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VOLUME 2

Paléolithique supérieur ancien,
Paléolithique final – Mésolithique

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Illustration de couverture : Création graphique réalisée à partir d'une statuette du gisement gravettien récent d'Amiens-Renancourt (Somme). En bleu : figuration stylisée du tracé du fleuve Somme. Couleur de fond : loess lités du gisement d'Amiens-Renancourt.

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Archaeology across the Pleistocene-Holocene boundary in western Germany:

Human responses to rapid environmental change

Martin STREET, Michael BAALES, Birgit GEHLEN, Martin HEINEN, Wolfgang HEUSCHEN, Jörg ORSCHIEDT, Nele SCHNEID and Annabell ZANDER

Abstract: *In recent years, new insights into the Final Palaeolithic and Mesolithic in North Rhine-Westphalia have been gained. The Early Mesolithic human remains of the Blätterhöhle in Hagen should be mentioned specifically as they even attracted international attention. Here, a stratigraphic sequence containing hearth remains and lithic assemblages from the Early to Late Mesolithic has been excavated for the first time in this region. Recent results of excavations demonstrate that the sequence even dates back to the Late Pleistocene. Moreover, newly dated sites and single finds of the Final Palaeolithic – Early Mesolithic transitional period from this region suggest varying influences from northern and southern as well as western regions on the development of the Westphalian Mesolithic. Several sites, which have been assigned to the broad blade complexes or the "Long Blade industries"/the Belloisien due to the distinct blade technology and microlithic projectile points, seem to represent the initial stage of the Mesolithic in the Rhineland and in Westphalia.*

Keywords: *Younger Dryas, Preboreal, Long Blades, Early Mesolithic, Western Germany, Radiocarbon dating.*

Résumé : *De nouvelles découvertes en contexte mésolithique ont été réalisées en Rhénanie-du-Nord-Westphalie au cours des dernières années. Il faut mentionner, par exemple, les restes humains du Mésolithique ancien de la grotte de Blätterhöhle à Hagen qui ont suscité un intérêt important. En outre, et pour la première fois, une séquence stratigraphique comportant des vestiges de foyers associés à des vestiges lithiques couvrant l'ensemble du Mésolithique ancien, moyen et final a été découverts sur ce même site. D'autres nouveaux sites, ainsi que des analyses radiométriques menées sur des découvertes isolées de la transition Paléolithique final – Mésolithique ancien semblent indiquer que le Mésolithique de la Westphalie a été influencé par différents courants culturels originaires des régions septentrionales et méridionales ainsi que celui des zones occidentales. Plusieurs sites, attribués aux Long Blade Assemblages, ou Belloisien, en raison de leur caractéristique technique et de la présence d'armatures microlithiques, représentent la première phase du Mésolithique de Rhénanie et de Westphalie.*

Mots-clés : *Dryas récent, Préboréal, Industries à longues lames, Mésolithique ancien, Allemagne de l'ouest, Datations radiocarbone.*

ARCHAEOLOGY ACROSS THE PLEISTOCENE – HOLOCENE BOUNDARY IN WESTERN GERMANY

We present a brief summary of the current state of our knowledge of the archaeological record for the transition from the most recent Palaeolithic to the earliest Mesolithic at the western boundary of Germany. This is here broadly defined by the state of Nordrhein-Westfalen (NRW/North Rhine-Westphalia) with some reference to bordering regions.

The Rhineland and Westphalia are historically important for the investigation of some of the earliest humans in Europe, perhaps most famously as the location of the type specimen for Neandert(h)al hominins (Schmitz, 2006). Many limestone caves, particularly those in the Hönne river valley near Balve in the Westphalian Sauerland upland, became the focus of further pioneering prehistoric investigations by renowned contemporary researchers such as Hermann Schaaffhausen and Rudolf Virchow. A number of syntheses exist for the Pleistocene and earlier Holocene archaeology of the region under study (Westphalia: Günther,

1988; Baales et al., 2015; Rhineland: Bosinski et al., 1995; Bosinski, 2008).

The archaeological events of interest here fall together with the last period of major climatic and ecological change, the Pleistocene – Holocene boundary around 11,600 cal. BP (calibrated values are based on 1950 AD). It is not the purpose of this paper to discuss the role played by environmental change in the observed developments in the archaeological record, something which can only be attempted at a larger geographical scale and by the incorporation of many more archives. Instead, this study will characterize the archaeological/cultural contexts recognized in the region at this time of major environmental and cultural change and concentrate on the few sites with well documented stratigraphic context and/or good radiometric dates which can serve as fixed points of reference (fig. 1). A number of newly discovered archaeological sites and recently obtained radiometric dates make it possible to re-examine this theme at a level of resolution not possible even only a few years ago.

SOUTHERNMOST TANGED-POINT GROUPS DURING THE YOUNGER DRYAS

The Younger Dryas is marked by a pronounced fall in temperature relative to the preceding Allerød interstadial, bringing a return to sub-arctic conditions. Radiocarbon ages from the Northern European Lowland in Germany or the Netherlands and from Remouchamps in the Belgium uplands suggest that archaeological assemblages defined as the Ahrensburgian may have appeared in north-western Europe very soon after this ecological change (Weber et al., 2011).

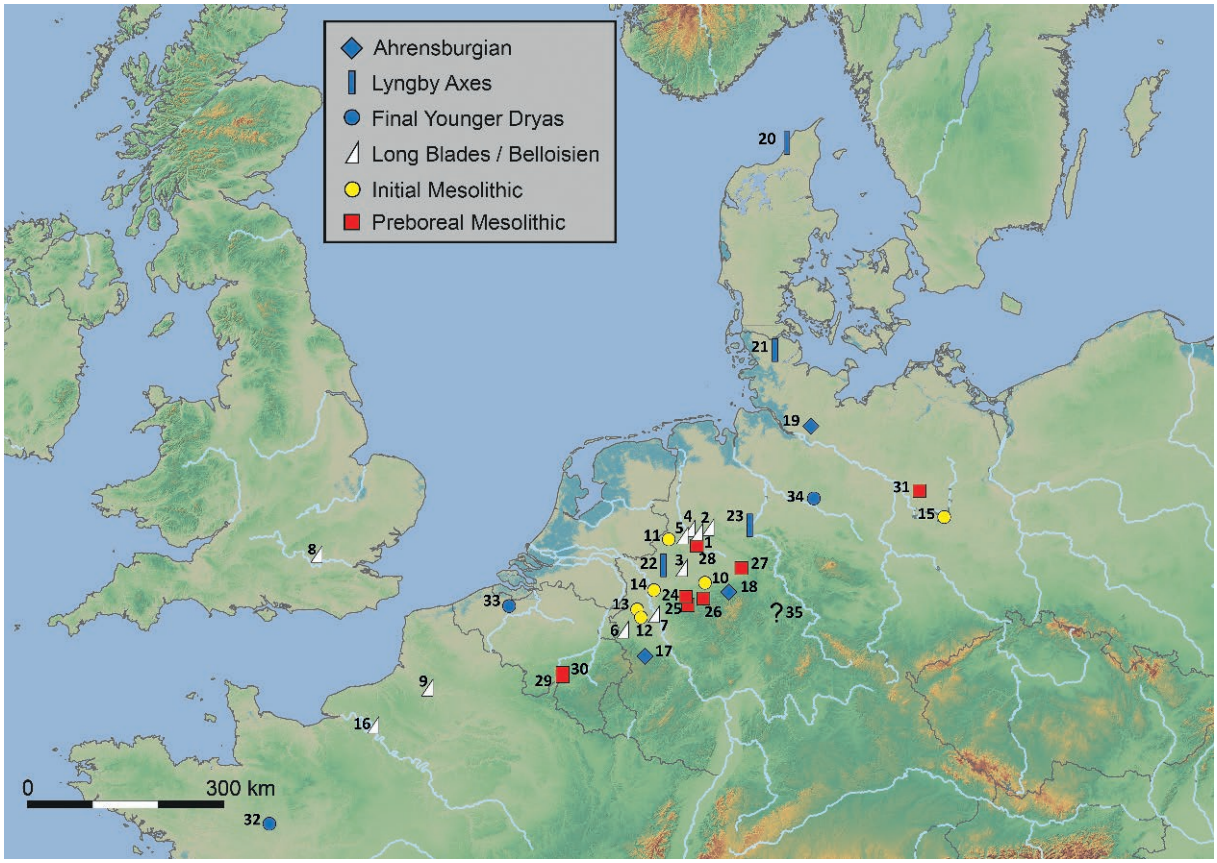

Fig. 1 – Rhineland and Westphalia consist of different landscapes: their northern regions are part of the North European Lowland, while the southern regions consist of upland landscapes. Sites mentioned in the text: 1 Saerbeck-Sinningen; 2 Westerkappeln-Brennesch; 3 Lüdinghausen-Emkum II; 4 Rheine-Altenrheine; 5 Wettringen; 6 Übach-Palenberg; 7 Dormagen-Nievenheim; 8 Three Ways Wharf; 9 Belloy-sur-Somme; 10 Werl-Büderich; 11 Heek-Nienborg; 12 Bedburg-Königshoven; 13 Mönchengladbach-Geneicken; 14 Duisburg-Kaiserberg; 15 Potsdam-Schlaatz; 16 Alizay; 17 Kartstein; 18 Hohler Stein; 19 Stellmoor; 20 Nørre Lyngby; 21 Klappholz LA 63; 22 Marl-Sickingmühle; 23 Minden; 24 Hagen "Rieger Busch"; 25 Hagen-Holthausen "Blätterhöhle"; 26 Balver Höhle; 27 Paderborn-Sande; 28 Greven-Bockholt; 29 Grotte Margaux; 30 Abri des Autours; 31 Friesack 4/27; 32 La Fosse; 33 Evergem-Nest; 34 Höfer; 35 Rhünda (illustration: University of Cologne/B. Gehlen, N. Schneid, K. Vogl, M. Zickel).

Fig. 1 – *La Rhénanie et la Westphalie sont composées de différents paysages : leurs régions septentrionales font partie de la plaine nord-européenne tandis que leurs régions méridionales consistent en paysages de moyenne montagne. Sites mentionnés dans le texte : 1 Saerbeck-Sinningen ; 2 Westerkappeln-Brennesch ; 3 Lüdinghausen-Emkum II ; 4 Rheine-Altenrheine ; 5 Wettringen ; 6 Übach-Palenberg ; 7 Dormagen-Nievenheim ; 8 Three Ways Wharf ; 9 Belloy-sur-Somme ; 10 Werl-Büderich ; 11 Heek-Nienborg ; 12 Bedburg-Königshoven ; 13 Mönchengladbach-Geneicken ; 14 Duisburg-Kaiserberg ; 15 Potsdam-Schlaatz ; 16 Alizay ; 17 Kartstein ; 18 Hohler Stein ; 19 Stellmoor ; 20 Nørre Lyngby ; 21 Klappholz LA 63 ; 22 Marl-Sickingmühle ; 23 Minden ; 24 Hagen " Rieger Busch " ; 25 Hagen-Holthausen " Blätterhöhle " ; 26 Balver Höhle ; 27 Paderborn-Sande ; 28 Greven-Bockholt ; 29 Grotte Margaux ; 30 Abri des Autours ; 31 Friesack 4/27 ; 32 La Fosse ; 33 Evergem-Nest ; 34 Höfer ; 35 Rhünda (illustration : Université de Cologne/B. Gehlen, N. Schneid, K. Vogl, M. Zickel).*

Tanged points characteristic of this period are known as surface finds from several localities in the region under study (*e.g.* Bosinski, 2008), however sites with reliable radiometric dating or stratigraphic controls are the exception in western Germany. Two sites recovered *in situ* which exceptionally have organic preservation are the Kartstein rock shelter in the northern Eifel uplands (Baales, 1996) and the Hohler Stein cave near Rüthen-Kallenhardt in the Westphalian uplands (fig. 2; Baales, 2013a; Baales et al., 2013a; 2019). At both sites it was possible to document in detail the exploitation of hunted reindeer and identify the spring hunting of migrating reindeer herds as an economic strategy of Younger Dryas Ahrensburgian hunters at the margins of the Rhineland and Westphalian uplands.

Fig. 2 – Three Ahrensburgian tanged points from the site of Hohler Stein at Rüthen-Kallenhardt (photo: LWL/M. Baales, A. Müller).
Fig. 2 – *Trois pointes pédonculées ahrensbourgiennes du site de Hohler Stein à Rüthen-Kallenhardt (cliché : LWL/M. Baales, A. Müller).*

Lyngby axes made from the beams of reindeer antlers are a recurring element in northern European Final Palaeolithic contexts such as the northern German sites Stellmoor (Ahrensburgian) and Klappholz LA 63 or the eponymous Danish Nørre Lyngby locality and other sites in southern Scandinavia (*e.g.* Clausen, 2004; Weber et al., 2011; Fischer et al., 2013). They are usually manufactured on robust male antlers collected after they had been shed following the autumn rut (Baales, 2013b), which is also the case for all three such artefacts known from Westphalia (fig. 3). A specimen found at the spring-occupied Hohler Stein site must have been brought there as a curated object. The two further Westphalian specimens were recovered as single finds without closer context at Marl-Sickingmühle and Minden. Their location near the Lippe and Weser rivers may suggest the existence here of autumn hunting grounds, when reindeer herds migrated from

Fig. 3 – Three certain "Lyngby axes" are known from Westphalia, all probably dating to the Ahrensburgian (Tanged Point complex). – 1 Minden; 2 "Hohler Stein" near Rüthen-Kallenhardt; 3 Marl-Sickingmühle. Minden and Marl-Sickingmühle show similar traces from their manufacture and/or use (photo: LWL/S. Brentführer and A. Müller).
Fig. 3 – *Trois « haches de Lyngby » certaines sont connues en Westphalie, toutes les trois datant probablement de l'Ahrensbourgien (complexe à pointes pédonculées). – 1 Minden ; 2 « Hohler Stein » à Rüthen-Kallenhardt ; 3 Marl-Sickingmühle. Les deux « haches de Lyngby » de Minden (en haut) et de Marl-Sickingmühle (en bas) montrent des traces similaires de leur fabrication et/ou de leur utilisation (cliché : LWL/S. Brentführer, A. Müller).*

							(CalPal)		(OxCal)	
Site	**Context**	**Material**	**Species**	**Lab ID**	**14C date**	**SD**	**cal BC**	**SD**	**cal BC 1σ**	**cal BP 1σ**
Balver Höhle	old find	bone	*Homo sapiens*	GrA-19538	9,160	50	8,385	67	8,538-8,281	10,488-10,231
Hagen-Riegerbusch	find layer	charcoal	*Salix* sp.	MAMS 14123	9,333	36	8,603	40	8,711-8,477	10,661-10,427
Paderborn-Sande	dredging find	antler	*Alces alces*	MAMS 14119	9,591	30	8,993	116	9,157-8,814	11,107-10,764
Blätterhöhle / platform	BV 07 - SU 3 - 4	charcoal	Pomoideae	COL 2667	8,116	48	7,120	51	7,307-7,032	9,257-8,982
Blätterhöhle / platform	BV 08 - SU 4	charcoal	*Corylus avellana*	COL 1443	8,122	32	7,111	37	7,183-7,047	9,133-8,997
Blätterhöhle / platform	BV 07- SU 3 - 4	charcoal	*Quercus* sp.	COL 2668	8,210	47	7,224	81	7,419-7,072	9,369-9,022
Blätterhöhle / platform	BV 08 - SU 3 - 4	charcoal	*Corylus avellana*	COL 1444	8,227	35	7,249	61	7,355-7,082	9,305-9,032
Blätterhöhle / platform	BV 09, SU 4 - 6	charcoal	*Quercus* sp.	COL 1451	8,240	36	7,264	63	7,450-7,085	9,400-9,035
Blätterhöhle / platform	BV 06 - SU 4	bone	*Sus scrofa*	KIA 37513	8,330	45	7,411	59	7,522-7,196	9,472-9,146
Blätterhöhle / platform	BV 09, SU 4	charcoal	*Corylus avellana*	COL 1926	8,335	49	7,413	63	7,526-7,195	9,476-9,145
Blätterhöhle / platform	BV 08, SU 4	charcoal	*Corylus avellana*	COL 1440	8,438	32	7,528	22	7,576-7,478	9,526-9,428
Blätterhöhle / platform	BV 08, SU 4	charcoal	*Corylus avellana*	COL 1445	8,441	34	7,530	24	7,578-7,478	9,528-9,428
Blätterhöhle / platform	BV 08, SU 4	charcoal	*Corylus avellana*	COL 1446	8,473	35	7,550	21	7,584-7,499	9,534-9,449
Blätterhöhle / platform	BV 08, SU 4	charcoal	*Corylus avellana*	COL 1442	8,529	31	7,571	16	7,595-7,536	9,545-9,486
Blätterhöhle / platform	BV 08, SU 6a	charcoal	*Quercus* sp.	COL 1441	8,618	31	7,625	26	7,712-7,581	9,662-9,531
Blätterhöhle / platform	BV 11 - SU 6a	bone	*Sus scrofa*	AAR 15713	8,732	38	7,754	79	7,938-7,608	9,888-9,558
Blätterhöhle / platform	BV09/11 - SU 6a	bone	*Sus scrofa*	AAR 15714	9,036	38	8,267	17	8,292-8,227	10,242-10,177
Blätterhöhle / platform	BV 09, SU 6b	charcoal	*Corylus avellana*	COL 1928	9,215	50	8,436	84	8,560-8,300	10,510-10,250
Blätterhöhle / platform	BV 11 - SU 6a - 6b	charcoal	*Betula* sp.	COL 1454	9,243	37	8,458	78	8,572-8,319	10,522-10,269
Blätterhöhle / platform	BV 09 - SU 6b	charcoal	*Betula* sp.	COL 1449	9,244	39	8,458	58	8,596-8,320	10,546-10,270
Blätterhöhle / platform	BV 12 - SU 6a - 6b	charcoal	unbest.	COL 1973	9,274	52	8,497	90	8,634-8,324	10,584-10,274
Blätterhöhle / interior	BV 06 - CSU 3	bone	*Homo sapiens*	KIA 37511	9,275	45	8,506	77	8,626-8,340	10,576-10,290
Blätterhöhle / platform		charcoal	*Betula* sp.	COL 1447	9,301	36	8,553	55	8,697-8,353	10,647-10,303
Blätterhöhle / platform	BV 11 - SU 6b	charcoal	*Corylus avellana*	COL 1453	9,329	68	8,585	101	8,758-8,347	10,708-10,297
Blätterhöhle / interior	BH 07 - CSU 3	bone	*Homo sapiens*	KIA 37516	9,355	40	8,638	56	8,744-8,544	10,694-10,494
Blätterhöhle / interior	BH 04, probably CSU 3	bone	*Homo sapiens*	KIA 37509	9,370	45	8,652	58	8,762-8,546	10,712-10,496
Blätterhöhle / platform	BV 12 - SU 6a - 6b	charcoal	*Betula* sp.	COL 1971	9,371	46	8,653	59	8,767-8,491	10,716-10,441
Blätterhöhle / platform	BV 12 - SU 6a - 6b	charcoal	*Betula* sp.	COL 1972	9,379	51	8,660	63	8,788-8,491	10,738-10,441
Blätterhöhle / interior	BH 04, probably CSU 3	bone	*Homo sapiens*	KIA 24689	9,389	36	8,676	44	8,838-8,626	10,788-10,576
Blätterhöhle / platform	BV 11 - SU 6a - 6b	charcoal	*Betula* sp.	COL 1455	9,414	36	8,696	45	8,789-8,615	10,739-10,565
Blätterhöhle / interior	BH 04, probably CSU 3	bone	*Homo sapiens*	KIA 26265	9,435	40	8,713	51	8,805-8,606	10,755-10,556
Blätterhöhle / interior	BH 08 - CSU 3	bone	*Homo sapiens*	KIA 37515	9,460	45	8,748	67	8,846-8,622	10,796-10,572
Blätterhöhle / platform	BV 11 - SU 6b	charcoal	*Corylus avellana*	COL 1452	9,511	38	8,931	149	9,126-8,714	11,076-10,664
Blätterhöhle / interior	BH 08 - CSU 3	bone	*Homo sapiens*	KIA 45012	9,700	30	9,210	29	9,247-9,179	11,197-11,129
Blätterhöhle / platform	BV 09 - disturbed	charcoal	*Betula* sp.	COL 1448	10,981	40	10,949	96	11,027-10,779	12,977-12,729
Werl-Büderich	find horizon	charcoal	deciduous species	MAMS 15941	9,923	33	9,369	45	9,641-9,287	11,591-11,237
MG-Geneicken	Area 169-4 (aurochs site)	plant remain		COL 2616	9,770	58	9,246	38	9,340-8,936	11,290-10,886
MG-Geneicken	Area 181-193	charcoal		COL 2886.1.1	9,803	56	9,276	28	9,376-9,180	11,326-11,130
MG-Geneicken	Area 178-35a	charcoal		COL 2882.1.1	9,806	57	9,278	30	9,385-9,176	11,335-11,126
MG-Geneicken	Area 169-361a (aurochs site)	bone	*Bos primigenius*	COL 2681.2.1	9,925	55	9,431	105	9,659-9,277	11,609-11,227
MG-Geneicken	Area 169-361 (aurochs site)	bone	*Bos primigenius*	COL 2681	9,948	51	9,468	124	9,664-9,291	11,614-11,241
MG-Geneicken	Area 181-184	charcoal		COL 3098.1.1	9,987	42	9,513	117	9,747-9,317	11,697-11,267
MG-Geneicken	Area 178-35b	charcoal		COL 3201.1.1	10,021	46	9,585	155	9,802-9,363	11,752-11,313
Bedburg-Königshoven	preliminary sample	peat		KN-3883B	9,540	120	8,933	190	9,252-8,611	11,202-10,561
Bedburg-Königshoven	101/103 Vt 3/4	wood		KN-3998	9,600	100	8,998	163	9,260-8,722	11,210-10,672
Bedburg-Königshoven	preliminary sample	peat		KN-3883A	9,660	120	9,038	177	9,318-8,711	11,268-10,661
Bedburg-Königshoven	93/105	peat		KN-4001	9,690	85	9,074	156	9,290-8,820	11,240-10,770
Bedburg-Königshoven	100/107 Vt4	wood		KN-3999	9,780	100	9,176	174	9,461-8,823	11,411-10,773
Bedburg-Königshoven	87/108-4	bone	*Bos primigenius*	COL 2669.2.1			9,560		9,544	11,494
Bedburg-Königshoven	83-85/106-110	wood		KN-3997	10,010	85	9,598	192	9,981-9,292	11,931-11,242
Bedburg-Königshoven	85/105-3	bone	*Bos primigenius*	COL 2674.1.1			9,574		9,562	11,512
Bedburg-Königshoven	91/107-1	bone	*Bos primigenius*	COL 2672.1.1			9,579		9,569	11,519
Bedburg-Königshoven	96/108-1	bone	*Bos primigenius*	KN-4136	10,020	100	9,626	213	9,892-9,292	11,842-11,242
Bedburg-Königshoven	104/102-1 (Streu 33)	bone	*Bos primigenius*	COL 2680.2.1			9,608		9,592	11,542
Bedburg-Königshoven	93/110-1	bone	*Bos primigenius*	COL 2675.1.1			9,617		9,595	11,545
Bedburg-Königshoven	93/106-2	bone	*Bos primigenius*	COL 2948.1.1			9,641		9,593	11,543
Bedburg-Königshoven	97/107-3	bone	*Bos primigenius*	COL 2673.1.1			9,668		9,624	11,574
Bedburg-Königshoven	83-85/106-110	wood		KN-3996	10,070	95	9,701	233	10,043-9,324	11,993-11,274
Bedburg-Königshoven	97/107-4, 7	bone	*Bos primigenius*	COL 2671.2.1			9,758		9,747	11,697
Bedburg-Königshoven	93/106-2	bone	*Bos primigenius*	COL 2974.1.2			9,763		9,749	11,699
Bedburg-Königshoven	80/100	wood		KN-3995	10,270	90	10,134	255	10,466-9,695	12,416-11,645
Dormagen-Nievenheim	38-15-733	charcoal	*Betula* sp.	KIA 51665	10,136	73	9,792	214	10,098-9,451	12,048-11,401
Hohler Stein	excavation 1920/30s	bone	*Rangifer tarandus*	MAMS 11804	10,174	46	9,894	146	10,106-9,680	12,056-11,630
Hohler Stein	excavation 1920/30s	bone	*Rangifer tarandus*	MAMS 11805	10,198	39	9,947	127	10,129-9,804	12,079-11,754
Rhünda (Hesse)		bone	*Homo sapiens*	GrA-15947	10,200	60	9,939	158	10,180-9,676	12,130-11,626
Kartstein		bone	*Rangifer tarandus*	OxA-9031	10,220	75	9,988	192	10,428-9,665	12,378-11,615
	SU = Sedimentary Unit									
	CSU = Cave Sedimentary Unit									

Table 1 – Radiocarbon dates for the archaeology of the Pleistocene-Holocene interface (terminal Palaeolithic – early Mesolithic) in western Germany. Only dates considered to be reliable (on grounds of context, methodology, precision…) are included in this overview.
Tabl. 1 – *Datations radiocarbone de la transition Pléistocène – Holocène (Paléolithique final – Mésolithique ancien) en Allemagne de l'ouest. Seules les dates considérées comme fiables (pour des raisons de contexte, de méthodologie, de précision…) figurent dans cet inventaire.*

the upland zone to overwinter somewhere in the North European Plain. The surface of the Lyngby axe from Hohler Stein is quite weathered but the antlers from Minden and Marl-Sickingmühle still preserve traces of ancient anthropogenic surface modifications (fig. 3; Baales, 2013b).

Although none of the Lyngby antler axe specimens contained sufficient dateable collagen, it was possible

(CalPal)				
cal BP 1σ	Environment*	Archaeology	Details / Comments	Reference
10,402-10,268			*os parietale*	Baales et al., 2013b
10,593-10,513		Early Mesolithic		Stapel et al., 2013; Baales et al., 2013b
11,059-10,827		Early Mesolithic	elk antler mattock	Baales et al., 2013b
9,121-9,019	*late Boreal*	Middle Mesolithic	BV 07 - G4d/Po.112.2, close to Hearth 1	unpublished CRC 806, D4
9,098-9,024	*late Boreal/early Atlantic*	Middle/Late Mesolithic	BV 08 - E5a/Po.16.2, Hearth 2	unpublished DFG OR 98/6-1
9,255-9,093	*late Boreal*	Middle Mesolithic	BV 07 - G4d/Po.123.2, Hearth 1	unpublished CRC 806, D4
9,260-9,138	*late Boreal*	Middle Mesolithic	BV 08 - E5c/Po.15.5, Hearth 2	unpublished DFG OR 98/6-1
9,277-9,151	*late Boreal*	Middle Mesolithic	BV 09 - E4c/Po.36.2, Hearth 3 - pit filling	unpublished DFG OR 98/6-1
9,420-9,302	*middle Boreal*	Middle Mesolithic	BV 06 - F6/Po.18.1, juvenile mandible	unpublished DFG OR 98/6-1
9,426-9,300	*late Boreal*	Middle Mesolithic	BV 09 - E4c/Po.29.2, Hearth 3	unpublished DFG OR 98/6-1
9,500-9,456	*middle Boreal*	Middle Mesolithic	BV 08 - F4d/Po.11, Hearth 4	unpublished DFG OR 98/6-1
9,504-9,456	*middle Boreal*	Middle Mesolithic	BV 08 - E5c/Po.17, Hearth 2	unpublished DFG OR 98/6-1
9,521-9,479	*middle Boreal*	Middle Mesolithic	BV 08 - E5c/Po.19, Hearth 2	unpublished DFG OR 98/6-1
9,537-9,505	*middle Boreal*	Middle Mesolithic	BV 08 - E5c/Po.17, Hearth 2	unpublished DFG OR 98/6-1
9,601-9,549	*middle Boreal*	Middle Mesolithic	BV 08 - F4d/Po.13.1, Hearth 4	unpublished DFG OR 98/6-1
9,783-9,625	*middle Boreal*	Middle Mesolithic	BV 11 - G6a/Po.113.3, calcaneus	unpublished DFG OR 98/6-1
10,234-10,200	*early Boreal*	Middle Mesolithic	BV 09/11 - G5c/Po.117.3 + G6a/Po.115.1, metacarpal	unpublished DFG OR 98/6-1
10,470-10,302	*early Boreal*	Middle Mesolithic	BV 09 - E4d/Po.39.3, Below Hearth 3	unpublished DFG OR 98/6-1
10,486-10,330	*early Boreal*	Middle Mesolithic	BV 11 - G6a/Po.117.1	unpublished DFG OR 98/6-1
10,466-10,350	*early Boreal*	Middle Mesolithic	BV 09 - G5c/Po.115.3	unpublished DFG OR 98/6-1
10,537-10,357	*early Boreal*	Middle Mesolithic	BV 12 - H5c/Po.85.1	unpublished DFG OR 98/6-1
10,533-10,379	*late Preboreal/early Boreal*	Mesolithic	BV 06 - G5d/Po.49.2, *os parietale*	Bollongino et al., 2013
10,558-10,448	*late Preboreal/early Boreal*	Early/Middle Mesolithic	BV 09 - G5c/Po.107.2	unpublished DFG OR 98/6-1
10,636-10,434	*late Preboreal/early Boreal*	Early/Middle Mesolithic	BV 11 - G5a/Po.128.4	unpublished DFG OR 98/6-1
10,644-10,532	*late Preboreal*	Mesolithic	BH 07 - I4/Po.1, tibia	Bollongino et al., 2013
10,660-10,544	*late Preboreal*	Mesolithic	BH 04 - 174, tibia	Bollongino et al., 2013
10,662-10,544	*late Preboreal*	Early Mesolithic	BV 12 - G6b/Po.190.1	unpublished DFG OR 98/6-1
10,673-10,547	*late Preboreal*	Early Mesolithic	BV 12 - G6a/Po.174.1	unpublished DFG OR 98/6-1
10,670-10,582	*late Preboreal*	Mesolithic	BH 04 - 001-04/008, skull cap	Bollongino et al., 2013
10,691-10,601	*late Preboreal*	Early Mesolithic	BV 11 - G6a/Po.117.5	unpublished DFG OR 98/6-1
10,714-10,612	*middle/late Preboreal*	Mesolithic	BH 04 - 055, costa	Bollongino et al., 2013
10,765-10,631	*middle/late Preboreal*	Mesolithic	BH 08 - 14a/Po.44, radius	Bollongino et al., 2013
11,030-10,732	*middle Preboreal*	Early Mesolithic	BV 11 - G5a/Po.128.1	unpublished DFG OR 98/6-1
11,189-11,131	*early Preboreal*	Mesolithic	BH 08 - 16b/Po 22.1, *os parietale*	Bollongino et al., 2013
12,995-12,803	*Late Allerød*		BV 09 - G5c/Po.109.2	unpublished DFG OR 98/6-1
11,364-11,274	early Preboreal	Initial Mesolithic		Baales et al., 2013b
11,234-11,158	early Preboreal	Initial Mesolithic	in contact with skeleton, associated with 2 oblique microlith points	Heinen, 2014
11,254-11,198	early Preboreal	Initial/Early Mesolithic	from hearth, with calcined bone splinters and artefacts, some burned	unpublished
11,258-11,198	early Preboreal	Initial/Early Mesolithic	from hearth, with calcined bone splinters and artefacts, some burned	unpublished
11,486-11,276	early Preboreal	Initial Mesolithic	*os petrosum*, associated with 2 oblique microlith points	unpublished
11,542-11,294	early Preboreal	Initial Mesolithic	*os petrosum*, associated with 2 oblique microlith points	unpublished CRC 806, D4
11,580-11,346	initial Preboreal	Initial/Early Mesolithic	from hearth, with calcined bone splinters and artefacts, some burned	unpublished
11,690-11,380	initial Preboreal	Initial/Early Mesolithic	from hearth, with calcined bone splinters and artefacts, some burned	unpublished
11,073-10,693	middle Preboreal		level B or C	Street, 1991 and 1993; Street et al., 1994
11,111-10,785	middle Preboreal		Sample 4, level C1	Street, 1991 and 1993; Street et al., 1994
11,165-10,811	middle Preboreal		level B or C	Street, 1991 and 1993; Street et al., 1994
11,180-10,868	middle Preboreal		Sample 7, level B (reed peat), 51.50-51.60m	Street, 1991 and 1993; Street et al., 1994
11,300-10,952	middle Preboreal		Sample 5, level C1	Street, 1991 and 1993; Street et al., 1994
11,510	early Preboreal	Initial Mesolithic	ID Ur 009 (Ind 4), *os petrosum*	unpublished; for context Street, 1999
11,740-11,356	early Preboreal		Sample 3 (organic band)	Street, 1991 and 1993; Street et al., 1994
11,524	early Preboreal	Initial Mesolithic	ID Ur 014 (Ind 9), metacarpus	unpublished; for context Street, 1999
11,529	early Preboreal	Initial Mesolithic	ID Ur 012 (Ind 2), humerus, juvenile	unpublished; for context Street, 1999
11,789-11,363	early Preboreal	Initial Mesolithic	rib	Street, 1991 and 1993; Street et al., 1994
11,558	early Preboreal	Initial Mesolithic	ID Ur 016 (Ind 8), *os petrosum*	unpublished; for context Street, 1999
11,567	early Preboreal	Initial Mesolithic	ID Ur 015 (Ind 10), metacarpus	unpublished; for context Street, 1999
11,591	early Preboreal	Initial Mesolithic	ID Ur 20 (Ind 7), skull, horn core	unpublished; for context Street, 1999
11,618	early Preboreal	Initial Mesolithic	ID Ur 013 (Ind 11), metacarpus	unpublished; for context Street, 1999
11,884-11,418	Younger Dryas/Preboreal		Sample 2 (organic band)	Street, 1991 and 1993; Street et al., 1994
11,708	early Preboreal	Initial Mesolithic	ID Ur 011 (Ind 3), *os petrosum*	unpublished; for context Street, 1999
11,713	early Preboreal	Initial Mesolithic	ID Ur 021 (Ind 6), *os petrosum*	unpublished; for context Street, 1999
12,339-11,829	Younger Dryas		Sample 1 (basal sandy silts)	Street, 1991 and 1993; Street et al., 1994
11,956-11,528	Younger Dryas/Preboreal	"Long Blade" industry		Heinen, 2017
11,990-11,698	Younger Dryas	Ahrensburgian	*os parietale*	Baales et al., 2013b
12,024-11,770	Younger Dryas	Ahrensburgian	femur	Baales et al., 2013b
12,047-11,731	Younger Dryas		skull, calotte	Rosendahl, 2002
12,130-11,746	Younger Dryas	Ahrensburgian	femur	Bronk Ramsey et al., 2002
	*The environmental attribution of the Blätterhöhle deposits is on the basis of the calibrated radiocarbon chronology only.			

to obtain radiocarbon dates for both the Hohler Stein and the Kartstein sites on other faunal remains (Bronk Ramsey et al., 2002; Weber et al., 2011; Baales et al., 2013a). Many of the Kartstein dates must be rejected for reasons of poor context (*e.g.* no evidence for human association, sometimes bulked samples…) or methodology (inadequate pretreatment/low precision of conventional results…). The three dates remaining for the two Ahrensburgian contexts all fall towards the end of the Younger Dryas stadial (table 1).

It has been suggested that during the final phase of the Ahrensburgian, while the overall technology of lithic assemblages remained unchanged, the lithic armature component was characterized by a reduction in size of the typical tanged points and the appearance/increase in numbers of so-called simple microlithic

("Zonhoven") points created by oblique retouch (cf. Taute, 1968; Richter, 1981; Baales, 1996). Although it is difficult to define an exact chronology for this development it probably dates to the end of the Younger Dryas stadial. Ultimately, the total disappearance of tanged points and their replacement by oblique retouched points at the onset of the Holocene has led to nomenclatural proposals such as "tanged point groups without tanged points" (Veil, 1987), a phenomenon discussed below.

"LONG BLADE INDUSTRIES" AT THE PLEISTOCENE – HOLOCENE BOUNDARY

The boundary between the Pleistocene and the Holocene is marked in north-western Europe by the appearance of lithic assemblages characterized by the presence of long and regular rectilinear blades, serially produced from exhaustively worked broad and partially bipolar cores, which are usually associated with various simple microlithic and/or basally retouched points of "Zonhoven-type". These "Long Blade industries" are particularly well known from southern England (Barton, 1998; Lewis and Rackham, 2011) and northern France (here also referred to as the "*Belloisien*": Fagnart, 1997; Valentin, 2008), but are also found in contexts much further to the North (Sørensen and Sternke, 2004). At a number of "Long Blade" sites the edges of some of the heavier laminar elements show very distinctive patterns of invasive flake negatives. They are referred to as "bruised blades" or "*lames mâchurées*" and were probably used for some sort of chopping or battering activity (Barton, 1986; Fagnart and Plisson, 1997).

Western German sites assigned to the "Long Blade industries" include Saerbeck-Sinningen (Stapel, 2006, 2013a and 2016), Westerkappeln-Brennesch (fig. 4, nos. 2-10; Stapel, 2010 and 2013b), Lüdinghausen-

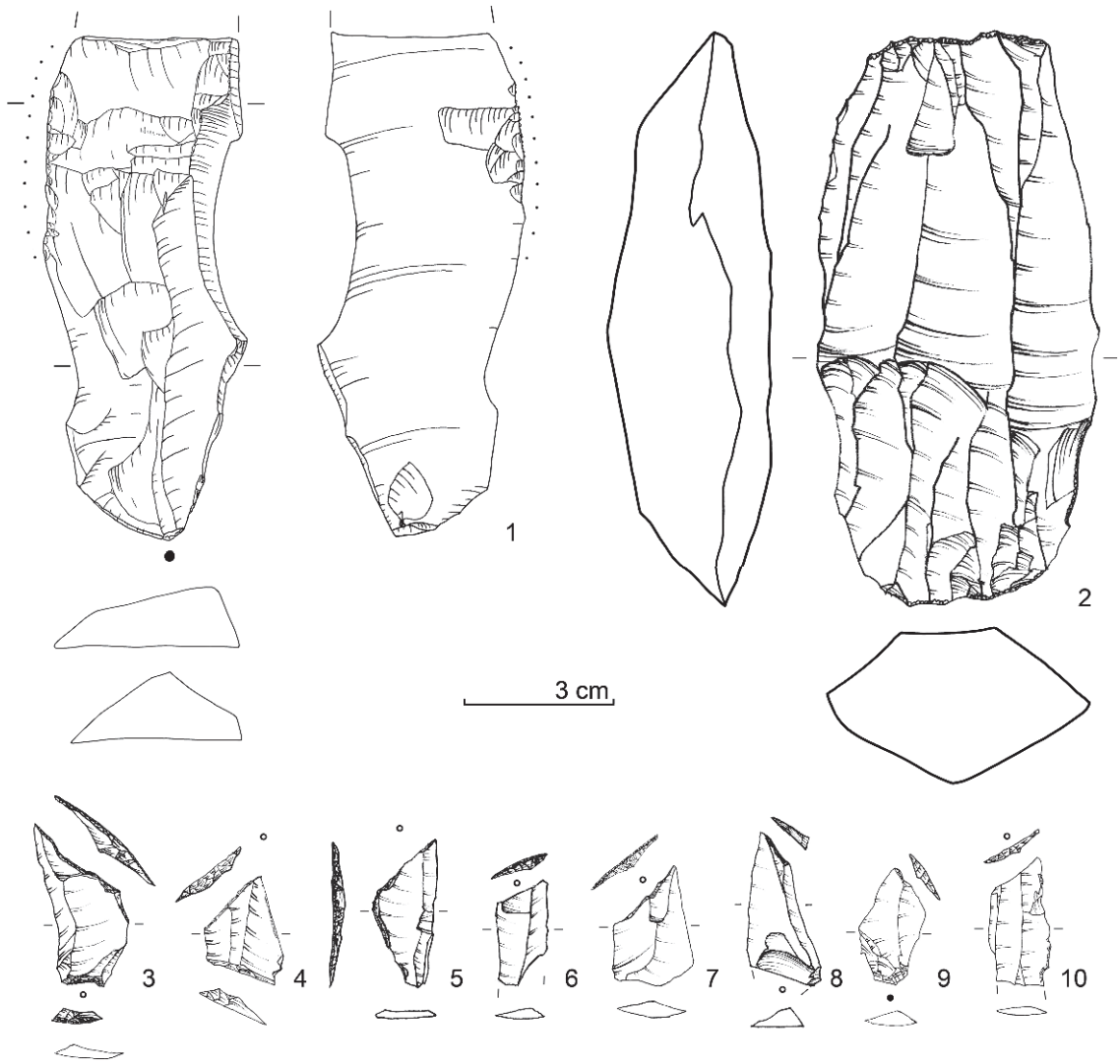

Fig. 4 – Westphalian "Long Blade" finds from Wettringen (1) and Westerkappeln-Brennesch (2-10): 1 bruised blade; 2 large blade core; 3-10 microliths; all made of Baltic flint (drawings: LWL/K. Koana, M. Kloss).
Fig. 4 – *Vestiges lithiques des séries de type « Long Blade » de Westphalie à Wettringen (1) et Westerkappeln-Brennesch (2-10) : 1 lame mâchurée ; 2 nucléus à lames larges ; 3-10 armatures ; tous en silex baltique (dessins : LWL/K. Koana, M. Kloss).*

Emkum II, Rheine-Altenrheine (Stapel, 2013b), and Wettringen (which produced a bruised blade; fig. 4, no. 1; Baales et al., 2015; Stapel, 2016), all in Westphalia, and the Rhineland sites Übach-Palenberg (Jöris and Thissen, 1997) and Dormagen-Nievenheim (this paper).

Comparable very large blades ("*Riesenklingen*"), sometimes in the form of bruised blades with battered edges, also occur together with tanged points and microlithic Zonhoven points in some Ahrensburgian contexts (*e.g.* in Rissen 14a, Stellmoor, Teltwisch 2, Borneck-Ost and Borneck-Nord; Taute, 1968) in which case they are assigned to the Younger Dryas-Preboreal transition. The absence of tanged points in "Long Blade" assemblages thus probably reflects an even younger chronological position, exactly at the transition from the Pleistocene to the Holocene, when they probably represent only a short-lived phenomenon[1].

At most western German "Long Blade" sites no organic matter has been preserved which might be radiometrically dated so that the estimation of the chronological position of these industries is largely based on techno-typological arguments. The suggested dating of the assemblage is supported at Übach-Palenberg by strong stratigraphic arguments (Jöris and Thissen, 1997, p. 613-615, fig. 3) since the "Long Blade" assemblage here lay within cover sands but stratigraphically below the numerous Mesolithic assemblages.

DORMAGEN-NIEVENHEIM

The recent discovery of a new "Long Blade" site in the Rhineland has provided the first evidence for the radiometric age of this phenomenon. Archaeological investigations in 2016 near Dormagen-Nievenheim, some 10 km south of Düsseldorf, uncovered settlement structures located close to a channel of the late Pleistocene Rhine braided river system (Heinen, 2017). The Palaeolithic finds were embedded in and covered by deposits of high flood loam which are OSL dated to about 11.5 ± 0.9 ky BP. An area of 366 m^2 was investigated, uncovering two artefact concentrations some 10 m apart, which together produced 2,355 lithic artefacts. Both areas contained burnt artefacts and bone fragments suggestive of hearths and yielded the same range of tool types (fig. 5): Zonhoven points with and without basal retouch, backed bladelets, scrapers, burins and large numbers of blades with use wear. Most of the 138 retouched tools, particularly scrapers and burins, are made on larger blades of good quality. The largest blade, although incomplete, measures 17 cm in length.

The composition of the raw material is remarkable. Moraine-transported (Baltic) Cretaceous flint is the dominant material (76%) among which is a specific type (1.4%) identified as red Heligoland flint.

The distance between the Rhineland site and Heligoland is almost 350 km and Nievenheim appears to be the most southern evidence for Heligoland flint in Europe known to date. Alongside the northern raw material, Cretaceous flint of western origin (~ 21%) was used, among which are materials derived from Meuse river gravels and of Rijckholt type transported over distances of 40-80 km. A few artefacts are made of Lousberg Flint obtained from an outcrop which today lies at the centre of the city of Aachen some 80 km to the southwest. The combination of Zonhoven points with very long rectilinear blades would on its own identify Nievenheim as a "Long Blade" industry from the end of the late Palaeolithic. Moreover, the techno-typological attribution of the site is supported by an AMS date for birch-charcoal from the middle of one concentration (KIA 51665: 10,136 ± 73 BP/ ~ 11,750 cal. BP) which falls just at the transition from Younger Dryas to Preboreal (table 1), exactly the same period as the sites of Three Ways Wharf in England (Barton, 1998; Lewis and Rackham, 2011) and Belloy-sur-Somme in France (Fagnart, 1997).

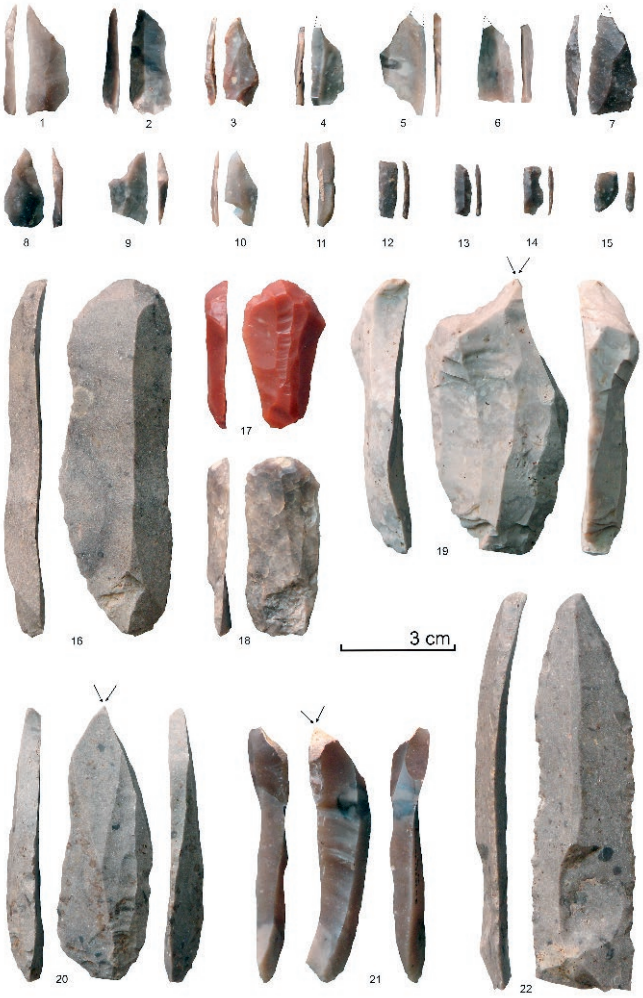

Fig. 5 – Dormagen-Nievenheim, "Long Blade" artefacts including a specimen manufactured of characteristic red Heligoland flint (photo: M. Heinen).
Fig. 5 – *Dormagen-Nievenheim, Industrie de type "Long Blade" comprenant un exemplaire en silex rouge caractéristique de Heligoland (cliché : M. Heinen).*

BLÄTTERHÖHLE

Mesolithic horizons uncovered in the rock shelter platform in front of the Blätterhöhle, a small cave at Hagen in the northern Sauerland region, have been under investigation for several years (see below). Excavations have also provided hints for an older, late glacial occupation (fig. 6). Birch wood charcoal (*Betula*) from a disturbed area (possibly due to animal burrowing) was radiocarbon dated (COL 1448: 10,981 ± 40 BP) to ~ 12,900 cal. BP (table 1) and a few lithics recovered from disturbed sediments belong to a pre-Mesolithic context.

The 2016 to 2019 excavations of a small area of deposits from the very end of the Pleistocene produced beside some flint blades several small and/or slender backed points, distinct from Mesolithic types, mostly linked to a greyish sediment layer (fig. 7). Of special interest is a small bi-pointed piece resembling a tanged point (Heuschen et al., 2017 and 2018; Orschiedt et al., 2017). The variety of points most possibly correspond to similar elements from French (Épi-Laborien) or Belgian assemblages with further distinct backed elements variously described as Blanchères- or Auvours-type points and small tanged pieces (Naudinot, 2008 and 2013, fig. 1, no. 2; Naudinot and Jacquier, 2009; Devriendt et al., 2010).

THE INITIAL MESOLITHIC OF THE EARLY PREBOREAL

A number of further lithic assemblages from western Germany and adjacent regions of north-western Europe are characterized by obliquely retouched microlithic points and by quite large blades which are however smaller and less standardized than those of the "Long Blade" tradition. These assemblages present clear differences to unambiguous Mesolithic assemblages characterized by regular narrow lamellar debitage (bladelets), base retouched micropoints and geometric microliths. Although they often lack precise stratigraphic or radiometric contextual controls they can probably be attributed to the initial Holocene.

Sites such as Duisburg-Kaiserberg in the Rhineland (Tromnau, 1982; Baales, 1996, p. 318) or Gramsbergen and Swalmen in the northern Netherlands (Stapert, 1979; Johansen and Stapert, 2000) were suggested to derive from or represent the final expression of a Final Palaeolithic tradition of blade production. Even though tanged points are absent this was specifically equated with the Ahrensburgian of the Younger Dryas stadial as reflected by terminology such as "*Epi-Ahrensbourgien*" (Gob, 1991). Although the equivalent German term "*Stielspitzengruppen ohne Stielspitzen*"/"tanged point groups without tanged

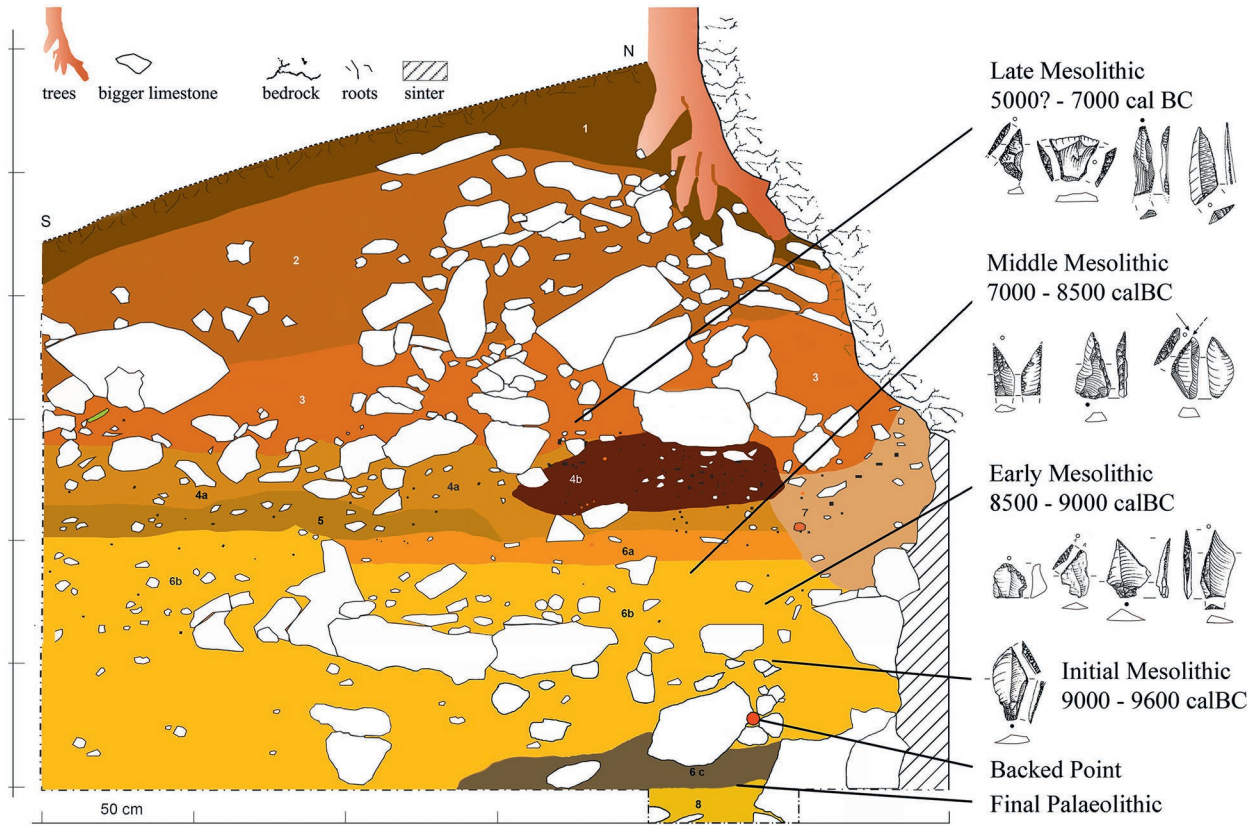

Fig. 6 – Idealized stratigraphy of the Blätterhöhle cave platform "Vorplatz" (drawing: LWL/W. Heuschen, S. Grunwald; University of Cologne/B. Gehlen, J. Orschiedt).
Fig. 6 – *Stratigraphie synthétique du porche de la grotte de « Blätterhöhle » (dessin : LWL/W. Heuschen, S. Grunwald ; Université de Cologne/B. Gehlen, J. Orschiedt).*

Fig. 7 – Lithic projectile points of the Blätterhöhle Final Palaeolithic sediments. Sediment 6b: 1 partially backed, slender point (moraine-transported flint); 3 basal retouched, broken backed point (Malaurie point-like, lydite); 6 straight backed point (lydite). Sediment 6c: 2 partially backed point (moraine-transported flint); 4 curved backed point with impact fracture (erratic flint); 5 slender atypical tanged point (moraine-transported flint) (photos: LWL/H. Menne, A. Müller).
Fig. 7 – *Pointes de projectiles lithiques provenant des niveaux du Paléolithique final de Blätterhöhle. Couche 6b : 1 pointe à dos partiel (silex transporté par les moraines) ; 3 pointe à dos à base retouchée fragmentée (« pointe de Malaurie », lydite) ; 6 pointe à dos rectiligne (lydite). Couche 6c : 2 pointe à dos partiel (silex transporté par les moraines) ; 4 pointe pédonculée atypique à dos courbe portant une fracture d'impact (silex transporté par les moraines) ; 5 pointe pédonculée atypique (silex transporté par les moraines) (clichés : LWL/H. Menne, A. Müller).*

points" (Veil, 1987) was applied to an assemblage from Höfer near Celle in Lower Saxony, this was interpreted here as reflecting functional variability within the Tanged Point complex and not a chronologically younger derivation.

Looking beyond present day continental Europe to the British Isles, similar assemblages with microliths in association with a significant component of larger blades ("Broad Blade" tradition) have here long been accepted as a manifestation of the Early Mesolithic (Jacobi, 1978) and this interpretation will be adopted here for the following earliest (Initial) Mesolithic sites and inventories.

Bedburg-Königshoven

One of the very few early Mesolithic sites of this type in western Germany to be found in stratigraphic context is the Rhineland locality Bedburg-Königshoven (Street, 1991, 1993 and 1998). Excavation of the surviving part of a waterside encampment produced a small lithic assemblage and well preserved remains of hunted large and medium-size mammals discarded as butchered waste into the off-bank area adjacent to the site. The hunted species – aurochs (*Bos primigenius*), red and roe deer (*Cervus elaphus*/*Capreolus capreolus*), wild pig (*Sus scrofa*) and horse (*Equus* sp.) – indicate temperate conditions, with woodland but also open spaces.

Among the recovered faunal remains were two bone tools and two "frontlets" of red deer antler which show affinities with other northern European early Mesolithic sites (summary in Street and Wild, 2015), while the hunting of aurochs as the principal game species finds parallels at early Holocene localities such as Potsdam-Schlaatz in Brandenburg (Benecke et al., 2002) or Alizay in northern France (attributed to the Belloisien; Bémilli et al., 2014).

Stratigraphic, palynological and radiometric evidence shows that the organic gyttja containing the Bedburg archaeological assemblage formed in sub-aquatic conditions during the middle Preboreal (Street, 1991) and it was assumed until recently that the age of the deposit was the exact equivalent of that of the contained bones. Attempts to radiocarbon date the faunal assemblage directly using conventional bulk samples had delivered anomalous results, probably due to unrecognized contaminants, and were rejected. However, a recent project by two of the authors (BG, MS) has dated several aurochs individuals directly using AMS and rigorous pretreatment protocols.

The new results show conclusively that the occupation of the Bedburg site was earlier than was thought and dates to the initial Preboreal at the very beginning of the Holocene warming event (table 1). The formation of gyttja took place subsequently during the Middle Preboreal as this sediment was precipitated onto the discarded butchery waste lying on the bed of

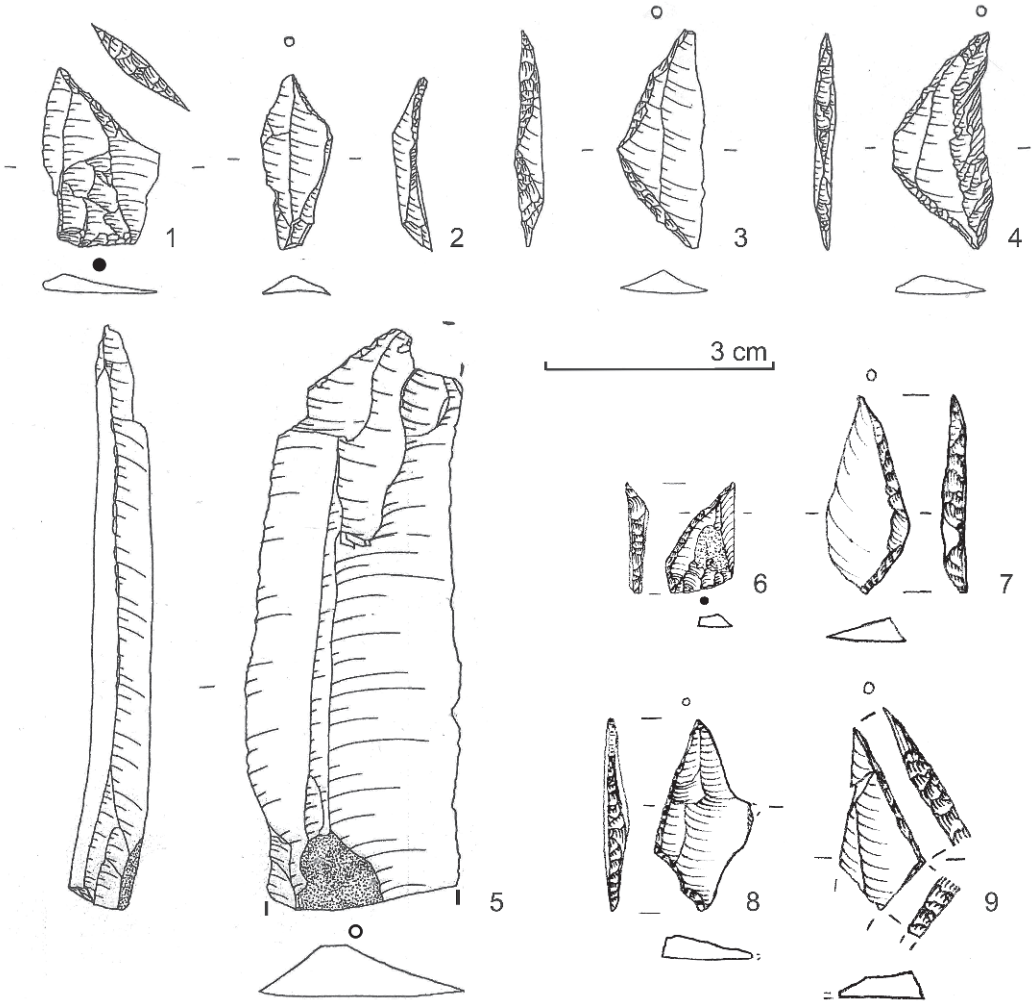

Fig. 8 – "Broad Blade" lithic artefacts from Heek-Nienborg (1-5) and Werl-Büderich (6-9): 1 Zonhoven point; 2 concave truncated point; 3 scalene triangular point; 4 elongated trapeze; 5 one of the broad blades; 6 Zonhoven point with a unilateral edge retouch; 7 rhombic slightly bent point; 8 slightly notched point; 9 fragment of a triangular point (drawings: LWL/J. Piesniewski; University of Cologne/B. Gehlen, A. Zander, K. Vogl).

Fig. 8 – *Industrie de type « Broad Blade » provenant de Heek-Nienborg (1-5) et Werl-Büderich (6-9): 1 pointe de Zonhoven ; 2 pointe à troncature concave ; 3 triangle scalène ; 4 pointe trapézoïdale ; 5 lame large ; 6 pointe de Zonhoven avec retouche marginale unilatérale ; 7 pointe rhomboïdale légèrement anguleuse ; 8 pointe à faible cran ; 9 fragment d'armature triangulaire (dessins : LWL/J. Piesniewski ; Université de Cologne/B. Gehlen, A. Zander, K. Vogl).*

the meander during the process of silting up and subsequent overgrowth.

The very early Holocene context of the site can now be defined more clearly and the interpretation of the technology and typology of the lithic artefact assemblage (relatively large blades and a non-geometric microlithic spectrum) as characteristic for the "Broad Blade" tradition can now be explained by the Initial Mesolithic status of the Bedburg site at the very beginning of the Holocene.

Heek-Nienborg

At the site of Heek-Nienborg in the western Münster region of Westphalia, a total of 361 lithics were recovered which bear similarities to the assemblage from Bedburg-Königshoven. However, no organic artefacts were preserved making it difficult to confirm this possible Initial Mesolithic date of the assemblage. Among the finds were 12 microliths, including a triangular point and an elongated trapeze, which suggested a possible Early Mesolithic occupation. The assemblage further contains several well-made large blades of up to 76 mm length, which although initially regarded as quite unusual in the Mesolithic context have led to the subsequent identification of the inventory as a "Broad Blade" assemblage (fig. 8, nos. 1-5).

Over 70% of the artefacts from Heek are made of Baltic flint, which was available locally from the terminal moraine of the Saale/Drenthe glaciation. However, an analysis of the raw material showed that 87 artefacts were made of Western European flint. An investigation of the cortex indicates that at least some of these pieces were made of flint deriving

from southern Limburg in the Netherlands. This primary source is located over 100 km to the southwest of Heek-Nienborg, showing a possible cultural connection to this western region. Based on the small size of the assemblage the site of Heek-Nienborg was probably occupied for a short period of time only (Zander, 2016a, 2016b and 2016c).

Mönchengladbach-Geneicken

In 2013 and 2014 extensive excavations at the Rhineland site of Mönchengladbach-Geneicken (Heinen, 2015) uncovered Final Palaeolithic and early Mesolithic finds and features in several locations over a total area of 2,723 m^2 (fig. 9). Of outstanding importance are more than 150 bones of an aurochs found at the bottom of a palaeo-channel of the River Niers which silted up during the Preboreal (Area 169). The bones were distributed over a surface of approximately 25 m^2 and represent almost 80% of the entire skeleton. Two microliths found among the remains show that the animal was killed by Mesolithic hunters. Radiocarbon dates show that the Geneicken aurochs was hunted towards the middle of the 12th millennium BP (table 1).

To judge by the almost complete representation of the skeletal material, the aurochs must have been killed near to the place of discovery. After butchery the waste and unwanted remains of the animal were discarded into the shallow water-filled channel. Several smashed long bones show that the marrow was first extracted from them. The discovery at Geneicken represents the most complete archaeological skeleton of an aurochs in Germany and the association of the hunted animal and arrow armatures remains unique for the country, although close parallels are known (Aaris-Sørensen and Brinch Petersen, 1986; Hartz and Winge, 1906; Noe-Nygaard, 1973).

It is unclear whether the hunting event represented by the aurochs skeleton is related to one or both of two broadly contemporary concentrations of Mesolithic finds excavated some 10 m (Area 177/178) and 20 m (Area 181) away from the channel. Each of the areas contained a hearth, numerous flint artefacts and a few bones. The assemblage from Area 181 contains basally retouched triangular points and their presence here might demonstrate the replacement of Initial Mesolithic assemblages (possibly without geometric microlithic elements) by others with such geometric forms, which might be ultimately of southern origin.

Werl-Büderich

In 2011, an open-air site with preserved, unburnt animal remains was discovered by chance on farmland near Werl-Büderich in the southern part of the Westphalian Embayment. This locality in the fertile loess region known as the Soester Börde turned out to be one of the earliest Mesolithic sites identified on the North European Plain. The fact that in addition to lithic artefacts animal bones and teeth and a fragment of red deer antler have been preserved in calcareous, silty sediments is of special interest. This was the first discovery of unburned animal remains certainly attributed to an Early Mesolithic open-air site in Westphalia. Most of the remains are identified as red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*), with a few fragments of wild boar (*Sus scrofa*) and red fox (*Vulpes vulpes*), all of which would be expected representatives of an Early Holocene fauna. Due to the generally bad preservation of bone surfaces, no cut marks are recognizable. However, the fragmentary skeletal remains in some cases show oblique breakage patterns generally accepted as a typical feature of green bone fracture, possibly due to intentional human smashing to gain bone marrow.

None of the bones from Werl-Büderich could be dated because of the lack of collagen, however a charcoal fragment (identified by Ursula Tegtmeier from Cologne University as a deciduous tree) was radiocarbon dated (MAMS 15941) to 9,923 ± 33 BP (table 1). The charcoal was recovered from a probable hearth in the western part of the excavation and is therefore assumed to derive from the Mesolithic settlement activities. With a calibrated age of 11,320 cal. BP Werl-Büderich is one of the oldest dated Mesolithic assemblages in Germany, or indeed in the whole of the north-west European Lowlands.

188 lithic artefacts (83%) are made of easily accessible "Baltic" moraine flint transported to the region by the Drenthe glaciation. This material can be collected in the Soester Börde, however, since larger flint nodules usually show numerous frost cracks and therefore tend to shatter irregularly when knapped, mainly small, compact nodules were selected for lithic production. Apart from a single flake made of a fine-grained quartzite the remaining lithic assemblage (16.5%) is made of siliceous slate (black lydite), a raw material which can be found in primary outcrops in the adjacent northern Westphalian uplands, the Sauerland (some 20 km away) or as pebbles within river gravels (*e.g.* the Ruhr, which is 6 km away). This pattern demonstrates the migration of the Büderich hunter-gatherer group from the southern uplands into the Soester Börde area. The biggest artefact – a broad flake 8 cm in length – is of lydite and has a heavily battered edge that may have resulted from working organic material. The five microliths identified at Werl-Büderich (fig. 8, nos. 6-9) are made of Baltic flint and comprise a Zonhoven point with unilateral edge retouch, a lanceolate form, and three irregular scalene triangles (Zander, 2016b). The Werl-Büderich assemblage shows a degree of similarity to one from the well-known site of Friesack 27a, layer 8 in Brandenburg in the northern German Lowlands (Gramsch, 2002; Groß, 2017; Groß et al., this volume). However, the inventory from Friesack 27a, seems to be slightly younger than Werl-Büderich, as it is dated to around 11 ky cal. BP at the beginning of the middle Preboreal.

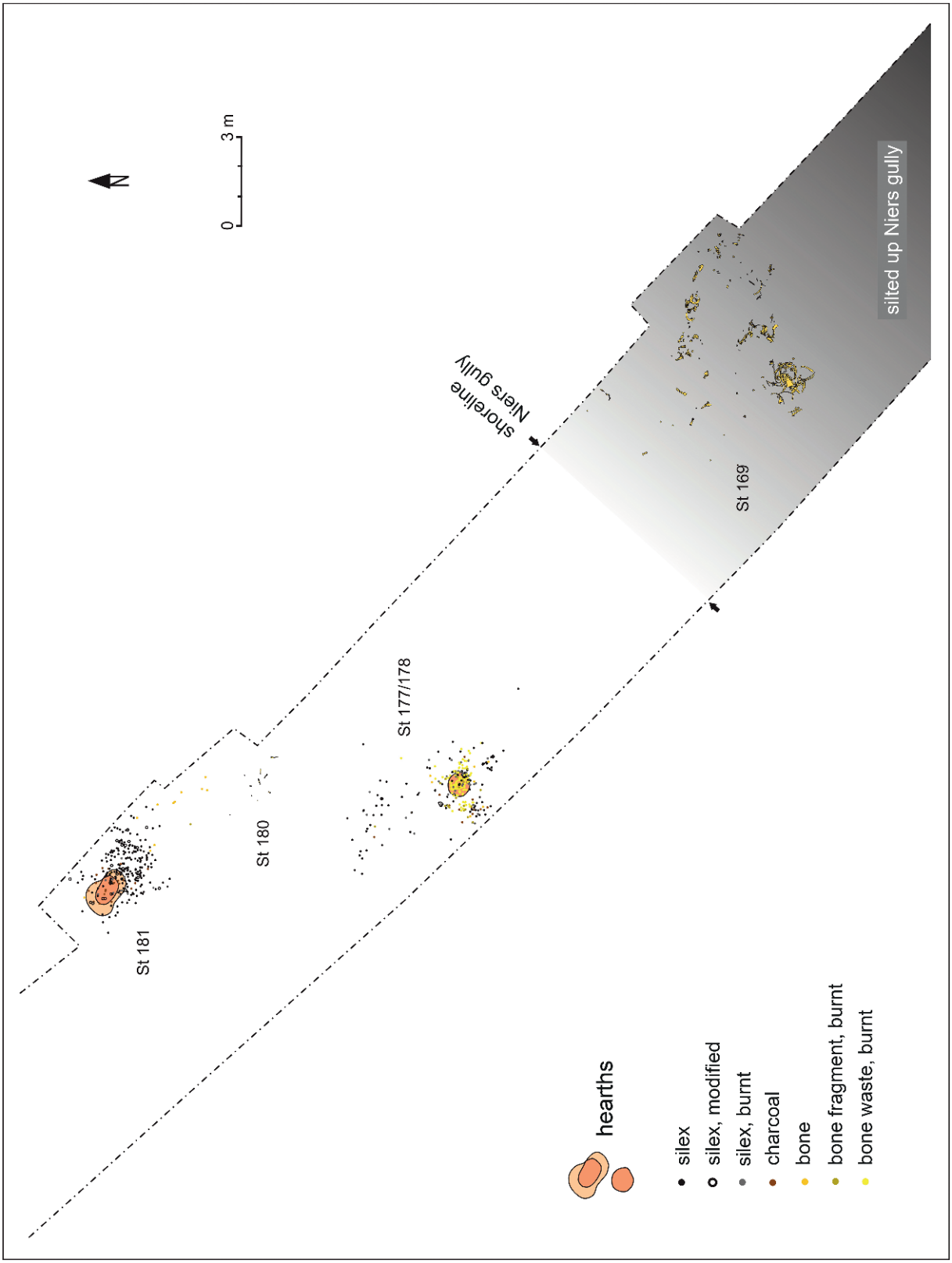

Fig. 9 – Plan of the early Holocene Mesolithic site Mönchengladbach-Geneicken (drawing: M. Heinen).

Fig. 9 – *Plan d'ensemble du gisement mésolithique de Mönchengladbach-Geneicken attribué à l'Holocène ancien (dessin : M. Heinen).*

EARLY TO LATE PREBOREAL ARTEFACTS AND SITES

Mesolithic bone and antler artefacts from the Westphalian Embayment

Similarities to (or perhaps influences from?) the North European Lowlands can be recognized in the Early Mesolithic Westphalian Embayment on the basis of analyses of organic single finds. Some decades ago, a mattock-head of elk (*Alces alces*) antler (fig. 10) was found in a sandpit near Paderborn-Sande in eastern Westphalia. Such implements are characteristic of the northern European early Mesolithic (Preboreal to Early Boreal) Maglemosian (Pratsch, 2006, p. 53). The specimen from Paderborn-Sande has an elongated, carefully shaped working edge and the perforation, which is located diagonally to the longer axis of the antler, penetrates the proximal part of the palmate area at an oblique angle. The implement is AMS-dated (MAMS 14119: 9,591 ± 30 BP) to the second half of the Preboreal, around 11 ky cal. BP (Stapel et al., 2013). This object in particular strongly suggests that the Early Mesolithic of the Westphalian Embayment formed part of a region subject to Nordic influences.

Sub-aquatic sand dredging at locations within the Westphalian Embayment has resulted in occasional discoveries of slender bone points, so called Duvensee points. They are of types common for the Maglemosian, but may also have been in use during the late glacial (Cziesla and Pettitt, 2003). Only one attempt to directly date the Westphalian specimens was successful, however a basal fragment found during sand dredging at Greven-Bockholt was dated to 10.7 cal. BP (MAMS 18465: 9,402 ± 32 BP) and therefore to the late Preboreal-early Boreal transition (Stapel and Schlösser, 2014). This fragment is similar to those from the Early Mesolithic of Friesack (Gramsch, 2011, p. 23, fig. 9, 28).

Hagen "Rieger Busch"

Although broad micro-points with dorsal-ventral basal retouch already appear in south-western Germany in Beuronien A contexts dating to the middle Preboreal (*e.g.* layer 13 at the Jägerhaus-Höhle: Heinen, 2005, p. 154-156; Gehlen, 2009, p. 373), no such microliths have yet been identified from contemporary contexts in Westphalia and further north. The tradition of dorsal-ventral basal retouch on micro-points first began

Fig. 10 – Distinctive Early Mesolithic elk antler mattock-head from Paderborn-Sande. Such implements are typical of the northern European Early Mesolithic (Maglemosian sites, Star Carr) dated to ca 11.0 ky cal. BP (photo: LWL/S. Brentführer, A. Müller, from: M. Baales et al., 2015, fig. 7).

Fig. 10 – *Pic de bois d'élan caractéristique du Mésolithique ancien provenant de Paderborn-Sande. De tels outils sont typiques du Mésolithique ancien d'Europe du nord (sites Maglemosiens, Star Carr), datée à ca 11.0 ky cal. BP (cliché : LWL/S. Brentführer, A. Müller ; d'après M. Baales* et al., *2015, fig. 7).*

to expand northward only during the Boreal, however without gaining in importance comparable to that in southern and western Germany (cf. Gehlen, 2009; Koch et al., 2017), and in fact never reached eastern and northern Germany (cf. Cziesla, 2016).

Bearing this in mind, it is interesting to note that broad micro-points with dorsal-ventral basal retouch are represented in the Early Mesolithic lithic assemblage from Hagen "Rieger Busch". Located at the northern edge of the Sauerland, the site was excavated in the 1980s by amateurs and produced a small lithic assemblage together with some charcoal. One of us (NS) has recently analyzed the lithic inventory in the course of a thesis at the University of Cologne (Schneid, 2013 and 2017), while some of the charcoal determined as willow by Ursula Tegtmeier (who excluded a number of intrusive recent fragments) was dated by the Mannheim laboratory (MAMS 14123: 9,333 ± 36 BP). The calibrated age of around 10.6 ky cal. BP provides a Late Preboreal context for the lithic assemblage (Stapel et al., 2013).

The presence of basally-retouched micro-points alongside triangular microliths shows that some influence from regions to the west and south extended at least as far as the southern part of the Westphalian Embayment. Since the Hagen "Rieger Busch" microlithic assemblage also includes four slender lanceolate points of a type present at Friesack during the Late Preboreal (Gehlen, 2009, p. 367) it appears that quite different regional influences are represented during this period, at least in southern Westphalia (Schneid, 2017).

The Blätterhöhle – a unique Mesolithic stratigraphy in Westphalia

Although the presence of hundreds of open-air sites demonstrates that the whole of the Central European uplands were used intensively during the Mesolithic, only few excavations of material in stratified context have been conducted in this region using modern techniques like in the sandstone areas of the Göttingen forest (Lower Saxony; Grote, 1994) and northern Bohemia (Svoboda et al., 2007 and 2013). In our region the Westphalian cave and rock shelter site Blätterhöhle (see above) is of special interest for the question of Early to Late Mesolithic settlement in the northern Central European upland zone. The discovery of human remains in 2004 within the narrow cave fissure first drew attention to the site and in subsequent years these finds were supplemented by further human remains and the excavation of several hearths and lithic finds in stratigraphic superposition in front of the small cave entrance. The area in front of the Blätterhöhle was identified as a former rock shelter and has now been excavated methodically since 2006, proving to be of exceptional importance for the Early to Late Mesolithic chronology of Westphalia (Orschiedt et al., 2010, 2012, 2013, 2015 and 2017; Heuschen et al., 2016, 2017 and 2018).

Upon discovery, the cave entrance initially appeared only as a small hole, however recent excavations revealed that the opening was originally much larger and had only subsequently been buried by a 1.5 m thick debris layer collapsed from the rock shelter roof.

Sediments containing Mesolithic lithic artefacts and faunal remains identified and excavated below this debris so far cover a sequence including the second half of the Preboreal, early, middle and late Boreal, and probably the early Atlantic (table 1). High concentrations of charcoal due to the existence of former hearths located at different parts of the site are dated exclusively to the Middle Mesolithic. The amount of charcoal in earlier and later levels indicate further structures which were destroyed by taphonomic processes. Microlithic spectra here correspond to the chronological periods suggested by the radiocarbon dates, and thus represent the first stratified sequence of Mesolithic artefacts to be identified at a single Westphalian site (fig. 6). Oblique retouched microliths and irregular specimens of triangular shape similar to elements in the Werl-Büderich assemblage are assigned, together with a large semi-lunate, to the Preboreal. Nevertheless, the majority of finds are dated to the late Boreal Middle Mesolithic – including some surficially retouched microliths of the older Rhine-Meuse-Schelde Mesolithic (RMS A; cf. Baales et al., 2013b, p. 217-218) – showing this to be the main phase of occupation at the site, as was already indicated by most dates for the hearths. A few Late Mesolithic artefacts found in stratigraphic position above the later Middle Mesolithic find horizon have up to now not been associated with any features identified as hearths.

Human remains from the Blätterhöhle

Human remains found since 2004 in the small and narrow interior of the Blätterhöhle cave can be assigned to both the Late Neolithic and the Early Mesolithic (Orschiedt et al., 2010, 2012, 2013, 2014, 2015, 2017 and in press). According to micromorphological analyses, the lower layer of the Blätterhöhle was partly disturbed by rodent activity and contained the remains of a minimum of five Mesolithic individuals, including two children. All radiocarbon dates on six of the human bones cluster between 10.5 ky and 10.8 ky cal. BP (see table 1) and can therefore be attributed to the middle and late Preboreal (Orschiedt et al., 2010 and 2012; Bollongino et al., 2013).

An additional small human cranial fragment with an age of 11,150 cal. BP (KIA 45012: 9,700 ± 30 BP) is the earliest Mesolithic human find at the site and probably one of the oldest postglacial human remains in Central Europe (Orschiedt et al., 2010 and 2012). In stratigraphic association but at a slightly higher level than the human remains were found three boar skulls without canines and mandibles. Direct dating suggests they are a few hundred years younger but they are in a similar spatial context as the humans.

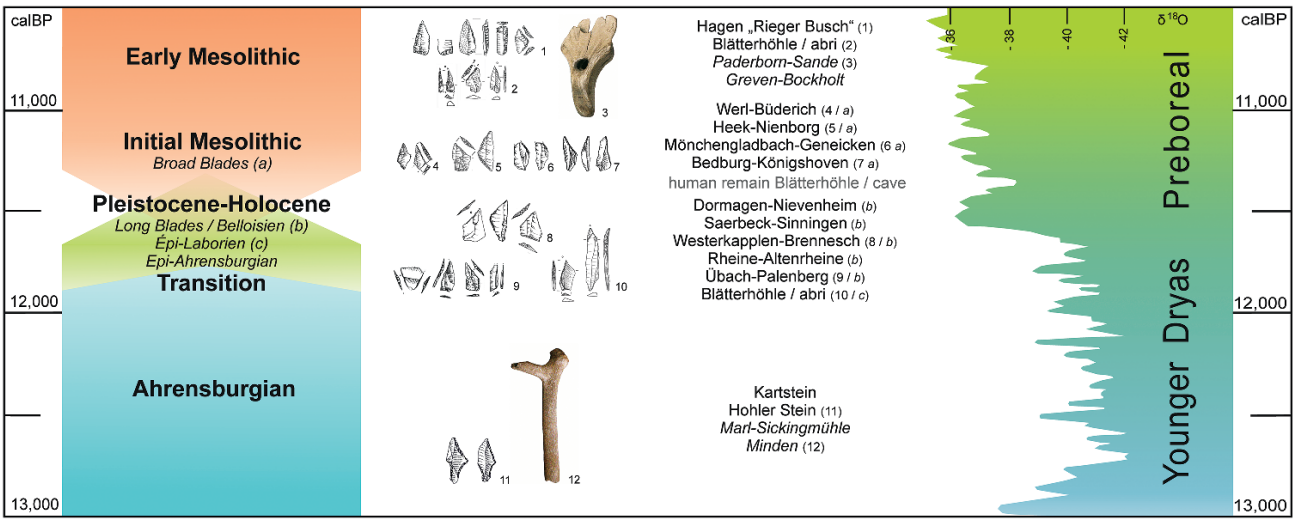

Fig. 11 – Proposed chronology for the archaeology of the Pleistocene-Holocene interface (terminal Palaeolithic – early Mesolithic) in western Germany based on the few radiocarbon dated sites and occurrence of distinct "Long Blade", "Broad Blade" and younger microlithic inventories (illustration: University of Cologne/B. Gehlen).

Fig. 11 – *Proposition chronologique de la séquence des industries attribuées à la transition entre le Pléistocène et Holocène (Paléolithique terminal – Mésolithique ancien) en Allemagne de l'ouest, basée sur les quelques sites datés par le radiocarbone et la présence de séries indiscutables de type " Long Blade ", " Broad Blade " et du Mésolithique plus récent (illustration : Université de Cologne/B. Gehlen).*

Although affected by bioturbation the Preboreal human remains and the boar skulls might together represent a ritual deposition. The placing of Early Mesolithic human remains inside caves is a phenomenon well documented at contemporary sites in Belgium and the southern British Isles and might reveal a special treatment of the dead during the Preboreal, at least for western Europe. The closest parallels for the particular situation at the Blätterhöhle is provided by Preboreal human remains from Grotte Margaux and Abri des Autours in southern Belgium (Cauwe et al., 1998; Polet and Cauwe, 2002; Orschiedt, 2016; Orschiedt et al., in press).

A Mesolithic human from the Balver Höhle

A second Westphalian site with evidence for the probably intentional disposal of older Mesolithic human remains inside caves is the Balver Höhle, a large and important cave in the Sauerland region (Baales, 2013c). A fragment of a robust skull cap found long ago in this well known but now almost completely emptied out cave was directly dated to 9,160 ± 50 BP (GrA-19538). The calibrated age of some 10,350 cal. BP (table 1) means that this Mesolithic individual, probably a man, died during the early Boreal. Possibly by the early Holocene the originally large (and today once again emptied) vault of the cave had become infilled to such a degree that only a small space was left, suitable for a similar ritual of disposal of the dead as at the far smaller Blätterhöhle cave.

A human skull recovered without archaeological context at Rhünda in the neighbouring state of Hesse yielded a radiocarbon date within the Younger Dryas stadial (Rosendahl, 2002). However, since the specimen produced a stable isotope signature indicating a significant freshwater component in the diet (Drucker et al., 2016), a reservoir effect cannot be ruled out and this human might in fact derive instead from an early Holocene context.

CONCLUSIONS

To conclude, the results presented here in synthesis suggest that the Pleistocene-Holocene transition in the western regions of Germany represents a period of extremely rapid technological and typological change characterized by a mosaic of successive or parallel developments reflecting influences from quite different regions (fig. 11).

During the final Younger Dryas and early Preboreal the archaeological record of the hunter-gatherer communities of the north-west European Lowlands can be seen to reflect a survival or continuation of settlement within the Final Palaeolithic (Ahrensburgian) tradition. Certain aspects of their lithic and organic techno-typological equipment are subject to modification and evolution or are lost or discarded, probably within the context of an adaptation of subsistence practises and social systems to radically changing ecological conditions.

The few lithic artefacts of the "Long Blade" tradition to have been found in the northern part of the Westphalian Embayment and Lower Rhineland are believed to fit in with this scenario. So far there is a lack of finds dating to this defining period from both the Westphalian and the Eifel uplands to the south, perhaps suggesting the pre-existence of other traditions in this region during the (late) Younger Dryas. The

Final Pleistocene finds containing backed points found below Mesolithic horizons in the Blätterhöhle rock shelter are indications of perhaps sporadically westerly influences.

Sites from the region dated to the very beginning of the Preboreal appear to fall into a tradition recognised across some parts of early Holocene northern and north-western Europe, the "Broad Blade" Mesolithic (Jacobi, 1978; Street, 1998; Zander, 2016b)(2). The subsistence economy of these Initial Mesolithic assemblages is clearly attuned to the temperate, broadly woodland fauna now present across western Europe although elements of their lithic technology and typology may be directly derived from the earlier "Long Blade" industries. It is unclear what role, if any, the northward movement of people (or transmission of their ideas/adaptations) may have played in the first appearance of a "Mesolithic" way of life in the region.

An ecological gradient may have continued to play a role, leading to a broader-based hunting economy (perhaps aurochs dominated: *e.g.* Street, 1991 and 1999; Benecke et al., 2002; Bémilli et al., 2014(3)) at the edge of the upland zone and contemporaneous specialisation on elk at more northern lowland sites such as the oldest phase at Lundby in Denmark (Møller Hansen, 2003; Møller Hansen et al., 2004; Leduc, 2014), where a more diverse fauna is first demonstrated after the passage of a few hundred years (Jessen et al., 2015).

In western Germany it is only somewhat later in the Preboreal (after the Preboreal Oscillation?) that there appear to have followed further, innovative developments in the lithic assemblages, which can now be defined as fully Mesolithic and are characterized by an expanded spectrum of geometric and non-geometric, often highly standardized microlithic forms. Until the arrival of the Neolithic the different and changing spectra of these microlithic assemblages define the Mesolithic chronologically and geographically across much of Europe.

In summary, both the Final Palaeolithic and the Initial Mesolithic of the western German regions under study reflect shifting influences from several neighbouring regions. Investigations in progress, such as the excavation of the cave platform at the Blätterhöhle, may provide more details of how Final Palaeolithic humans survived the Pleistocene – Holocene transition, resulting in the widely shared but variable adaptation we know as the Mesolithic. ■

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NOTES

(1) The presence of a tanged point at the Avington VI "Long Blade" site (Barton and Froom, 1986) in southern England, far outside the northern European distribution of Ahrensburgian tanged points is enigmatic (another Avington VI backed armature resembles a *pointe des Blanchères* typical of the French *Épi-Laborien*). Far to the North, rare finds of tanged points and lithic assemblages from Scottish final Pleistocene or initial Holocene sites (Ballin and Saville, 2003; Mithen et al., 2015) have also been discussed in the context of a geographical extension of the Ahrensburgian. It is beyond the scope of this paper to discuss this material, which should probably be seen within the broader context of the early Holocene expansion of human groups (*e.g.* Fosna [Komsa]/Hensbacka) along newly deglaciated north European coastlines (Bang-Andersen, 2003; Fuglestvedt, 2007; Wygal and Heidenreich, 2014; Ballin, 2016). At La Fosse in northwestern France, Naudinot (2013, fig. 2, nos. 23-27) also describes a few points as tanged points and puts them in relation to the "Epi-Ahrensburgian".

(2) Scandinavian and northern German sites have not been attributed to the "Broad Blade" tradition yet.

(3) For Alizay, the chronological attribution is not completely clear, with radiocarbon dates covering the late Younger Dryas as well as the early Holocene and the sediments comprising the finds being attributed to the Younger Dryas (Bémilli et al., 2014, p. 172.).

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