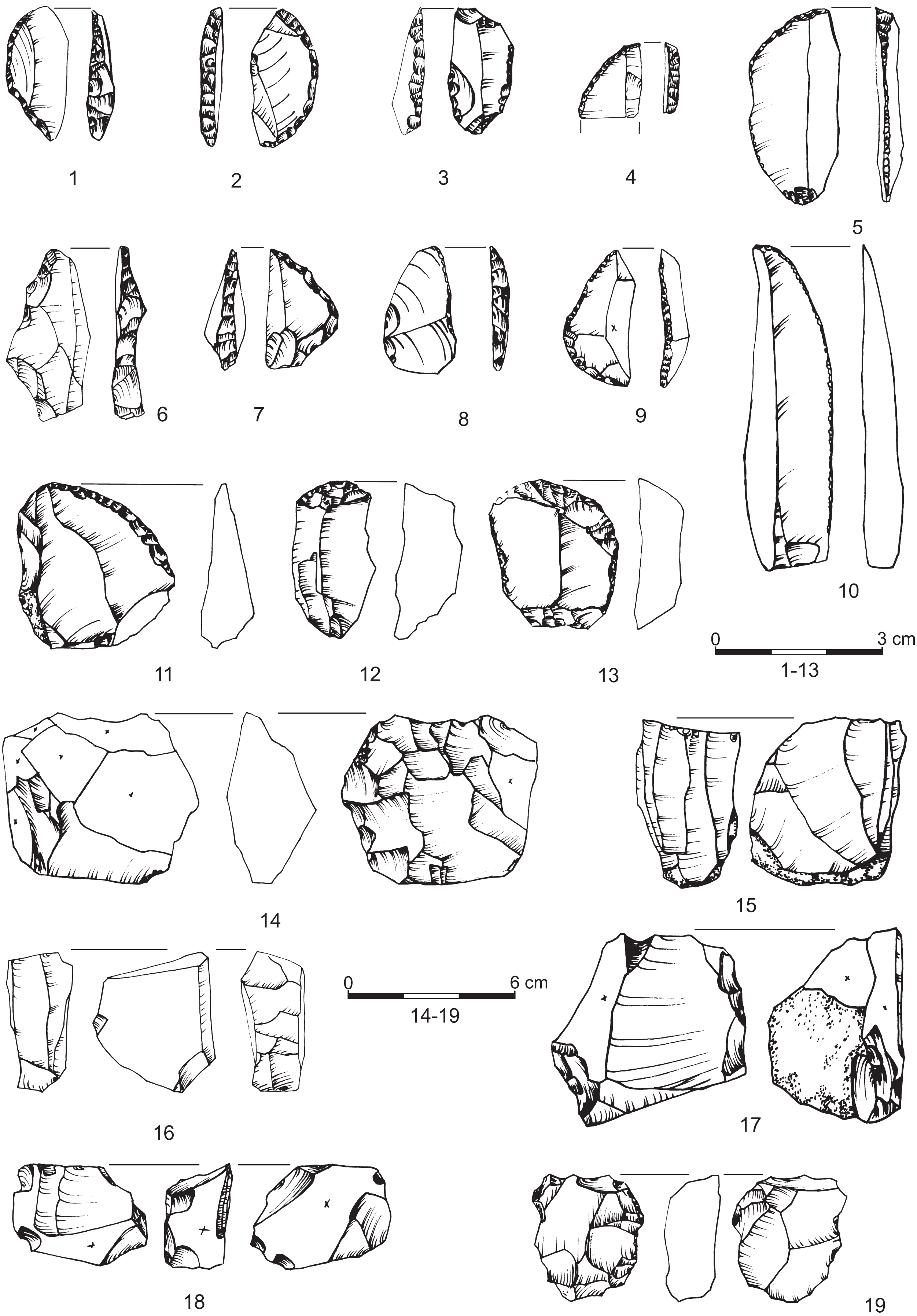

Fig. 5 Sromowce Niżne, distr. Nowy Targ, site 1. Selected stone artefacts: **1-10** backed forms. – **11-13** end-scrapers. – **14-19** cores. – **4-5** Cracow-Jurassic flint. – **1-3. 6-19** radiolarite.

caused by the specification of the raw material and the processing technique that was used. Concretions in the raw material with strong cracking and traces of a hard hammer used in many cases resulted in some unintended effects. Nine pieces show no core preparation. The uneconomical treatment of raw materials puts the studied artefact inventory closer to assemblages occurring in areas rich in raw materials.

Flakes predominate significantly in the whole assemblage (63.8 %), among which there are no cortical flakes resulting from the primary phase of the knapping. It seems that only already pre-prepared items were brought to the site. A large number of blades (total amount of blades in the whole inventory: 10.7 %, 261 items) bear some traces of intentional fragmentation, however, many breaks seem to be random.

Tools represent 8.9 % of the whole inventory. The structure of the group of tools is as follows: 64 end-scrapers (30 %), 24 arch-backed points (11 %), 29 burins (13 %), 19 truncations (9 %), eight perforators (4 %), four macro-tools (2 %), 46 retouched blades and flakes (21 %), five combined tools (5 %), two other items (1 %).

The most numerous group is composed of end-scrapers. Within this group thumbnail end-scrapers of Tarnowa type, made on flakes, predominate (**fig. 5, 11-13**).

Among the 24 backed pieces there are small and microlithic forms with arched or fully arched backs. Most of the items are complete (nine pieces). Forms with an angled back and oblique reduced base, a double angled back (**fig. 5, 3. 6**), and a semi-arched back (**fig. 5, 1**) were also recorded. Particularly interesting is one item considered as a blade with a tiny backed-like retouch on its right side (**fig. 5, 10**).

A collection of 1,702 stone artefacts were excavated from the site in Nowa Biała, and 1,321 of them lay *in situ* in layer II.

The raw materials structure for this site may be outlined as follows: Pieniny radiolarite predominates (77.44 %), some artefacts are made of other kinds of stone materials, e. g. Cracow-Jurassic flint (12.79 %), chocolate flint (6.28 %), obsidian (0.68 %), Świeciechów flint (0.08 %), and undetermined flint (0.68 %).

All in all, there are 19 cores in the whole inventory (2 %). Red radiolarite finds predominate (nine pieces), other cores are made of Cracow-Jurassic flint.

Single-platform cores, the core trimming of which was related to the preparation of striking surfaces, predominate. One of them is tablet-shaped with no traces of core preparation on the platform, another one is conical (**fig. 6, 18**).

Other cores, planned generally for blade exploitation, are characterised by one striking platform. The cores never transited into the flake stage. Two such cores were of Cracow-Jurassic flint (**fig. 6, 17**). Soft hammer knapping is documented in general.

Flakes prevail in the inventory (48 %), however, the representation of blades is also significant (22 %), especially when compared to the inventory of Sromowce Niżne 1.

Among the artefacts 144 items have been classified as tools (24 %). End-scrapers dominate the inventory (48 pieces). These items are of Tarnowa-type, small and short, made out of flakes or blade-fragments. Forms with rounded, oblique or straight working edges occur numerously (**fig. 6, 19-22**). Nine tools were classified as burins.

Backed pieces are represented by 14 items and are mostly preserved fragmentarily. During the excavations carried out in 2012 a complete arch-backed piece made of Cracow-Jurassic flint, with refracted back and oblique reduced base, was found (**fig. 6, 12**). A fragment of a massive backed piece made of Volhynian flint (**fig. 6, 3**) as well as a proximal fragment of a backed piece with notched retouch on its base, made of red radiolarite (**fig. 6, 11**), were recognised as slender forms. All these items correspond to classical forms of the Federmesser-Gruppen found in different variants of the »Penknife civilization« (Taute 1963; Schwabedissen 1954; 1973, 253). Among them there is a distinctive backed form with a straight back and notched retouch in the proximal left part formed on a blade of chocolate flint (**fig. 6, 15**).

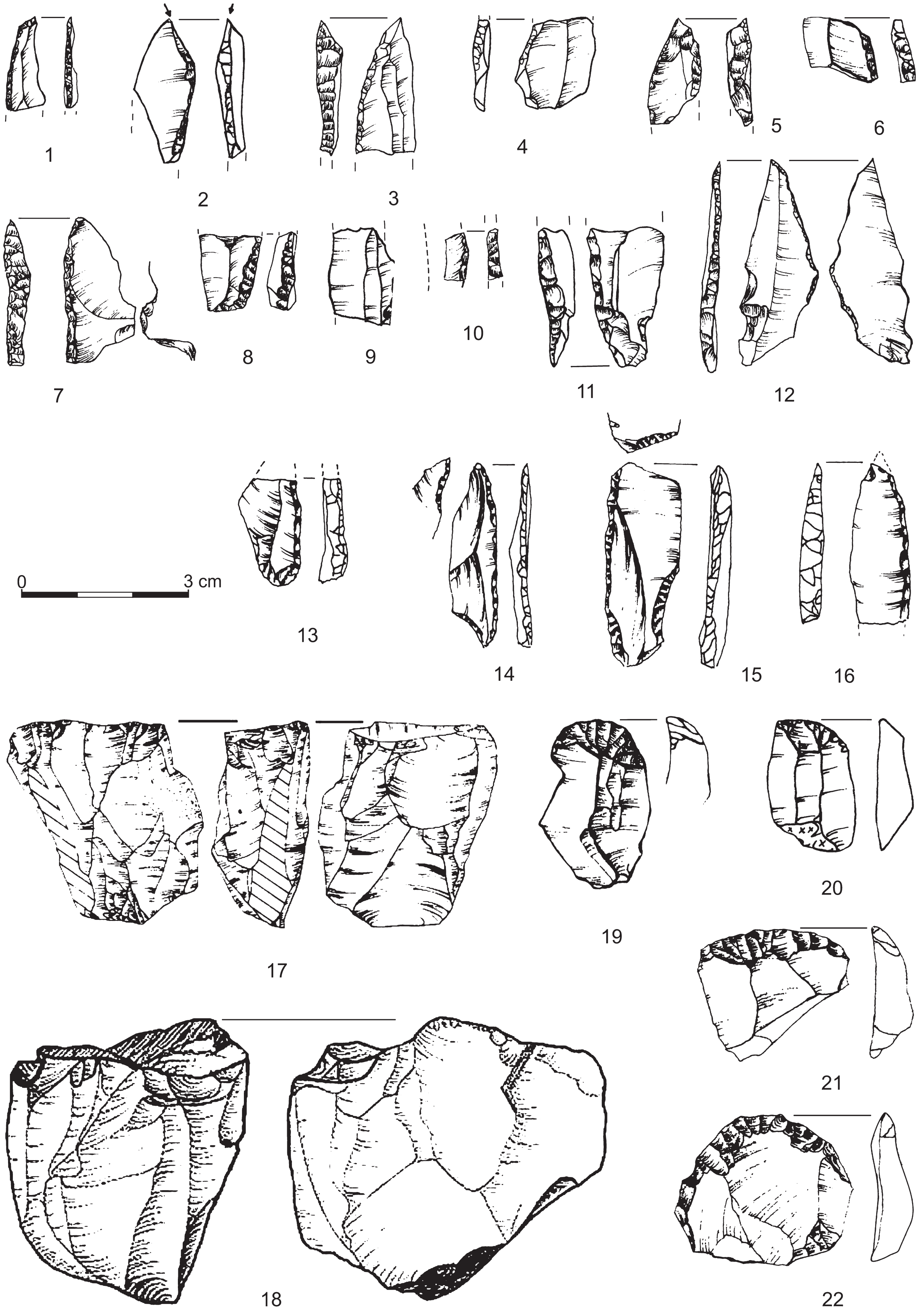

Fig. 6 Nowa Biała, distr. Nowy Targ, site 1. Selected stone artefacts: **1-16** backed forms. – **17-18** cores. – **19-22** end-scrapers. – **1-2. 5. 9-11. 14. 18. 20. 22** radiolarite; **3** Volhynian flint; **4. 6-7. 12. 17** Cracow-Jurassic flint; **13** limnoquarzite; **8. 15. 21** chocolate flint; **16. 19** obsidian.

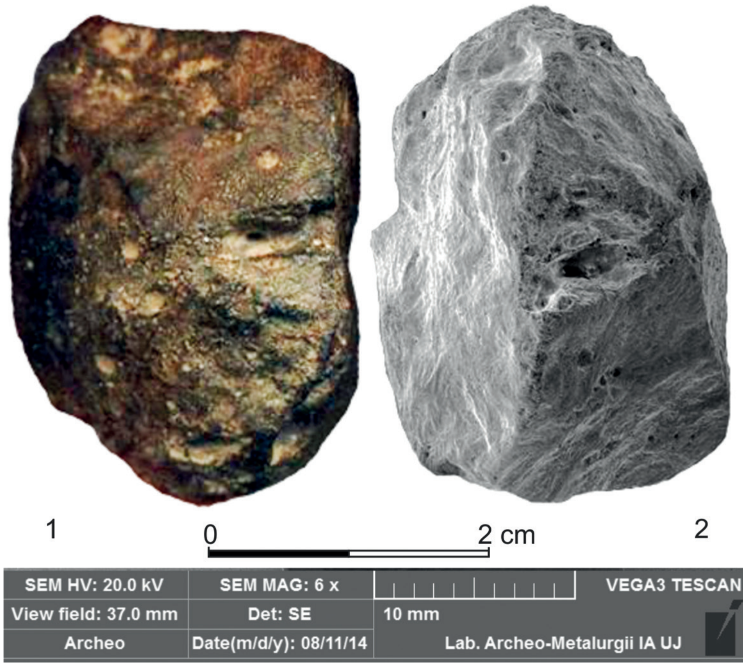

Fig. 7 Nowa Biała, distr. Nowy Targ, site 1: **1** general view. – **2** Scanning Electron Microscop (SEM) view of iron concretion found in layer II in trench II/2012. – (Photos P. Valde-Nowak [1] / M. Biborski [2]).

No thickset, ogival forms – as known from Witów and Katarzynów (Chmielewska 1978), and characteristic for Sromowce Niżne 1 – have been reported from the inventory from Nowa Biała.

Numerous hammerstones of quartz and sandstone come from the workshop situated in front of the feature (the possible hut structure) discussed above. A flat, broken retoucher, now in three pieces, comes from the first season of excavation.

A ferruginous concretion with characteristics similar to limonite was found in layer II at a distance of 3.5 m from the dwelling structure to the south-west. It bears traces of percussion working (**fig. 7**). A function of this tool as a fire striker has been confirmed (Skłucki et al. 2018). The edges of the concretion show some traces of crushing. This creates the possibility of regarding the item as an element of a tinder-box kit.

TWO CARPATHIAN ABP SITES IN A WIDER PERSPECTIVE

The regional context of both sites is particularly interesting as they are 20 km away from each other, but located within the same river basin. Moreover, it is difficult to find other assemblages in the Carpathian range that provide a context for either of the variants represented by the inventories discussed here. Very few finds of arch-backed points have been made within a radius of several tens of kilometers around the sites. Furthermore, the connection of these finds with the ABP is certain only in varying degrees.

The first site we would like to highlight in this context is the cave Sucha Diera in Slovakia. During rescue excavations a fireplace was found there and few silica artefacts; among these was one thick backed point (Soják / Harničár 1999; Soják / Suchý 2001; Soják / Hunka 2003). Two ^{14}C dates were obtained from a mountain chamois (Rupicapra rupicapra) bone: 11,620 ± 390 years ^{14}C-BP (Gd-300123), 11,230 ± 280 years ^{14}C-BP (Gd-18146). Although the dates were made on bone their relation to the settlement is not certain; however, the ranges of both dates fit well the early stage of the Allerød.

The second West Carpathian site which we believe to be important is Zagórze 2, which was examined as part of a rescue excavation connected with the construction of a reservoir dam on the Skawa River in the Western Beskidy Mountains. Amid numerous flint artefacts a fragment of a big and slender backed point was found.

It is particularly noticeable for its massive back (unpublished results of A. Kraszewska's excavations). This specimen is similar to the obsidian backed point from the Nowa Biała site, which has been shown above.
Returning to the sites Sromowce Niżne and Nowa Biała it has to be mentioned that both sites have features of base camps, most probably with a dwelling space. This is particularly important as no traces of settlements on a big river in the Central Western Carpathians have been reported prior to this discovery. In both cases the assemblage inventories may be regarded as household stone-processing workshops, because of their structure and the high number of finished tools, often with traces of intensive use.
A comparison of the lithic assemblages suggests clear differences in the case of cores and arch-backed points. Most cores from Sromowce lack any traces of preparation, except for platforms. They represent a concept of flake-blade, or just flake cores. In the case of the inventory of Nowa Biała, unlike the Sromowce lithics, the blade- and blade-flake cores prevail, often in the double platform stage.
At Sromowce the majority of backed pieces have dimensions less than 3 cm and are stout and segment-like. Thick-backed and triangular forms attract attention. It is meaningful for the reconstruction of the technological phase of the end-scraper group that the majority of these items was made of flakes and not of intentionally fractured blades.
In the case of the Nowa Biała inventory the tool index reaches 24 %. Backed points are most characteristic in the tool group. These can be further differentiated: big (over 4 cm), lancet-like specimens, and backed pieces with reduced base are present. Extremely short flake end-scrapers are typical, however, there are also numerous scrapers made of blades. The technical and typological contrast between the two inventories is very clear.
It is difficult to indicate inventories in the Carpathian range as well as in the site's neighbourhoods providing a context for the technological variants represented by the two sites described above. Only few finds of arch-backed points were made within a radius of several tens of kilometers; furthermore, their connection with the technocomplex that we focus on – the ABP – is certain only by varying degrees. In addition to these Carpathian sites as Sucha Díera in Slovakia and Zagórze in the Skawa River Basin as well as site 1 in Skwirtne, distr. Gorlice, in the Lower Beskidy Mountains (Valde-Nowak 1991; 1996), the relatively large inventories from Potoczek, site 5, in the sub-Carpathian Sandomierz Basin (Libera 2002; 2005), the complex of flint workshops at Pawłów (Libera / Wąs / Zakościelna 2008) and – discovered recently in Upper Silesia – Sowin, site 9, and Kozłówki, site 36 (Bobak / Połtowicz-Bobak 2010; Wiśniewski / Połtowicz-Bobak 2013) as well as Lubrza, site 42, and other sites in the Odra River Basin (Sobkowiak-Tabaka 2011) should be mentioned.
It is relatively easy to find analogies to the Nowa Biała 1 assemblage among the Polish sites such as the Rydno-Sahara trench II and Całowanie III sites (Schild et al. 1999; 2011; 2014). Similarities between them apply to the raw materials (radiolarite is reported in Rydno, whereas chocolate flint appears in the Nowa Biała inventory), technology and tool kits. Dwelling structures were discovered in Rydno and Nowa Biała. Sizes, shapes, profiles and southern exposure of the huts are similar. In both cases, a fireplace was situated inside the hut, and the workshop was outside.
A radiocarbon date obtained from Nowa Biała, site 1 (11,270 ± 60 years ^{14}C-BP [Poz-53553]) is close to the results known from the Całownie Level III: 11,380 ± 95 years ^{14}C-BP (GrN-5967), 11,280 ± 60 years ^{14}C-BP (Poz-5093), 11,170 ± 60 years (Poz-49027) ^{14}C-BP, or 11,020 ± 50 years ^{14}C-BP (Poz-4670) (Schild 2014, 99-100) as well as to other dates obtained from other Polish sites (Kabaciński / Sobkowiak-Tabaka 2010, 153 fig. 17). They fit the dating of GI-1c, or, in other words, they generally date just after the mid-Lateglacial Interstadial period (Weber / Grimm / Baales 2011, 278-279).
The situation is different concerning the assemblage from the Sromowce Niżne site. It corresponds rather with the materials from Witów and Katarzynów (Chmielewska 1978). The technology of flakes, forms of arch-backed points, and hard hammer processing are similar. Possible relations between this assemblage and the southern zone require further research.

There is a possibility for the observed technological differentiations to be of chronological significance. A succession from regular blade technology to flake core procedure through the time of the Allerød is well documented either from the Azilian range (Bodu/Valentin 1997), the Federmesser-Gruppen from the Rhine Basin (Baales/Street 1997, 376-377; Grimm 2014, 16) or, according to the last publication by R. Schild (Schild et al. 2011, 129-130), from the Kamienna River Basin in Poland. It may be significant because there is no absolute chronometric determination for the Sromowce Niżne inventory which could be younger than the one from the occupation layer at Nowa Biała.
The issue of arch-backed points from the Allerød Interstadial period is best understood in its two Western European variants: Azilian and Federmesser-Gruppen (Jöris et al. 2006). In Central Europe, in the Odra- and Vistula Basins, the issue of the ABP is not fully understood. Federmesser-Gruppen complexes in the western part of contemporary Poland were distinguished a long time ago (Wołczkowo, Tarnowa, Rydno IV, Siedlnica, site 17). They used to be called Tarnowan industries after the Tarnowa site in the lowland (Krukowski 1939-1948; Taute 1963; Burdukiewicz 1977; Schild 1975; Kobusiewicz 1999, 201; Sobkowiak-Tabaka 2011; 2014) or, according to the last publication by R. Schild (Schild et al. 2011, 129-193. 376-377), classic Tarnowian/Witowian. In the same work the Kamienna variant mentioned above was separated as an older phase of ABP development (Schild et al. 2011, 187-193). The discoveries from over half a century ago in Witów, Katarzynów and Całowanie let researchers realise the existence of some distinctive ABP complexes from the Allerød period in that region. Many factors distinguished them from the typical Federmesser-Gruppen, as emphasized by J. K. Kozłowski and S. K. Kozłowski (Kozłowski/Kozłowski 1975; Kozłowski 1978), M. Chmielewska (1978), and especially by S. K. Kozłowski (1987). The complexes highlighted previously by M. Chmielewska (1961) – those of the Witów type (Witowian) – were associated with the terminal Tardigravettian (Kozłowski 1978). The taxonomic set outlined in that manner is commonly accepted to this day (see Kabaciński/Sobkowiak-Tabaka 2010, 146-149; Sobkowiak-Tabaka 2011, 82-83; 2014).
The problem seen from a southern perspective leads to the following conclusion. The mentioned Tardigravettian is generally still not well recognised. Some Romanian sites, e.g. the Cuina Turcului Dubova rock shelter, document the long lasting development of the »romanello-azilien« Tardigravettian industries. The tendency to an enlarged distribution range of such elements up to the Carpathian Basin – sites Ságvár (Gábori/Gábori 1959), Jászfelsôszentgyörgy-Szúnyogos (Dobosi 2001), Páli-Dombok (Meszter at al. 2015) – and Lower Austria – sites Limberg, Horn, Kamegg (Gulder 1952; Brandtner 1954/1955) – is suggested (Cârciumaru 1999, 182-183). However, in the territory of the Carpathian Basin these issues have not been studied sufficiently, and regional variants of the Epigravettian are poorly understood (Eichmann 2004, 165).

FINAL REMARKS

The two described ABP assemblages differ significantly from each other. This is even more interesting since both sites are just 20km away from each other and situated in the same river basin and homogeneous landscape formation. Moreover, it is difficult to indicate inventories in the Carpathian range providing a context for either of the variants represented by the two sites. Only few further finds of arched points were made within a radius of several tens of kilometers; furthermore, their connection with the ABP technocomplex is not certain. Both sites have features of base camps, most probably with a possible dwelling each, both are situated on a big river in the Central Western Carpathians, where no traces of such settlements have been reported so far. In both cases the assemblage inventories may be regarded as household stone-processing workshops. Aside from such remarks in our opinion the above-mentioned strong differentiations cannot be explained by special tasks, function, hunting strategies or a stylistic drift of toolmaker manufactures alone.

If we evaluate the natural conditions during the two last phases of the Pleistocene in this region, two elements contrast with the situation known from the lowland. The first is the composition of the vegetation. Both in the Allerød as well as in the Dryas III pine-spruce forests developed initially in the northern Carpathians, with an advance of hazel and elm. Only during the Dryas III period did the forest line decrease to an altitude of 600-700 m a.s.l. In the Allerød the forest line reached again its former higher position, documented at the altitude of around 1,150 m a.s.l. (Koperowa 1961; Obidowicz 1990; Hrynowiecka-Czmielewska 2009). This means that during the whole Late Palaeolithic stage dense forests developed here, which is in strong contrast to the plant cover in the lowlands.

The second element comprises of easily accessible and differentiated beds of silica rocks, which allowed a definition of Carpathian raw material provenances (Valde-Nowak 1995; 2013).

The value of the findings from Sromowce Niżne and Nowa Biała is also emphasised by their geographical location. Firstly, they prove that the ABP also embraced mountainous landscapes, in this case the Tatra and the Pieniny Mountains, with their characteristic climate and fauna. Secondly, intensive studies of the discovered inventories will allow us to better define a south-eastern boundary of the area penetrated by the population of the Federmesser-Gruppen. Thirdly, the finds provide new information for the discussion about the scale of presumed southern (Epigravettian) influences on ABP communities developing in the European Lowland in the Allerød period.

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Summary

The issue of arched-backed points from the Allerød Interstadial period – the Arch-Backed Point (ABP) technocomplex – is best understood in its two Western European variants, the Azilian and Federmesser-Gruppen. Intensification of archeological research in the northern Carpathian Mountains has led to the discovery of two relatively large sites of this technocomplex. Our aim is to focus on them as each one represents a different technological and typological variant.
Both sites are situated within small areas of radiolarite occurence, and this raw material is seen in the two assemblages, proving that it was exploited. Some elements differentiating backed points as well as different ways of stone processing are presented. In view of a proposal of a classification of the ABP complexes, it may be concluded that one of these sites represents the elements that were formerly classified as Witovian, while the other indicates a link with the Federmesser-Gruppen.

Keywords

Arch-Backed Points, Late Palaeolithic, Carpathians, radiolarite

IWONA SOBKOWIAK-TABAKA

SIMILAR, YET DIFFERENT. THE ARCH-BACKED PIECE TECHNOCOMPLEX IN POLAND

The 13th millennium BC saw the onset of »azilianisation« – cultural transformations in North-Western and Central Europe marking the transition between the Upper and Late Palaeolithic. Best documented at archaeological sites in the Paris Basin (Bodu et al. 2006), this process spanned nearly the whole of Europe. »Azilianisation« was generally marked by the substantial simplification of the knapping technology and hunting toolkit, characterised by the presence of a variety of arch-backed pieces and short end-scrapers on flakes, in Polish archaeological research known as Tarnovian end-scrapers. Considerable regional variation in flint inventories along with a wide chronological span of their occurrence prompted the identification of several units in the rank of cultures, groups or types: Azilian, Federmesser-Gruppen, Tarnovian Culture, Witovian Culture, Kamienna variant, Penknife Point phase, Hengistbury Head type, Curved-Backed Point groups, Arch-Backed Point technocomplexes (ABP), Ostroměř group, and Tišnov type. Assemblages related to the groups mentioned above have been uncovered throughout vast areas of Western Europe (including the British Isles) and Central Europe (Barton 1991; Bodu / Valentin 1997; Burdukiewicz 1987; 2011; Kabaciński / Sobkowiak-Tabaka 2010; Kaminská 2007; Pettitt / White 2012, 477-489; Schild et al. 2011, 125-130; Svoboda et al. 2002, 244; Vencl 2007), and are reported to occur as far east as western Russia (Zhilin 1996).

The first part of this paper gives a general overview of ABP settlement in Poland. It lays down the main criteria for identifying particular ABP groups, and discusses associated methodological issues and factors possibly determining the typological differentiation of flint artefacts. I shall then attempt to provide an explanation and interpretation of the ABP's considerable diversity.

THE ABP IN POLAND

Archaeological evidence of ABP settlement in Poland was first identified before the Second World War at the site of Tarnowa (Pyzdry commune), which was discovered in the early 1920s by Józef Kostrzewski (**fig. 1**). The analysis of the lithic inventory led Stefan Krukowski to link the materials with the Azilian industry. Having included also the inventory from Grzybowa Góra (Skarżysko Kościelne commune), Krukowski defined the so-called Tarnovian industry (Krukowski 1939-1948, 92). W. Taute (1963) included the inventories from Tarnowa, Grzybowa Góra, Witów (Piątek commune), Siedlnica (Wschowa commune) and Krzekotówek (Kotla commune) into the Federmesser-Gruppen as »Tarnowa Group«.

At present, three groups in the rank of »archaeological cultures« or »technocomplexes« (Federmesser-Gruppen, Tarnovian group, and Witovian group) are believed to have been related to the ABP tradition in Poland. Their variants are sometimes distinguished, mostly on the basis of morphological analyses of assemblages, the appearance of single tool types and sometimes differences in the proportions of certain groups of tools (**tab. 1**). However, the terms »Arch-Backed Piece Technocomplex« (Schild 1984; 2014; Schild et al. 2014) or »Arch-backed Point Technocomplex« (Burdukiewicz 2011) are most commonly used as generic terms.

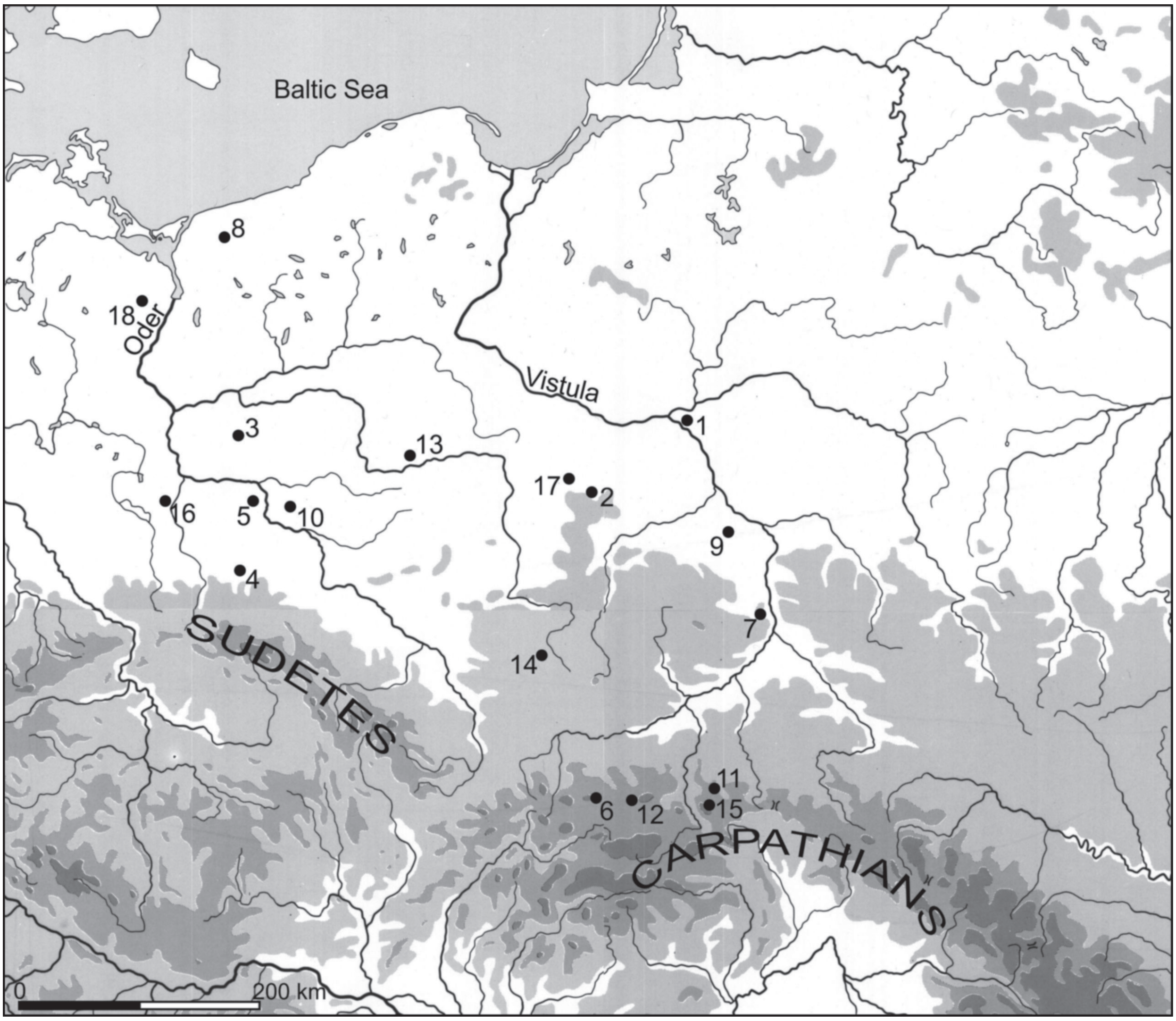

Fig. 1 Map showing the extent of the settlement of the ABP technocomplex in Poland with its most important sites: **1** Całowanie. – **2** Katarzynów. – **3** Lubrza. – **4** Nowa Wieś. – **5** Niedoradz. – **6** Nowa Biała. – **7** Pawłów. – **8** Rotnowo. – **9** Rydno. – **10** Siedlnica. – **11** Skwirtne. – **12** Sromowce Niżne. – **13** Tarnowa. – **14** Trzebca. – **15** Tylicz. – **16** Węgliny. – **17** Witów. – **18** Wołczkowo. – (Map A. Tabaka).

Since the 1960s, two or even three hypotheses on the origin of ABP groups in Poland have been considered plausible. The origin of the ABP is sought, for example, in an influx of people from the Federmesser-Gruppen of the North German Plain (Schild 1975, 255-256), in an influence of Tardigravettian communities (Kozłowski/Kozłowski 1977, 170), or of the communities occupying the western part of the Russian Plain through the Belarusian and Ukrainian ABP groups (Chmielewska 1978, 116-118).

According to J. K. Kozłowski and S. K. Kozłowski (1975, 254), the Federmesser-Gruppen were genetically related to the upland Magdalenian settlement of western Germany and Switzerland. The authors nevertheless questioned the relationship between the Witovian group and the Federmesser-Gruppen, since the inventories of the former lack the characteristic large end-scrapers. This concept was later developed in detail by S. K. Kozłowski (1987; 1992), who argued that the Witovian Culture was affiliated with the Tardigravettian circle developing in the region of the Carpathians and the Balkans.

The dating of the youngest Epigravettian assemblages in the area of the Carpathian Basin varies between the 14th and 12th millennium cal. BC (Lyngel 2009, 243). Three sites, Jászberény, Kiskúnság, and Szekszárd,

Name	Eponymic site / most important sites	Typical artefacts	References	Remarks
Federmesser-Gruppen	Siedlnica (Wschowa commune, Lubuskie Province), Wołczkowo (Dobra commune, Zachodniopomorskie Province)	great variety of backed pieces; backed blades; end-scrapers on blanks, often doubled, also short ones; different kinds of burins	Schild 1975; Burdukiewicz 1987	See **fig. 2**.
Tarnowa Culture (Tarnovian)	Tarnowa (Pyzdry commune, Wielkopolska Province)	short end-scrapers, so-called Tarnovian end-scrapers; burins are rare; different types of backed points; blade blanks	Krukowski 1939-1948; Sulgostowska 2005; Sobkowiak-Tabaka 2012	The homogeneity of the inventory seems highly questionable owing to the way the materials were sorted into earlier and later ones (the raw material criterion, more than 80 % specimens cannot be assigned to a specific flint concentration) – cf. Sobkowiak-Tabaka 2012. See **fig. 2**.
Witów Culture (Witovian)	Witów (Piątek commune, Łódź Province), Katarzynów (Zgierz commune, Łódź Province)	Epigravettian type of flint production; a very small number of greatly varied backed pieces, not unlike segments (»bipointes«); dominance of small end-scrapers; various types of burins; flake blanks	Chmielewska 1961; 1963; Kozłowski 1987	See **fig. 3**.
Classic Tarnovian / Witovian / ABP	Rydno (red ochre quarry and socio-economic centre), Holy Cross Mountains	blade and flake cores with single and opposed striking platforms; hard hammer technique of flint knapping; blanks and tools are often thick and short	Schild et al. 2011	The Rydno settlement complex yielded nearly 50 inventories with arch-backed pieces.
Kamienna variant	Rydno (red ochre quarry and socio-economic centre), Holy Cross Mountains	single platform blade/bladelet cores, often conical or sub-conical and with changed orientation; opposed platform cores are rare – late Magdalenian »inspirations«; exploitation of cores by direct percussion with a soft hammer (soft stone, antler, hard wood?), and sometimes hard hammer percussion; elegant regular elongated blades or bladelets; tools: elongated arch-backed pieces, including segments; straight-backed, short burins resembling the »Lacan variant«	Schild et al. 2011	The Rydno settlement complex yielded nearly 50 inventories with arch-backed pieces; see **fig. 4**.

Tab. 1 Characteristics of Polish ABP groups.

are deemed to be of Allerød age. Yet, they are located in wind-blown areas, and the radiocarbon determinations of their age, placing them in the second half of the 11th millennium, were obtained in the 1960s and are marked by huge standard deviations (500-1,200 years!) (Dobosi 1999, 307-313). The Szekszárd materials are believed by some archaeologists to be of Mesolithic origin (Kertész 2002). At the same time, the area of Slovakia has not yielded any radiocarbon-dated Epigravettian sites from the period after the Last Glacial Maximum (Kaminská 2007, 112-114). It seems that this dating issue still needs to be addressed; the least we can do is acquire well-dated assemblages.

The idea of an »eastern« origin of ABP groups dates back to the 1940s. The possibility that the Tarnovian assemblages might have been linked to the inventories from the Upper Palaeolithic sites of the Dnieper River Basin was originally put forward by S. Krukowski (1939-1948, 93). In the 1960s, M. Chmielewska (1961) presumed that the Witovian inventories were related to the Crimean assemblages with backed bladelets and points of the Shan-Koba Culture. More recent studies, however, suggest a much younger age of these assemblages, dating them to the period from the end of the Younger Dryas until almost the end of the Preboreal (Janevic 1999).

Given the almost total lack of ABP sites east of the Vistula River Valley (Kobusiewicz 1999a, 51; 1999b, 202), some researchers question the validity of the statement that ABP communities had their roots in the western part of the Russian Plain. Besides, with the exception of one excavated site with a poor inventory, only single specimens of backed pieces have been registered in the course of surface surveys, mostly as stray-finds or in heterogeneous inventories (Sulgostowska 1989, 63; Libera 2002, 205-209).

ASSEMBLAGES

In general, ABP inventories from Poland are typified by the presence of single and double platform cores for blades, which were exploited using a soft-hammer or punch technique. Also included are single and double platform cores for flakes, frequently with changed orientations, which were worked using a heavy hammer technique. The striking platforms were usually formed with one blow (Schild 1984, 204; Libera/Wąs/Zakościelna 2008). The aim of lithic reduction was to produce thick and short flake blanks with extensive bulbs and distinct butts, and also wide and thick blades.

Inserts, very characteristic tools in ABP assemblages, include numerous large and very long backed points of the Federmesser-Gruppen type, along with straight-backed pieces and backed pieces with truncated bases. There are also very small and very diverse backed pieces similar to segments (Kozłowski/Kozłowski 1977, 172). Slender, pointed pieces with arched backs, which are quite large in size, occur in considerable numbers (Schild 1975). End-scrapers and burins make up roughly equal groups. Most numerous among end-scrapers are Tarnovian forms, i.e. short, sturdy end-scrapers on flakes. Slender end-scrapers are infrequent. Burins are typically large and sturdy.

Typical artefacts for individual entities distinguished in present-day Poland are characterised in **table 1** and illustrated in **figures 2-4**.

Found in the village of Węgliny, a single-row harpoon made from an ungulate (*Cervidae* or *Bovidae*) metapodial is one of two radiocarbon-dated artefacts made of organic material. This artefact is chronologically related to the Federmesser-Gruppen (Cziesla/Masojć 2007). The other one is an artefact made of elk antler (*Alces alces*), with an ornamentation composed of engraved zigzag lines and a geometrical human figure, found in calcareous gyttja in Rusinowo (near Świdwin, Pomerania).

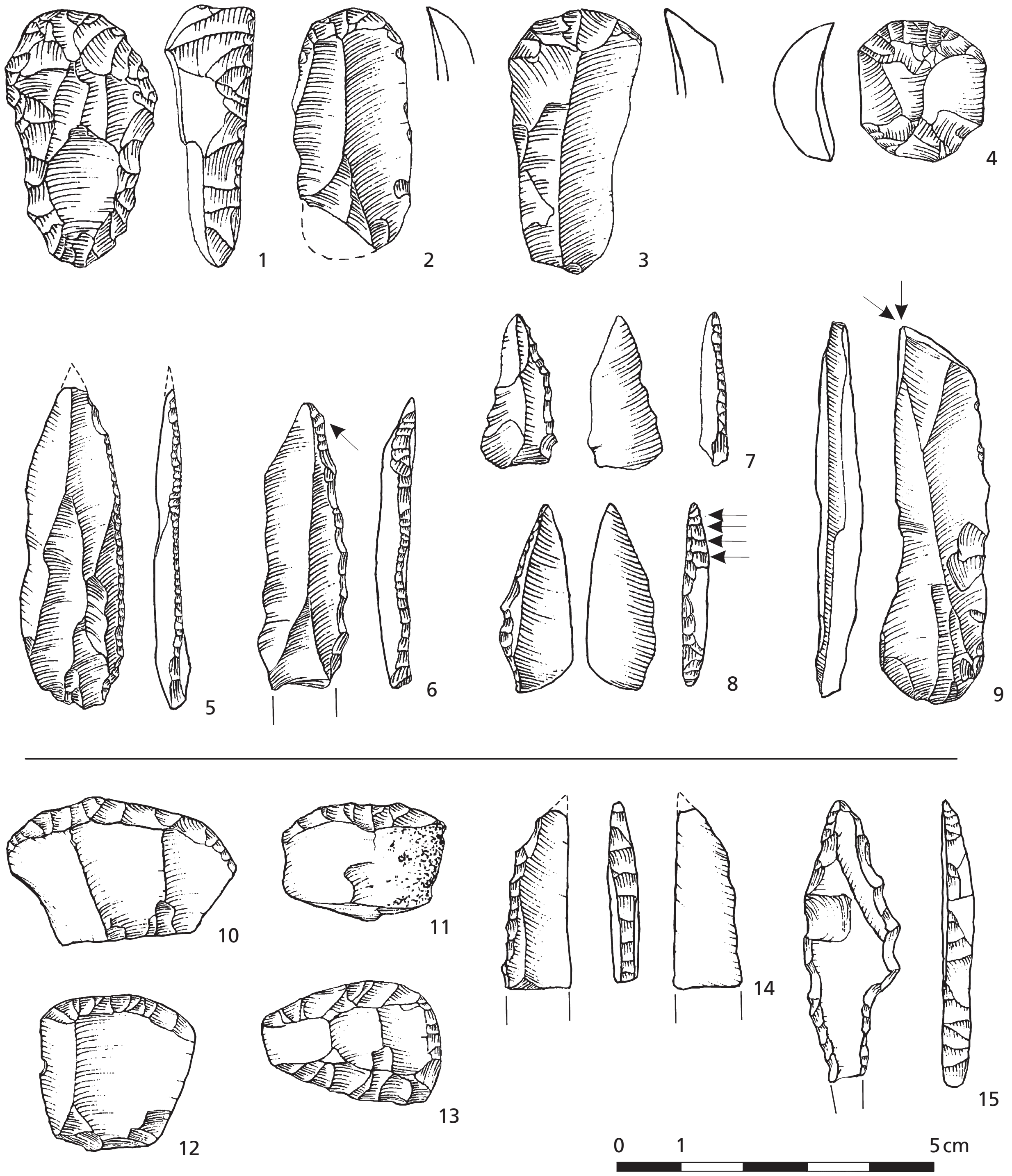

Fig. 2 The diagnostic tool-set of the Federmesser-Gruppen. – Wołczkowo, site 1: **1-4** end-scrapers. – **5-8** backed blades. – **9** burin. – Tarnowa, site 1: **10-13** end-scrapers. – **14** backed blade. – **15** shouldered point. – (After Schild 1975; Krukowski 1939-1948, re-drawn by J. Sawicka).

CHRONOLOGY

A total of 17 samples obtained from ABP settlement sites in Poland (eleven carbon samples, four burnt animal bones and two bone artefacts) have been radiocarbon-dated. The dating has established the earliest flint mining in Rydno (the northern part of the Holy Cross Mountains: Schild et al. 2011, 99) during the

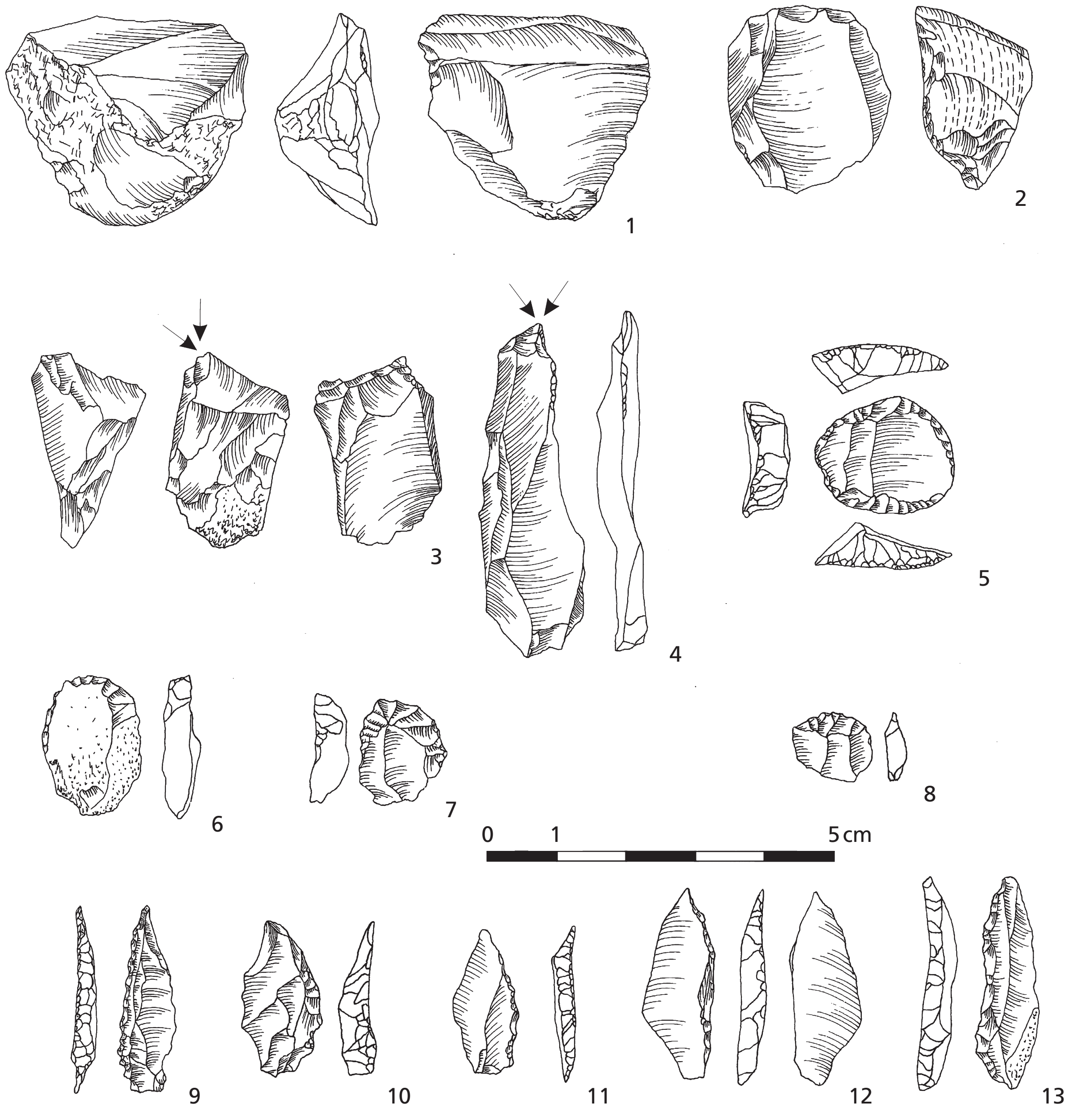

Fig. 3 The diagnostic tool-set of the Witovian Culture. – Witów, site 1: **1-2** cores. – **3-4** burins. – **5-8** end-scrapers. – **9-13** backed pieces. – (After Chmielewska 1978, re-drawn by J. Mugaj).

middle of the Allerød. This is the oldest radiocarbon date obtained for ABP communities in Poland as of yet. The samples from the sites at Rotnowo (Galiński 2007), Całowanie (Schild 2014), and Witów (Chmielewska 1961) have been estimated to date to the end of the Allerød/the beginning of the Younger Dryas. The youngest determination has been obtained for the bone artefact from Rusinowo. It places this object to the period of transition from the Allerød to the Younger Dryas (**tab. 2**). Moreover, a palynological analysis of the deposit in which the object was found indicates that the neighbouring area was covered by pine-birch forest of a cool climate, with some open areas present (Płonka et al. 2011). The taxonomic affiliation of this artefact is, however, uncertain.

It is worth noting that some of the dating results of material from the mine in Rydno (Bln-2037; Gd-713; Gd-724), from Całowanie (Gd-2882; Gd-2723; Gd-4165), and Witów (Gro-828) are marked by very large

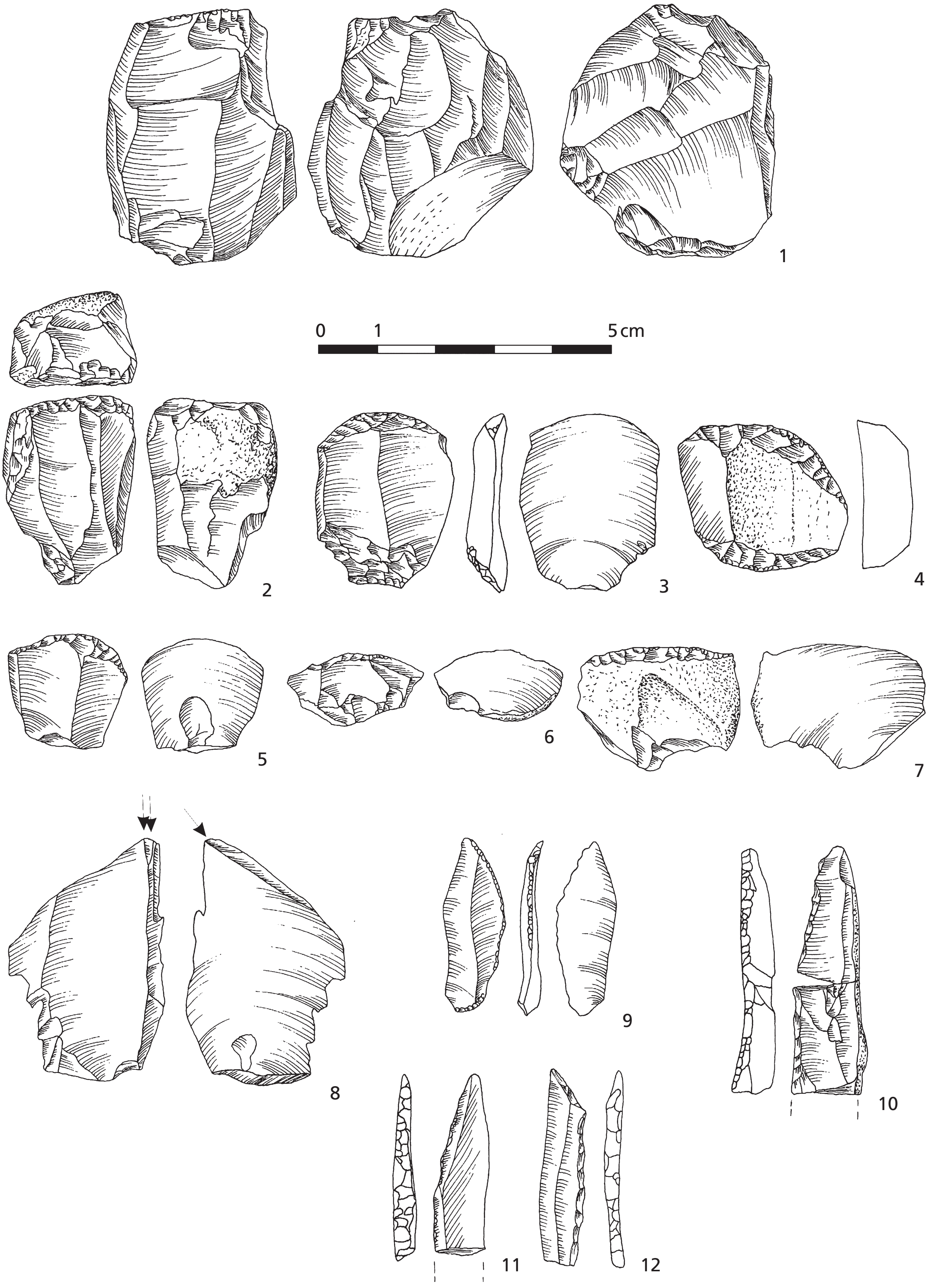

Fig. 4 The diagnostic tool-set of the »Kamienna variant«. – Rydno, Sahara: **1-2** cores. – **3-7** end-scrapers. – **8** burin. – **9-12** backed pieces. – (After Schild et al. 2011, re-drawn by J. Mugaj).

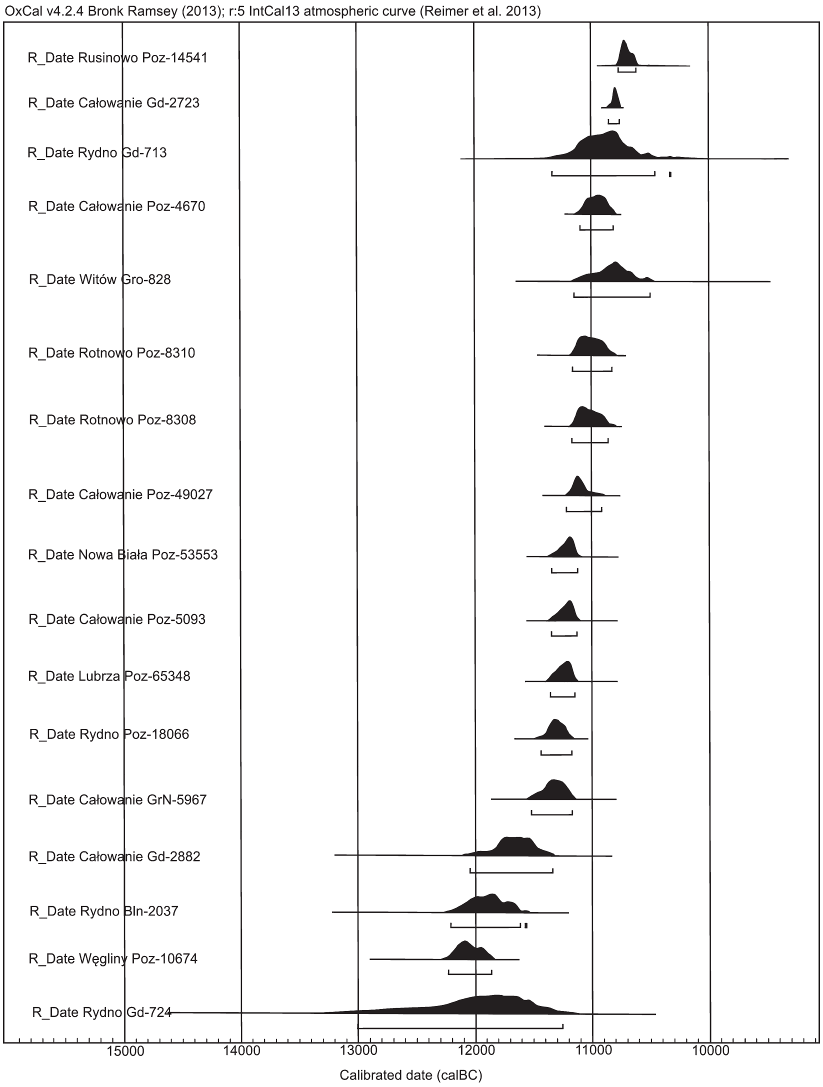

Fig. 5 Radiocarbon dating of ABP sites after calibration with the program OxCal v. 4.2.3 (Bronk Ramsey/Lee 2013); application available on: https://c14.arch.ox.ac.uk/oxcal/OxCal.html.

standard deviations, ranging from 125 to 300 years (Schild et al. 2011, 99-100; 1999; Chmielewska 1961). This minimises their accuracy and opens up various possibilities of interpretation (**fig. 5; tab. 2**).

ENVIRONMENTAL CONDITIONS

In general, ABP settlement in Poland developed in the Allerød (Greenland Interstadial [GI] 1a-1c; c. 11,950-10,700 cal. BC), and in the initial phases of the Younger Dryas. The results of archaeobotanical analyses have enabled the identification of two main phases of the development of the Allerød vegetation: the older one, the so-called birch phase, with a dominant share of birch in forest formations, and a younger phase, with a dominant presence of pine (Latałowa 2004, 387). Detailed studies have shown that the warm oscillation was interrupted by periods of cold climatic conditions. After an initial rise, the temperature fell (Gerzensee oscillation: GI-1b, lasting c. 400 years); after that period the temperature increased, only to drop once again (Schwander/Eicher/Amman 2000).

The then vegetation system in Poland was markedly stratified into horizontal bands, which resulted from thermal conditions, the time that had elapsed since the ice sheet retreat, and the distance from refuges. The changes in habitat conditions are reflected in the increasing share of birch in relation to pine towards the

Site	Lab. no.	Years ^{14}C-BP	Dates cal. BC 2σ	Level / trench	Remarks	References
Rusinowo	Poz-14541	10,700±60	10,776-10,614	found in calcareous gyttja	ornamented elk bone artefact	Płonka et al. 2011
Witów (»hut« 1)	Gro-828	10,815±160	11,116-10,471	Level 5, hearth from hut 1	charcoal	Chmielewska 1961
Rotnowo	Poz-8308	11,100±70	11,146-10,841	shallow pit-house	burnt bones from the hut; 0.9-1.0 m below the surface; Sq 58Gc	Galiński 2007
	Poz-8310	11,090±80	11,146-10,813	shallow pit-house	burnt bones from the hut; 1.0-1.2 m below the surface; Sq 59Gb	Galiński 2007
Całowanie	GrN-5967	11,380±95	11,466-11,123	Level III, Trench 6, Bed 4a, Sample BIS	charcoal from washed-out hearths	Schild et al. 1999
	Poz-5093	11,280±60	11,320-11,104	Level III, Cut XII, Concentration 2, Bed 4a	charcoal	Schild et al. 2014
	Poz-49027	11,170±60	11,196-10,899	Level III, Cut X, Bed 4a	charcoal	Schild et al. 2014
	Poz-4670	11,020±50	11,075-10,792	Level III, Cut XIII, Concentration 2, Bed 4a	charcoal	Schild et al. 2014
	Gd-2723	10,900±130	10,847-10,757	Level IV, trench IX, Bed 5c	charcoal from hydromorphic soil	Schild et al. 1999
	Gd-2882	11,770±160	12,046-11,341	Level ?, Peat Trench IX, Bed 5a, base?	charcoal	Schild et al. 1999; Schild et al. 2014
Lubrza	Poz-65348	11,300±60	11,326-11,115	hearth?	burnt bones	Sobkowiak-Tabaka et al. 2018
Nowa Biała 1	Poz-53553	11,270±60	11,317-11,096	pit	charcoal	Valde-Nowak / Kraszewska 2014
Rydno (Sahara-Cypel)	Poz-18066	11,390±60	11,410-11,146	Trench II / 1990, Sq. 39 (29) Cat. 151	calcium carbonate / bones from the hut	Schild et al. 2011
Rydno (ochre quarry)	Bln-2037	11,970±125	12,186-11,833	Sample 2, Pit 2, Cut I/77	Sample 2, charcoal – Pit 2	Schild et al. 2011
Rydno (ochre quarry)	Gd-724	11,940±300	12,999-11,260	Sample 3, pit	Sample 3, charcoal – pit	Schild et al. 2011
Rydno (ochre quarry)	Gd-713	10,910±220	11,336-10,302	Sample 1, pit	Sample 1, charcoal – pit	Schild et al. 2011
Węgliny 1	Poz-10674	12,120±60	12,194-11,833		barbed harpoon (*Cervidae* or *Bovidae*)	Cziesla / Masojć 2007

Tab. 2 Radiocarbon dates from ABP sites in Poland.

west and north-west. The share of herbaceous plants varied. In the western part of the Oder River Basin, the share of tundra plants increased at the expense of steppe-type plants. In the earlier period of the Allerød, central Poland was characterised by low density birch and pine forests. Woodless areas were dominated by willow, juniper, sea buckthorn and herbaceous plants, albeit in much smaller quantities than in previous periods.

In the second half of the Allerød, most parts of Poland were characterised by dense pine/birch as well as pine forests with aspen, rowan and willow. In the north, forests were rare and open. In southern Poland, the presence of larch was registered at several sites, sometimes along with spruce and alder. In mountainous areas, forests included the Swiss stone pine as well (Latałowa 2003, 271-272).
The Younger Dryas (Greenland Stadial 1, c. 10,700-9,600 cal. BC) saw another period of cool climate. Studies of Polish laminated sediments indicated that the deterioration of climate conditions occurred quickly, as reflected in the increase of non-arboreal pollen with taxa characteristic of a cold, dry climate. This change could have happened within 80-150 years, and as early as in the first period of climate deterioration, during which the forest cover was reduced, and steppe communities as well as the forest-tundra spread in central Poland (Latałowa 2004).
The poor condition of the animal remains recovered from ABP campsites does not permit a comprehensive reconstruction of the then fauna, thereby precluding the recognition of ABP subsistence strategies. The fill deposit of a shallow pit-house at Rotnowo yielded burnt bones of an ungulate (T. Galiński, pers. comm.). In addition, heavily burnt animal bones belonging to a small ruminant (roe dear or ovicaprid) and a large ruminant (red deer or horse) were recovered at Rydno (Sahara-Cypel, Trench II/1990; Schild et al. 2011, 130). Small fragments of burnt long bones of mammals were also discovered at Lubrza (Sobkowiak-Tabaka et al. 2018).

SETTLEMENT

Approximately 100 sites related to ABP settlement are known in Poland (Burdukiewicz 2011): single finds of backed points, small concentrations of flint artefacts, i.e. remains of workshops or domestic units (Lubrza, site 10, Lubrza commune), and large settlement structures, such as those registered at Witów (Chmielewska 1961), Całowanie, or Rydno (Schild 1984, 223; 2014; Schild et al. 2011).
A sandy island, standing clearly out against the peatland, and heavily damaged by deflation and sand exploitation, the site at Całowanie is located in the fossil Allerødian Vistula channel. This place was frequented by hunter-gatherer communities during the Late Glacial and the Holocene, perhaps owing to its favourable location in a wide Vistula Valley, in the vicinity of the confluence of three large rivers: Vistula, Bug, and Narew. The first three settlement levels (Levels II, III, and IVb) are related to the occupation of ABP communities, although this relation is uncertain in the case of level II. Levels III and IVb produced five and nine flint concentrations, respectively. Level III occupation is radiocarbon-dated to the second half of the Allerød, while the settlement activity from level IV occurred at the end of the Allerød (Schild et al. 1999; Schild 2014, 99. 130).
Rydno is a complex of more than 170 archaeological sites, located near chocolate flint outcrops in the northern part of the Holy Cross Mountains on the terrace of the Kamienna River. The location was occupied in the Late Palaeolithic, Mesolithic, Neolithic, and Early Bronze Age. The extraordinary role of this place, associated with the procurement of hematite by ABP communities, is confirmed by the presence of a few huts situated near hematite outcrops along with several workshops. The accumulation of these types of features is unparalleled at any other hunter-gatherer site in the Allerødian forests of Europe. The communities occupying the site have been shown to have controlled the quarrying, working and further distribution of hematite (Schild et al. 2011, 394-395).
Most frequent among settlement remains, however, are one- or two-family campsites (five to twelve people), manifested by the presence of single flint concentrations with a small number of tools, and small hunting camps, e.g. Niedoradz (Otyń commune; Kwiatkowski/Masojć 2011) and Lubrza, site 42 (Kabaciński/Sobkowiak-Tabaka/Winiarska-Kabacińska 2014).

ABP sites are most often located in the Polish Lowland and generally are not documented beyond the Vistula River Valley to the east, with the exception of individual inventories from the Chodelska and Sandomierz Basin (Libera 2002, 202-205). Single sites have also been registered in the Carpathians (the Pieniny Mountains – see **fig. 1**: Sromowce Niżne, Czorsztyn commune, Nowa Biała, Nowy Targ commune). The richest assemblages are known from the sites in Całowanie (the Mazovian Lowland), Witów (Central Mazovian Lowland), Katarzynów (Zgierz commune), Rydno and Pawłów (Zawichost commune, Sandomierz Upland).

The dispersion of ABP sites shows that that these communities exploited a variety of ecosystems. Some lived in the belt of lake districts and exploited the young glacial landscape, which was marked by a very diversified landform (e.g. Rotnowo, Gryfice commune, the complex of sites in Lubrza, Święty Wojciech, Międzyrzecz commune, Santocko, Kłodawa commune) (Galiński 2007; Sobkowiak-Tabaka et al. 2018). Other communities inhabited lowlands (e.g. Siedlnica, Wschowa commune, Niedoradz, Siciny, Niechlów commune, the settlement complex in Całowanie, Sowin [?], Łambinowice commune, Kozłówki, Kietrz commune). ABP sites are also known from uplands (the Rydno complex, Pawłów; Schild et al. 2011; Libera/Wąs/Zakościelna 2008), and basins (Potoczek, Potok Wielki commune; Libera 2002). A few sites have been registered in the Podhale region (southern Poland: Nowa Biała 1, Sromowce-Niżne 1 [Valde-Nowak 1987], Skwirtne 1, Uście Gorlickie commune [Valde-Nowak 1996] and Tylicz a, Krynica-Zdrój commune [Tunia 1978]).

It follows that unlike the Magdalenian and Hamburgian communities in the area of present-day Poland, which were connected exclusively to the ecosystems of the uplands and valleys, respectively (Kabaciński/Sobkowiak-Tabaka 2012; Połtowicz 2013, 136), the ABP societies exploited diverse, (mostly) Allerødian environmental zones (see Latałowa 2004, fig. 102). If we take into consideration the wide chronological span of the settlement, along with the climatic changes in the Allerød (see above), the image that emerges is that of extremely flexible communities, well-adapted to various ecological niches and skilfully exploiting the environment (Sobkowiak-Tabaka 2017, 320).

RAW MATERIALS

The ABP communities exploited a variety of lithic raw materials (**fig. 6**). The vast majority of inventories from the Polish Lowland were made from local raw materials: Cretaceous erratic flint, procured mainly in the form of cobbles at the edges of river and lake valleys, consisting both of till sediments and fluvioglacial deposits.

Unsurprisingly, ABP groups that inhabited the area of the ochre mine and chocolate flint outcrops at Rydno and its vicinity (the northern part of the Holy Cross Mountains) during the Allerød and Younger Dryas used mostly chocolate flint (Schild/Królik 1981). In addition, individual flint concentrations in the area showed a large share of Jurassic flint, ranging from a few to several percent of each total inventory (Schild et al. 2011). Chocolate flint was also used on a massive scale at Pawłów, which yielded almost 29,000 artefacts mostly made of this raw material (a few specimens were made of Świeciechów flint; Libera/Wąs/Zakościelna 2008). Exceptional in this case is the site at Tarnowa. Located c. 250 km away from chocolate flint outcrops, the site produced an assemblage made almost entirely of chocolate flint (Krukowski 1939-1948, 92). It is the only site at such a distance from any outcrop of raw chocolate flint to yield an assemblage with almost 90 % of the artefacts made of chocolate flint. We must nevertheless bear in mind the doubts as to the homogeneity of the inventory (Sobkowiak-Tabaka 2012).

Furthermore, the use of quartzite by ABP communities has been recently documented at Lubrza, site 10. The outcrops of quartzite are located in southern Wielkopolska, in Lower Silesia and in the Holy Cross Mountains (Osipowicz/Sobkowiak-Tabaka 2014).

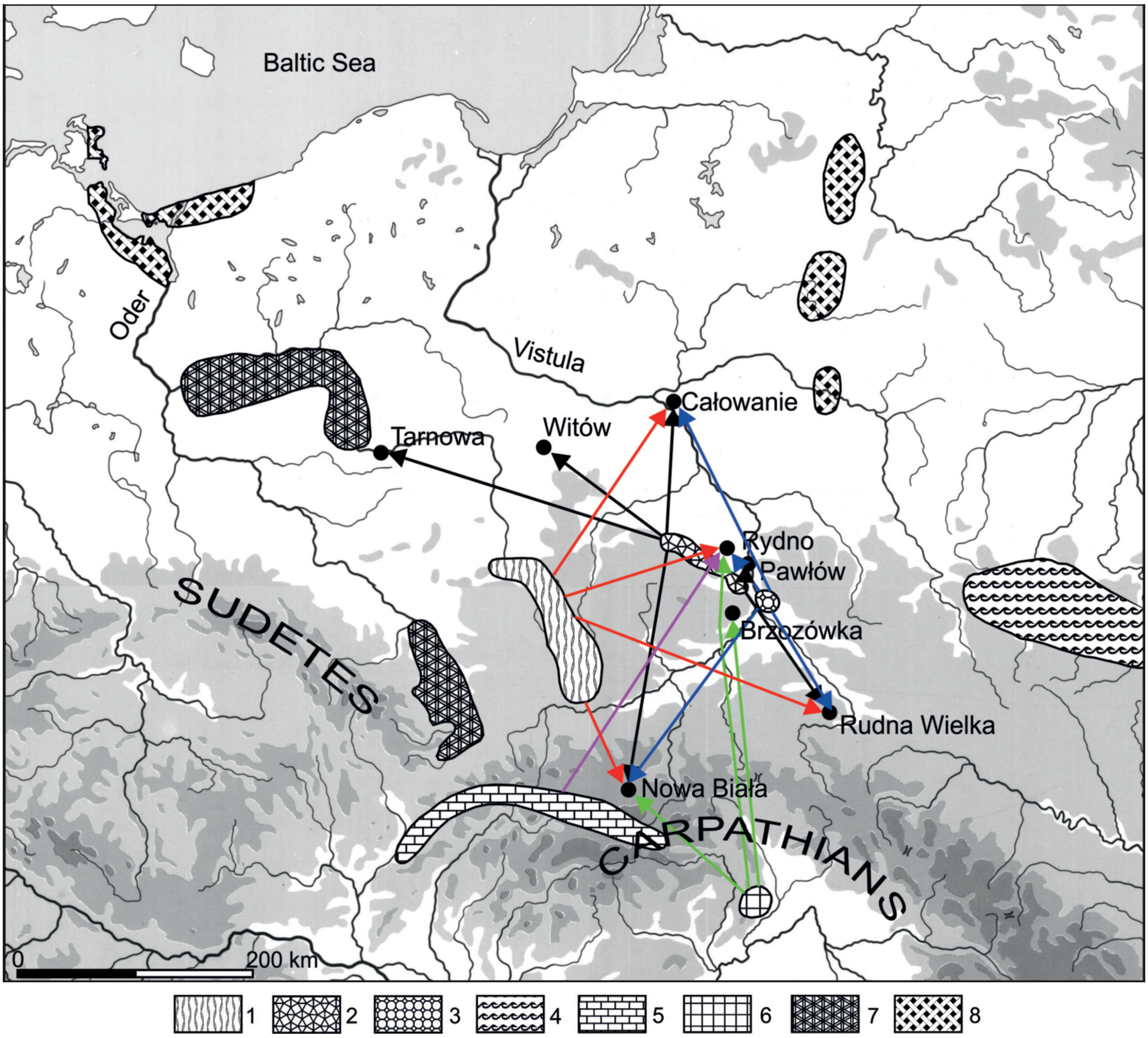

Fig. 6 Outcrops of flints and radiolarites in Poland: **1** Jurassic flint. – **2** chocolate flint. – **3** Świeciechów flint. – **4** Volhynian flint. – **5** radiolarite. – **6** obsidian. – **7** rich occurrences of erratic flint. – **8** concentrations of glacial rafts with Cretaceous flint. Arrows indicate raw material use at different sites. – (After Sulgostowska 2005, fig. 10; Bobrowski 2009; map A. Tabaka).

Noteworthy is the presence of artefacts made of obsidian in the Federmesser-Gruppen inventories: Outcrops of obsidian are found in central and south-eastern Slovakia and north-eastern Hungary. Given the macroscopic characteristics of the specimens (transparency, greyness), they are very likely to have come from outcrops in Slovakia. The provenance was also confirmed by geochemical investigations of some of the artefacts (Hughes/Werra/Sulgostowska 2018). A fairly large number of such findings are known from Rydno (Tomaszewski et al. 2008), and their concentration has been registered at sites in the Podhale region, i.e. Nowa Biała 1, Sromowce Niżne, Skwirtne 1 (Valde-Nowak 1991), and Tylicz, site A (Tunia 1978).

Intensive contacts between ABP communities inhabiting southern Poland, northern Bohemia and Moravia are evidenced by numerous erratic flint imports. Chocolate flint has also been found to have reached these regions (Kozłowski 1992; Vencl 2007, 117). The ABP communities engaged extensively in mining raw materials. Mine shafts were dug at chocolate flint outcrops in Orońsko II (Krukowski 1939-1948), and intensive exploitation and distribution of hematite by the Federmesser-Gruppen and the communities of the Sviderian Culture have been registered at Rydno (Schild et al. 2011, 53-58).

DISCUSSION

The basic list of backed point types was compiled in the 1950s by Schwabedissen (1954). Based on the inventories from Witów, Katarzynów, Rydno, Całowanie, and a few other less important sites, the list of types from Poland was presented by R. Schild (1975, 164, Zestawienie I). This fairly extensive catalogue of forms was grossly simplified by S. K. Kozłowski (1987, 242), who distinguished three basic types of backed points: Federmesser points (as defined by Schwabedissen in 1954), large and very long, with a slightly curved back, usually with steep and high retouch, and a transverse unretouched base (class I); similar to the above, yet shorter and smaller, typically with a more curved back and low retouch (class II); and short segments with a fairly curved back and both ends pointed (class III). According to the author, the differentiation has a functional, chronological, and territorial significance. Smaller backed pieces occur in assemblages from mountainous areas and uplands of eastern Germany, Poland, and the Czech Republic, while larger blades are registered in assemblages from eastern Germany, Poland, and parts of the Central European Lowland.

Such backed point diversity generates a huge variety of assemblages, notably within the group of points, and indirectly spawns the classification of a number of regional and/or chronological groups, with a concurrent invariance of the general pattern of the toolkit. To some extent, this stems from culture-history, the dominant theoretical paradigm in archaeology until the 1960s, when the basic ABP groups were defined in Poland. The culture-historical school of archaeology perceived particular categories of material culture as types. These were treated as criteria for sorting the materials in time and space, and used to define their spatial distribution (Marciniak 2012, 32-39).

It is important to note, however, that the morphological variability within the group of backed pieces, a group of implements that are used as the so-called taxonomic markers, may in fact result from functional differences. A microscopic analysis of backed points from Lubrza, site 42, has shown that massive forms were used as points, while smaller ones served as inserts and barbs (Kabaciński/Sobkowiak-Tabaka/Winiarska-Kabacińska 2014, 209). The backed pieces found at Całowanie also functioned as elements of weapons (Winiarska-Kabacińska 2014, 277). Backed pieces recovered from Lubrza, site 10, however, performed different tasks. They were used as elements of weapons (points and inserts) or knives, and one massive backed piece was used for piercing or punching/drilling (Sobkowiak-Tabaka/Kufel-Diakowska 2019). A different situation was observed in Rekem (Belgium), where smaller pieces served as projectile components, while wider and longer pieces were used as butchering knives. Perhaps that results from a difference in the size of the mentioned sites. With only a few artefact concentrations, sites Lubrza 10 and 42 provide examples of short-term, task-oriented occupations, whereas Rekem is a multi-seasonal occupation site where a variety of activities were undertaken (De Bie/Caspar 2000; Kabaciński/Sobkowiak-Tabaka/Winiarska-Kabacińska 2014, 209).

Let us recall here the aforementioned reduction of the extensive catalogue of typological forms carried out by S. K. Kozłowski. It is a sufficient example to illustrate how archaeologists create their concepts of a past reality, far from what it in fact could have been. Note that the primary criteria used by archaeologists to sort materials in order to determine time and cultural space is the principle of similarities and differences, generally regarded as universal. Similar artefacts are seen as concurrent, while physically different objects are deemed to be products of different times.

It has been widely accentuated in the subject literature that one of the major problems faced by archaeologists is »the cultural labelling« of Late Palaeolithic flint inserts to the total neglect of their symbolic meaning, which was an integral trait of past societies, closely interwoven with the objects' practical-technical use. A completely unsubstantiated contention – that the typological diversity matches cultural diversity – is thus implied. As a result, it is an archaeologist (not the Late Palaeolithic manufacturer!) who, through various metric classifications of artefacts, actually creates diverse cultural groups that were to occupy the same cultural territory (Schmitt 2007, 146-148).

Nonetheless, the understanding of identity in ancient societies did not quite match the meaning of the term as understood by contemporary people (Kowalski 2001, 87). Unlike archaeologists, people in the past treated items as identical not because of their physical similarity, but due to their coexistence within the same space and at the same time. For that reason, objects could have been utterly different in terms of their physical appearance and function. According to U. Eco (1998), two things that were considered to be different in Aristotelian categories come to be treated as the same if they manage to occupy the same spatial area at the same time. This statement is corroborated by observations by M. Mauss (2004) who in the early 20th century wrote about the Inuit of the Baffin Land and Hudson Bay. To the Inuit, there were rigid distinctions between »summer« and »winter« things, pertaining to the hunted animals, hunting equipment, type of clothing, or tents to live in, and even people (born in winter or summer). Using these inventories at the same time, or at any other time of the year than the one for which they were intended, was not allowed. Yet, seeing two different types of inventories in the same area, an archaeologist would eagerly identify two cultures/cultural groups.

The basic issue to be addressed herein is the reason for the variations in the ABP material culture, regardless of its subsequent classifications by archaeologists.

Here, an environmental factor should first and foremost be taken into consideration. It is undeniable that we cannot simply equate the change in environmental conditions with the change in tool production technology, as evidenced by the results of long-term research of J. Bower and M. Kobusiewicz (1998). Societies inhabiting comparable environmental zones in Europe and North America in the late Pleistocene and early Holocene did not develop in the same way. While a significant technological change (i.e. microlithisation and geometrisation of flint artefacts) occurred in Europe, a continuous development of bifacial technology is observable in North America. Note that the development of flint tool production in communities occupying various ecological zones of southern Africa stands in marked contrast to this (Mitchell 2000), as the flint industries of societies there were identical, and any transformation happened roughly at the same time. Hence, »toolkits were modified for social (rather than) ecological reasons, though the nature of social reasons« (Bower/Kobusiewicz 2002, 138) is unspecified. Local environmental conditions are nonetheless significant in regard to choosing hunting strategies, site location and hunting equipment. Thus, a specific landscape type (i.e. open landscape, woodland) could have determined the employed subsistence strategies (Mortensen/Henriksen/Bennike 2014; Mortensen et al. 2014). While a specific type of adaptation/specialisation, e.g. reindeer or horse hunting, necessitated a proper toolkit, it nevertheless did not precisely regulate the form of implements or weapons. Such forms were the outcome of the influence of the cultural environment and the resultant stylistic diversity of artefacts. We can therefore define Late Palaeolithic hunter-gatherers as functional communities differentiated in terms of artefact styles, the variation, though, stemming from pre-existing diverse cultural environments (Kozłowski 2012, 938).

An example of the influence of the cultural environment has been recently discussed by R. Schild. The author argues that the »Kamienna variant« is technologically and stylistically affiliated to Magdalenian inventories known from southern Poland and site Rydno II/1959. Schild believes that the observable changes resulted from the adaptations of technological strategies, aimed at saving time and minimising raw material loss (Schild et al. 2011, 129-130).

The problem arises now whether the changes in material culture go indeed back to such technological considerations. I am of the opinion that it would not be appropriate to explicitly assume that rationality focused on technological utility – a basic human trait typical of modern humans – also characterised archaic mentality. Hence, the development of archaic societies cannot be simply a reflection of the scheme of development of their material culture, as constructed by archaeologists. According to C. Lévi-Strauss (1963, 4): »A[n] ax […] does not generate another ax. There will always be a basic difference between two identical tools, or two tools which differ in function but are similar in form, because one does not stem from the other; rather, each of them is the product of a system of representations«. Moreover, the whole category of points as parts of arrows functioned in a more symbolic context as social markers and exchangeable items, too (see Wiessner 1983).

CONCLUSIONS

In my paper, I attempted to highlight problematic areas related to the issue of ABP settlement in Poland and discussed the reasons for considerable variability in ABP inventories, taking into account typological, functional, environmental and methodological aspects. The processes of »azilianisation« that occurred in Western Europe at the end of the Magdalenian settlement also took place in the area of present-day Poland, highlighted by changes in economic strategies, settlement models (decline in the number of sites and their structure), the structure of raw materials supply, and a simplification of flintworking technologies. This argument has lately been raised by R. Schild, according to whom a transformation is likely to have occurred in Poland between Late Magdalenian/ABP assemblages, analogous to the one in Western Europe (Bodu et al. 2006), i.e. in the Paris Basin with the gradual techno-stylistic transformation of Magdalenian artefacts into Azilian artefacts. However, the author emphasises that the weakness of this hypothesis lies in the rather tenuous proxy chronology of Terrace III of the Kamienna River at Rydno, which yielded material from Magdalenian and ABP occupations, and the problem of dating Magdalenian settlement in southern Poland to the early phases of the Late Glacial (GI-1e) (Schild et al. 2014, 350-355). We should bear in mind that Federmesser-Gruppen settlement of a fairly early origin (Older Dryas: GI-1d) is known not only from the Paris Basin, but also from Reichwalde (Saxony, Germany), next to the Polish border, documented by radiocarbon measurements of burnt bones along with palynological and stratigraphic observations (Vollbrecht 2005, 19-24). On the other hand, the area of eastern Poland yielded assemblages (Mosty, Wierzawice) that could possibly attest to a long-term classic Magdalenian occupation in its eastern peripheries (Połtowicz-Bobak 2013, 322-323). Not only did ABP communities occupy areas hitherto settled by Magdalenian societies, they enjoyed a fair amount of »colonisation success« as well, having moved considerably towards the north (Bocquet-Appel et al. 2005). This hints at a high degree of flexibility resulting from the ability to adapt to various ecological niches.

There are several conceivable reasons for the variability of ABP inventories noticeable not only in Poland but in the whole of Europe. It is noteworthy that the typological diversity within the group of inserts may simply stem from the variation between contemporary craftsmen (Thomas 1974). Alternatively, it might have been the result of a stylistic drift, as in the case of Palaeoindian fluted points (Morrow/Morrow 1999, 227). This diversity may also stem from the functional diversity of camp sites or the length of camp occupation (e.g. Lubrza, Rekem). We also cannot rule out environmental factors completely, although at this point I wish to emphasise once again that it is rather about the selection of hunting strategies and appropriate equipment, not the shape of the tools.

Regional differences in ABP diversity, notably within the group of projectile points, could be explained by the intensity of cultural transmission. Studies carried out by R. L. Bettinger and J. Eerkens (1999) concerning the morphological diversity of projectile points showed that communities that only occasionally come into contact with each other (most likely groups speaking different languages, meeting occasionally for commercial purposes) are marked by a very high diversity of blades, unlike groups that maintain regular contact. Compared to earlier Hamburgian groups, found exclusively in the Polish Lowlands, and Magdalenian groups, known to have lived mostly in the Polish uplands, ABP communities have been shown to have occupied much larger and more diverse areas. Consequently, utterly different ecological conditions enforced the application of various hunting strategies. Hamburgian reindeer hunters migrated seasonally following reindeer herds and hunted in larger groups (see Grøn 2005) – all that fostered contacts and cultural transmission. Life in the luminous Allerød forests and the dissemination of bow and arrows could have brought about the development of individual hunting among ABP communities (large hunting groups were quite pointless); hence a greater variability of the hunting toolkit may have developed.

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Summary

This paper provides an overview of the settlement of the Arch-Backed Piece technocomplex (ABP) in Poland and seeks to explore and interpret the considerable variability in its material culture. ABP inventories were for the first time identified in Poland by S. Krukowski in the 1920s (at the time as the »Azilian« industry). Almost 100 years of excavations and studies have produced approximately 100 ABP assemblages (including stray-finds). Based mostly on lithic inventories marked by substantial technological, typological and morphological variability (notably in the group of backed points), three taxonomic units have been distinguished (the Federmesser-Gruppen, the Tarnovian, the Witovian), along with, recently, their local variants. The article provides the main criteria for identifying particular ABP groups in Poland and discusses associated methodological problems and factors that may have brought about the typological diversity of flint artefacts. Finally, the author offers an interpretation of the assemblage variability.

Keywords

Poland, Arch-Backed Piece technocomplex (ABP), assemblage variability, chronology, settlement patterns

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A session entitled »From the Atlantic to beyond the Bug River– Finding and defining the Federmesser-Gruppen/Azilian on the North European Plain and adjacent areas« was held at the 17th congress of the Union Internationale des Sciences Préhistoriques et Protohistoriques in September 2014 in Burgos on behalf of the U.I.S.P.P. commission »The Final Palaeolithic of Northern Eurasia«. In this volume we present some of the contributions to this session that explore different aspects of the behaviour of mid-Lateglacial hunter-gatherer groups in Western and Central Europe as a beginning for comparing the differently defined archaeological units. How distinct and/or related were those groups over time and space?

Propylaeum

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