THE SITE OF VERREBROEK 'DOK' AND ITS CONTRIBUTION TO THE ABSOLUTE DATING OF THE MESOLITHIC IN THE LOW COUNTRIES

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ABSTRACT. The wetland site of Verrebroek "Dok" situated in northern Belgium is one of the largest and best dated locations of Mesolithic material in northwestern Europe. Salvage excavations organized since 1992 at this large, unstratified open-air settlement have revealed more than 50 spatially independent artifact concentrations with traces of numerous fireplaces. Single entity dating of charred hazelnut shells from surface-hearths and charcoal from hearth-pits was used to obtain information not only on the sites duration, but also on the relation between the surface hearths and the hearth-pits. The dates were also used to look at discrepancies between the radiocarbon chronology and the typo-chronology of the lithic artifacts.

INTRODUCTION

Problems in Dating Stone-Age Settlements on Sandy Soils

In a recent article (Crombé et al. 1999) we discussed the problems of absolutely dating Final Paleolithic and Mesolithic camp sites situated on highly bioturbed sandy soils within the Low Countries. The origin of this dating problem is caused by: 1) a bad or doubtful spatial association of the dated sample and the lithic industry, 2) dislocation caused by bioturbation processes, 3) multiple site occupation, and/or 4) inbuilt age of the dating material. The use of single pieces of charred hazelnut shells (CH) from surface-hearths (SH) and single charcoal (CC) fragments from hearth-pits (HP) was recommended as a protocol for future dating projects in the sandy area of northwestern Europe. Between 1998 and now further testing has been done on the Mesolithic site of Verrebroek in view of refining the proposed dating strategy. The results of this project will be discussed in the present paper.

SITE DESCRIPTION

The site of Verrebroek "Dok" (51°16′00″N, 4°12′42″E) is situated in the polder area of Flanders on the extreme east end of a late glacial aeolian sandy dune ridge (ca. 80 km long, ca. 2–3 km wide) that blocks the north part of the Plain of the Flemish Valley. This sandy elevation in the lowlands of Flanders was intensively used during the stone ages, in particular during the Final Paleolithic and the Mesolithic, as can be demonstrated by the presence of numerous sites (Crombé 1998b:95–102). Sites situated on the eastern extremity of this sand ridge, such as the important sites of Melsele "Hof ten Damme" (Van Roeyen et al. 1992; Van Strydonck et al. 1995), Verrebroek "Dok" (Crombé et al. in press) and the recently discovered site of Doel (Crombé et al. 2000), are the only ones that are well-preserved. Peat and alluvial deposits from the river Scheldt have protected these sites against erosion and destruction.

Since 1992 the Department of Archaeology of the Ghent University is excavating the site of Verrebroek "Dok". Actually about 6000 m² have been investigated, corresponding to around 20% of the entire site-surface. The excavations revealed at least 50 artifact concentrations of varying size and composition. The smallest units cover 1–2 m², the largest ones 50–100 m². The majority of units however is smaller than 10–15 m². All excavated units mainly consist of stone artifacts, mostly made of local flint of inferior quality. Some units also yielded a certain amount of exotic raw materials,

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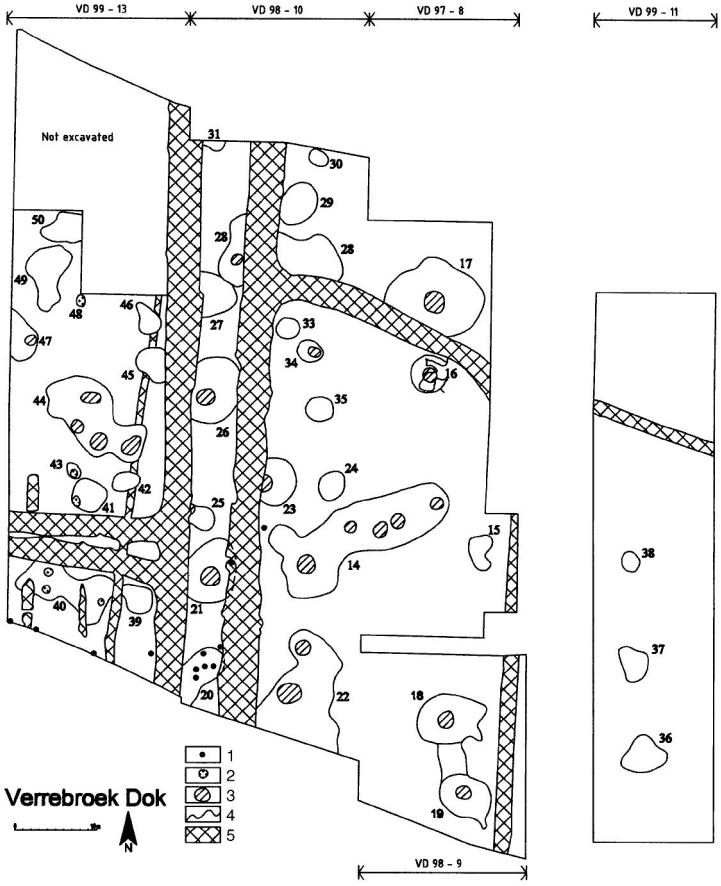

Figure 1 Schematic and preliminary draft of the artifact units excavated between 1997 and 1999. 1. hearth-pits; 2. bone clusters; 3. surface-hearths; 4. artifact units; 5. Medieval ditches.

such as quartzites and sandstones. Due to unfavorable preservation conditions (Ph-value and oxidation degree) organic material is extremely badly preserved on the site. It appears that only carbonized organic residue, such as charcoal, hazelnut shells and bones, is preserved. Besides numerous natural features (e.g. tree-falls) three main archaeological features are found at Verrebroek (Figure 1 above): i) surface-hearths (SH), ii) hearth-pits (HP), and iii) pits.

Due to later soil processes (e.g. formation of a heather podzol) the SH are no longer preserved as real soil features. Their position can only be deduced by the presence of concentrations of burnt artifacts and ecofacts. Associated charcoal was never observed. SH are always found within the boundaries of artifact concentrations associated with different types of tools (mainly microliths and scrapers) and lithic knapping waste (flakes, bladelets, chips, cores). It thus appears that these SH were used for various purposes (warming, cooking, melting of resin, etc.) and therefore can be interpreted as domestic hearths. On a spatial level it could be observed that all units smaller than 15–20 m² generally display one single SH, whereas larger units posses more SH, usually two but occasionally up to four and even five specimens (e.g. C.14, C.22, C.40, C.44). It is questionable whether the latter are all synchronous (see below).

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The HP (12 examples) on the other hand are visible in the soil as black, charcoal rich, three-dimensional structures of 0.50–0.70 m in diameter and 0.35–0.50 m deep. Most HP are located within the boundaries of the artifact units, either in the center or near the periphery. Only few pits are found isolated from the artifact units. Contrary to the SH, HP have a very restricted distribution as they are only found in the SW part of the excavated area. This part formerly corresponded to one of the highest grounds of the landscape. The filling of these HP mainly consists of CC fragments with *Pinus* as the dominant species, but also *Quercus* and *Corylus* (Louwagie et al. in press) were found. Lithics and CH only occur occasionally and in very small amounts. So far burnt bone fragments have not been found in HP.

In two units (C.22 and C.14) vague traces of shallow pits filled with numerous CH, in some cases associated with CC, were noticed. At present it is not yet clear how to interpret these features, but one cannot exclude that it concerns remains of shallow hearths used for the roasting of hazelnuts or small storage-pits.

SAMPLE SELECTION AND TESTING

Only single entities were dated. Each dated sample consisted of either one piece of CH from a SH or one piece of CC from a HP. Generally each feature was dated once. Some SH however were dated by more than one sample to obtain a better precision. This was the case for all features that were dated between 1992 and 1994 (Crombé 1998b:20–2) because some of the earliest AMS dates had very large standard deviations. Multiple dating on different CH samples was also done on some extremely large SH (e.g. in units C.17 and C.22) in order to verify their chronological homogeneity. Furthermore some HP were also dated several times for methodological purposes (see below).

All dated samples were cleaned using the acid-base-acid method, converted into graphite and measured by AMS. Since some of the CH samples were badly preserved and some dates deviated largely from the bulk of the measurements it was feared that humic acid infiltration from the overlaying peat layer altered some of the CH dates. To clarify this the efficiency of the pretreatment was tested in two ways. At first a duplo sample from unit C.17 was dated after a repeated pretreatment (Table 1). Furthermore a larger CH sample, containing different individual shells, from unit C.22 (SH.2) was pretreated several times and the different residues as well as the soluble fractions were dated (Table 2). These tests demonstrate that the ABA method was sufficient to clean the samples.

Judging by the small size of most HP only a limited "old-wood-effect" on the CC was expected. This was confirmed by dating determined branch and trunk wood from HP.66. It must however be admitted that anthracologically the term trunk wood is already applied to wood with a diameter exceeding 5 cm (Crombé et al. 1999).

Dating different wood species within HP.91 revealed that the HP were, as expected, most probably only used once within a limited period and that no intrusive or residual CC was present in the pits. Two CC samples (UtC-3450: 8700 ± 100 BP from unit C.6 and UtC-3443: 7700 ± 100 BP from unit C.10) were rejected because soil analysis indicated that they originate from presumed natural pits.

The above tests show that the CH as well as the CC samples are reliable and do date respectively the SH and the HP so that there is a close chronological connection between the ^{14}C event and the human event (Van Strydonck et al. 1999).

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Table 1 Radiocarbon dates from Verrebroek "Dok"

Unit	Structure	Reference[a]	^{14}C age (yr BP)	δ^{13}C (‰)	Sample material[b]	Cultural association
C.1	SH.	UtC-3915	9110 ± 65	–23.0	CH	Beuronian A
C.2.1	SH.	UtC-3445	9100 ± 130	–25.4	CH	Beuronian A
C.2.1	SH.	UtC-8398	9265 ± 40	–23.2	CH	Beuronian A
C.2.2	SH.	UtC-3436	9130 ± 170	–26.8	CH	Beuronian C
C.2.2	SH.	UtC-8391	8850 ± 50	–23.7	CH	Beuronian C
C.4	SH.	UtC-8397	9065 ± 40	–21.6	CH	Beuronian A
C.5.2	SH.	UtC-2743	9000 ± 190	–23.7	CH	
C.5.2	SH.	UtC-8396	8795 ± 40	–23.8	CH	
C.6	Pit 16	UtC-3439	9150 ± 100	–26.9	CH	Beuronian C
C.6	SH.	UtC-8961	9165 ± 45	–24.2	CH	Beuronian C
C.7	Pit 14	UtC-3451	9120 ± 120	–25.0	CH	Beuronian C
C.7	SH.	UtC-8395	9015 ± 40	–26.4	CH	Beuronian C
C.9	SH.	UtC-7851	9130 ± 75	–26.2	CH	Beuronian C
C.10	SH.	UtC-2744	8920 ± 130	–26.1	CH	Beuronian B
C.10	Pit 23	UtC-3444	8920 ± 100	–24.3	CH	Beuronian B
C.10	SH.	UtC-8394	8835 ± 40	–27.1	CH	Beuronian B
C.14	SH.1	UtC-7046	9100 ± 60	–25.6	CH	Beuronian A
C.14	SH.2	UtC-7045	9230 ± 50	–24.3	CH	Beuronian A
C.14	SH.3	UtC-7252	8750 ± 40	–23.9	CH	Beuronian B
C.14	SH.4	UtC-9222	8400 ± 60	–27.4	CH	
C.14	SH.5	UtC-9223	9080 ± 60	–23.9	CH	
C.14	Pit 90	UtC-9418	9060 ± 70	–24.5	CH	
C.14	Pit 89	UtC-9225	9270 ± 60	–23.0	CH	
C.14	SH.6	UtC-9419	9070 ± 70	–24.6	CH	
C.14	HP.88	UtC-9446	8230 ± 70	–25.5	CC *Pinus* branchwood	
C.16	SH.	UtC-7117	8850 ± 40	–23.4	CH	Beuronian B
C.17	SH.	UtC-7118	8930 ± 60	–25.4	CH	
C.17	SH.	UtC-7120	9270 ± 50	–25.2	CH	
C.17	SH.	UtC-7119	9280 ± 50	–23.3	CH	
C.17	SH.	UtC-7047	6260 ± 50	–25.5	CH after 1 pretreatment	
		UtC-7941	6290 ± 40	–25.5	CH after 2 pretreatments	
C.18	SH.	UtC-9224	9160 ± 60	–27.1	CH	Beuronian A
C.19	SH.	UtC-8392	8975 ± 40	–22.8	CH	
C.20	HP.66	UtC-9453	9100 ± 70	–27.8	CH	
C.20	HP.66	UtC-9452	8200 ± 70	–25.3	CC *Pinus* branchwood	
C.20	HP.66	UtC-9451	8190 ± 70	–24.5	CC *Pinus* trunkwood	
C.20	HP.67	UtC-9444	8390 ± 60	–24.8	CC *Pinus* branchwood	
C.20	HP.68	UtC-9443	8500 ± 60	–25.6	CC *Pinus* branchwood	
C.20	HP.70	UtC-9442	8450 ± 60	–25.6	CC *Pinus* branchwood	
C.20	HP.73	UtC-9447	8530 ± 60	–26.7	CC *Quercus* branchwood	
C.20	HP.92	UtC-9445	8330 ± 60	–22.6	CC *Pinus* branchwood	
C.21	SH.	UtC-8390	9200 ± 40	–23.5	CH	
C.21	HP.91	UtC-9448	8250 ± 70	–24.5	CC *Pinus* branchwood	
C.21	HP.91	UtC-9449	8320 ± 60	–25.3	CC *Quercus* large fragment	
C.21	HP.91	UtC-9450	8330 ± 70	–25.1	CC *Corylus* large fragment	
C.22	SH.1	UtC-8388	8755 ± 40	–26.0	CH	
C.22	Pit/SH.2	UtC-8389	9310 ± 40	–23.1	CH	
C.22	SH.2	UtC-8393	9210 ± 40	–25.2	CH	

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Table 1 Radiocarbon dates from Verrebroek "Dok" (*Continued*)

Unit	Structure	Reference[a]	^{14}C age (yr BP)	δ^{13}C (‰)	Sample material[b]	Cultural association
C.22	SH.2	UtC-9438	9290 ± 80	–26.0	CH after 2 pretreatments	
C.23	SH.	UtC-9228	9020 ± 60	–26.0	CH	
C.26	SH.	UtC-9227	8900 ± 60	–23.4	CH	
C.27	SH.	UtC-9454	8790 ± 60	–24.4	CH	
C.28	SH.1	UtC-9226	8810 ± 60	–26.0	CH	
C.28	SH.2	UtC-9433	8800 ± 80	–25.8	CH	
C.33	SH.	UtC-9456	9050 ± 70	–26.1	CH	
C.34	SH.	UtC-9455	7720 ± 60	–24.2	CH	
C.35	SH.	UtC-9457	8650 ± 60	–28.4	CH	
C.36	SH.1	NZA-11011	9190 ± 60	–24.7	CH	
C.36	SH.2	NZA-11247	8525 ± 60	–23.2	CH	
C.37	SH.	NZA-11022	9490 ± 60	–27.3	CH	
C.38	SH.	NZA-11016	9420 ± 60	–25.7	CH	
C.39	SH.	NZA-11015	8900 ± 90	–22.5	CH	
C.40	SH.1	NZA-11024	9160 ± 60	–23.7	CH	
C.40	SH.2	NZA-11009	8660 ± 60	–26.7	CH	
C.41	SH.	NZA-11012	9180 ± 60	–25.2	CH	
C.44	SH.1	NZA-11010	9200 ± 60	–23.0	CH	
C.44	SH.2	NZA-11025	8800 ± 60	–26.4	CH	
C.44	SH.3	NZA-11017	8790 ± 60	–26.5	CH	
C.44	SH.4	NZA-11248	8755 ± 85	–24.4	CH	
C.45	SH.	NZA-11250	8685 ± 55	–25.7	CH	
C.46	SH.	NZA-11023	7020 ± 60	–24.9	CH	
C.49	SH.	NZA-11249	8675 ± 55	–23.7	CH	

[a]Samples prepared at the Royal Institute of Cultural Heritage, Brussels and measured at the Van de Graaff laboratory, Utrecht, the Netherlands (UtC) and Rafter Radiocarbon Laboratory, Lower Hutt, New Zealand (NZA).
[b]CH = charred hazelnut shells; CC = charcoal; SH = surface-hearth; HP = hearth-pit; pit = natural or anthropogenic pit.

Table 2 Pretreatment test on CH sample from C.22 (SH.2). All treatments in hot 1% solutions for 25 min. All samples rinsed with hot distilled water after treatment and dried.

#	UtC-	Pretreatment	BP	^{13}C ‰
1	9692	No pretreatment	9120 ± 60	–24.4
		#1 + HCl wash		
2	9928	Soluble	5790 ± 50	–25.4
3	9436	Insoluble fraction after neutralization	9200 ± 90	–23.9
		#3 + NaOH		
4	9926	Soluble	9060 ± 50	–25.4
5	9437	Insoluble fraction after HCl rinse & neutralization	9370 ± 80	–24.3
		#5 + NaOH		
6	9927	Soluble	8920 ± 50	–25.3
7	9438	Insoluble fraction after HCl rinse & neutralization	9290 ± 80	–26.0

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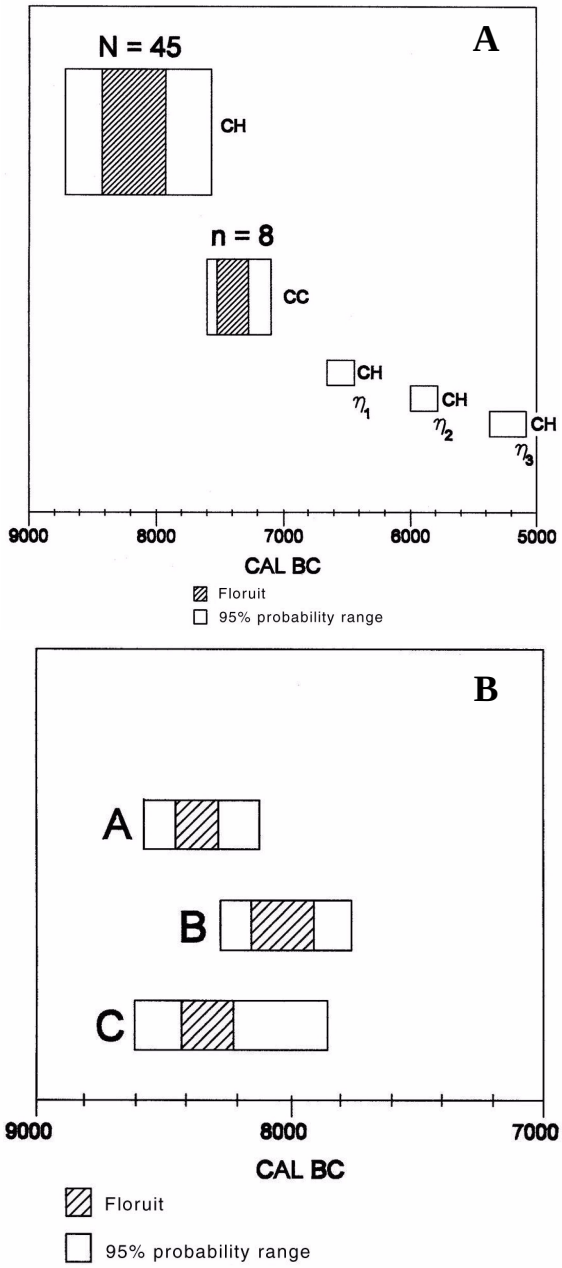

Figure 2 **A**: Floruit and 95% probability range of the dates from 45 surface-hearths dated on charred hazelnut shells, 8 hearth-pits dated on charcoal and 3 individual charred hazelnut shells. **B**: Floruit and 95% probability range of the charred hazelnut shell dates compared to the typo-chronology of the lithic artifacts (Beuronian A, B, and C).

RESULTS AND DISCUSSION

The ^{14}C results together with the sample location and, if possible, the cultural association are listed in Table 1. Figure 2A above represents the *floruit*, or inter quartile range (Aitchison et al. 1990), and the 95% probability range of the CH and the CC dates, except for the 3 youngest CH samples which are definitely from a different period than the bulk of the measurements. Figure 2B represents the *floruit* and the 95% probability range of the CH dates associated with typo-chronologically well-

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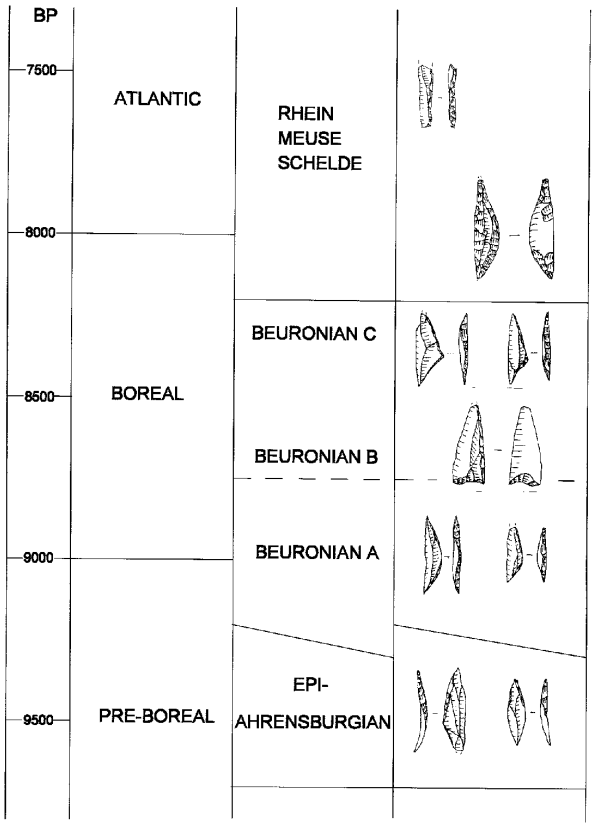

Figure 3 Typo-chronology for the Belgian Mesolithic according to Gob

defined lithic assemblages. The classification has been done according to the typo-chronology of Gob (Figure 3 above; Gob 1981). As the analysis of the archaeological finds is still in progress and the cultural attribution of most units is not yet known, Figure 2B is made up of only 17 dates.

The dates show that the CH samples (*floruit*: 8410-7930 cal BC, 95% probability range: 8710–7570 cal BC) and the CC samples (*floruit*: 7520–7280 cal BC, 95% probability range: 7600–7110 cal BC) represent two different cultural phases within the same site. The CH samples indicate that the main occupation of the site occurred during the second half of the Pre-boreal and the first half of the Boreal. All excavated concentrations seem to have been inhabited in the course of the Early Mesolithic except for three units, which apparently date back to the Late (Atlantic) Mesolithic. Recently the human presence during the Late Mesolithic has been confirmed by the discovery of some typical microliths, the so-called trapezes.

The CH dates also prove that all units cannot have been in use simultaneously but rather represent diachronic visits of the site. Even the largest units seem to be the result of repeated visits. This is well illustrated by the results obtained on eight samples from unit C.14. Here six SH and two presumed anthropogenic pits have been dated on CH. The results clearly demonstrate that this large unit comprises at least three different occupation phases. Similar results have been obtained for the other larger units excavated on the site. Units C.17, C.22, C.40 and C.44 all seem to have been inhabited

at least twice during the Early Mesolithic. We strongly believe that the larger units came to existence as a result of a spatial overlapping and intersecting of some smaller units.

The interpretation of the HP still poses serious problems. The measurements on CC samples from eight HP indicate that these features were in use apparently after the main occupation of the site as dated by the CH samples. This is nicely confirmed by the results of double dating on one CH and two CC samples from HP 66. It proves that, as we have stated already earlier (Crombé et al. 1999), it is rather dangerous to use hazelnut shells for dating Mesolithic HP as the former are generally residual fragments that slipped into the pit while it was dug or filled. It also proves that CC samples from HP cannot be used to date the associated lithic industry and/or artifact concentration.

The ^{14}C dates on CC samples further indicate that the site was also visited during the second half of the Boreal. However, clear prove of this has not yet been found among the archaeological finds. It could be that the remains of these occupations have not yet been excavated or that the function of the site and the activities that were performed had changed at the mid of the Boreal. Only further research can help us in solving this problem.

There are indications that the ^{14}C chronology of the site as obtained on the basis of the CH samples is in disagreement with the traditional chronology based on artifact typology (Figure 2B). In the 1970s and 1980s, various scholars worked out often contradictory typo-chronologies for the Mesolithic of the Benelux mainly based either on CC dates from HP and/or on ^{14}C-results from foreign areas (Crombé 1999). One of the most elaborate and refined ones has been conceived by Gob in 1981 and refined in 1990 (Gob 1990). Based on typological similarities with north European (Duvensee-complex) and southern German (Beuronian sequence) assemblages he proposed a diachronic model which starts with the Epi-Ahrensburgian (9700 BP–9300 BP), followed by the Beuronian A, B, C (9200 BP–8200 BP) and locally (southern Belgium) D. At Verrebroek at least three of these phases are present, namely the Beuronian A, B, and C. It should however be emphasized that, as we stated earlier (Crombé 1998a:24), a more appropriate term than "Beuronian" should be defined to indicate Early Mesolithic assemblages in Belgium. Contrary to Gob we believe that there exist only little typological similarities between the southern German Beuronian and the Belgian assemblages.

If we compare the Verrebroek dates with Gob's chronology at least two disagreements can be observed. First the Verrebroek dates point to an inversion of the Beuronian sequence with the Beuronian A and C as largely contemporaneous traditions and the Beuronian B as a younger one. Secondly the Verrebroek dates prove that the Beuronian A-B-C sequence was most likely shorter than previously thought. According to the presently available data the Beuronian in northern Belgium ended around 8800/8750 BP.

CONCLUSION

The Verrebroek-project clearly demonstrates that intensive ^{14}C dating can contribute considerably to a better understanding of the formation processes of unstratified open-air settlements from the Early Postglacial. Radiocarbon dating on CH from SH and CC from HP prove that: 1) the site has been repeatedly occupied from the second half of the Pre-boreal till the end of the Boreal (ca. 9500 BP–8200 BP), 2) the site was incidentally visited by Late Mesolithic hunter-gatherers, 3) HP were in use after the main occupation of the site, and 4) the largest artifact concentrations are palimpsests resulting from different diachronic visits and not, as traditionally thought, locations that were inhabited by larger groups.

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