



PALEO

Revue d'archéologie préhistorique

23 | 2012

Varia

Biostratigraphy of the Solutrean layers of Laugerie-Haute (Les Eyzies, Dordogne). Archaeological implications

Françoise Delpech



Electronic version

URL: <http://journals.openedition.org/paleo/2458>

DOI: 10.4000/paleo.2458

ISSN: 2101-0420

Publisher

SAMRA

Printed version

Date of publication: 15 December 2012

Number of pages: 105-116

ISSN: 1145-3370

Electronic reference

Françoise Delpech, « Biostratigraphy of the Solutrean layers of Laugerie-Haute (Les Eyzies, Dordogne). Archaeological implications », *PALEO* [Online], 23 | 2012, Online since 30 April 2013, connection on 08 August 2020. URL : <http://journals.openedition.org/paleo/2458> ; DOI : <https://doi.org/10.4000/paleo.2458>

This text was automatically generated on 8 August 2020.



PALEO est mis à disposition selon les termes de la licence Creative Commons Attribution - Pas d'Utilisation Commerciale - Pas de Modification 4.0 International.

Biostratigraphy of the Solutrean layers of Laugerie-Haute (Les Eyzies, Dordogne). Archaeological implications

Françoise Delpech

Introduction

- 1 In order to gain insights into prehistoric cultures, the organization of societies and prehistoric human relationships with the environment, interpretations are generally based on material data extracted from the earth. The position of all objects is accurately recorded during exhumation, long before the analytical study, in order to define their spatial location and to determine their relative age. In this way, they can be regrouped into sets coming from a specific place or (and) period of time. This regrouping into sets is essential as isolated finds, however significant or original, are only of limited interest. Comprehensive studies of groups of data are the only way of defining the specific characteristics of a complex. The quest for evolutionary characteristics, for example, only becomes possible when studies of datasets from different time periods are carried out.

As prehistoric finds often come from stratified sites, it is essential to take account of the stratigraphy in order to classify these finds. However, this is only possible if the different sets of finds are grouped by stratigraphic units. The latter are defined by specific characters; archaeological characteristics for archaeostratigraphic units, biological attributes for biostratigraphic units, chronological criteria for chronostratigraphic units.... (Hedberg 1979). There are thus as many different stratigraphic units as stratigraphic branches and each aspect should be studied separately before comparing the different results in order to reply to specific questions raised by the diverse specialties. In prehistoric archaeology, the "level" or the "layer" has wrongly been considered as a stratigraphic unit, as diverse criteria are used to differentiate "levels" and "layers" from overlying or underlying strata.

- 2 Of all these different stratigraphy branches, biostratigraphy is the branch which provides the best stratigraphic correlations. It allows us to determine the relative age of the fossiliferous strata. This branch of study has always been used for marine applications, but was only adapted to the continental domain a few decades ago when it was used to establish biozonations based on Pliocene, Pleistocene and Holocene mammals (cf. notably Mein 1975; Guérin 1982; Cordy 1982; Guérin and Patou-Mathis 1996). Indeed, in some cases, biostratigraphic chronological resolution is more accurate than radiochronological dating (Delpech 2005, 2007; Delpech and Texier 2007).
- 3 A lot of “classical” archaeological sites excavated a long time ago were not subjected to such studies. Yet our knowledge of prehistoric industries has been largely determined by these reference sites. A collective research program focusing on the revision of some of these sites was carried out, directed by J.-Ph. Rigaud then by J.-P. Texier (Texier *et al.* 1999; Texier *et al.* 2004). A dating program was conducted on the Solutrean levels of the Laugerie-Haute site using different methods (Roque *et al.* 2001) accompanied by geological research on their stratogenesis (Texier 2009). During a colloquium on the Solutrean at Preuilly sur Claise in 2007¹, I reviewed the biostratigraphical issues of this site, with particular attention to the levels where several evolutionary stages of the Solutrean technocomplex were defined.

“Stratigraphies” at Laugerie-Haute

- 4 The large Laugerie-Haute shelter is located on the right bank of the Vézère river, two kilometers upstream from Les Eyzies de Tayac. “It is spread over a length of 25 meters, a width of 35 meters and the thickness of the deposits varies from 4.5 to 6 meters in places. A non excavated zone with a house on it divides the site into two loci: *Laugerie-Haute-Est and Laugerie-Haute-Ouest*” (Laville 1975 - p. 310).
- 5 The site was identified as a prehistoric site in the second half of the 19th century (Lartet and Christy 1864, 1865-1875; Girod and Massénat 1893; Capitan 1895; Capitan and Breuil 1902 *apud* Laville 1975) and was exploited by several generations of excavators. In 1938, D. and E. Peyrony published a site monograph containing detailed stratigraphic information, which was later reused and expanded upon by F. Bordes and Ph. Smith, when they carried out work there fifty years ago (Bordes 1958; Smith 1966). At roughly the same time, H. Laville established a “climato-stratigraphy” of the site (1964, 1973, 1975) through a sedimentological study.
- 6 The comparison of the stratigraphic propositions advanced by D. and E. Peyrony and those who worked on the site after them shows their “preoccupation with a more accurate stratigraphic breakdown” (Texier 2007 - p. 49). This entailed the identification of localized subdivisions but also difficulties in synchronizing the east of the site with the west. At the east of the site, Peyrony’s 13 excavation complexes (layers A to K) correspond to 42 complexes from Bordes’ excavations. In addition, the number of non sterile layers varies depending on the excavated zone: the five Magdalenian layers 1, 2, 4, 6 and 8 at the east of the site correspond to 8 complexes on profile II (tab. 1). As for the comparison of the stratigraphic successions from the east and the west of the site, several questions have been raised. Without undertaking a comprehensive review of these issues, it is noteworthy that the Aurignacian level V overlies the Protomagdalenian level (Bordes 1964) and not the other way around (Peyrony and

Peyrony 1938). It is not easy to establish the limits between the Solutrean complexes (Lower, Middle or Upper Solutrean), nor between the east and the west of the shelter (Bordes 1958; Smith 1966). Moreover, it is pertinent to ask whether the material issued from Peyrony's H''' complex (Solutrean with shouldered points) was partly associated with the Magdalenian 0², a technocomplex contemporaneous with the formation of layer 0 (on the west side), according to H. Laville (1973, 1975) (tab. 1).

Table1 - Laugerie-Haute-Est and Laugerie-Haute-Ouest (Peyrony excavations, Bordes excavations, Bordes and Smith excavations). Relationships between stratigraphic subdivisions and technocomplexes.

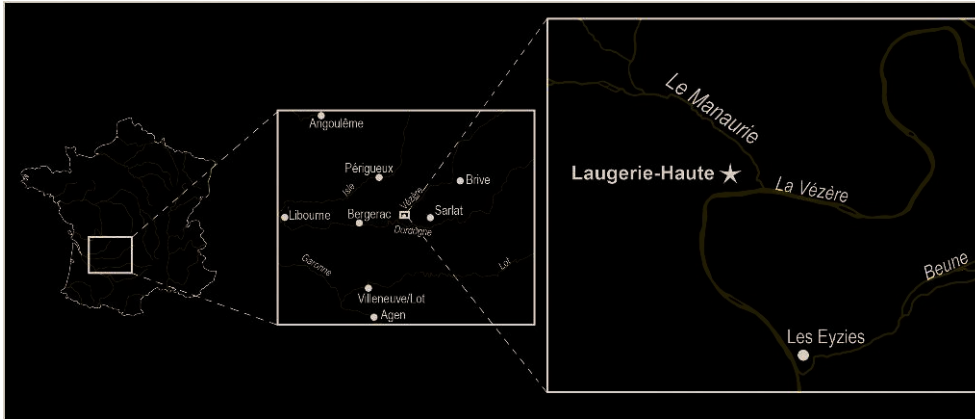


Table 2 - Laugerie-Haute-Est (Bordes excavations, Bordes and Smith excavations). Number of identified specimens by stratigraphic unit and taxon.

Tableau 1 :

LAUGERIE HAUTE EST (fouilles Peyrony ; fouilles Bordes)			LHE et LHO	LAUGERIE HAUTE OUEST (fouilles Peyrony, fouilles Bordes et Smith)		
Technocomplexes	Stratigraphie	Technocomplexes	Technocomplexes	Stratigraphie	Technocomplexes	
Magdalénien V	* « coupe II » (1)	in Bordes 1958, Smith 1966, Laville 1964-1975	« sur Magdalénien III » Magdalénien III			
Magdalénien III - niveau des objets en os à incisions et cannelures	I''' fn fn/c.brune/fn fm f''	1 2				
Magdalénien II - niveau des triangles scalènes	I'' fk/cj/l /d /s ff	4 (F1) 6 (E2) 8 (E3)	Magdalénien II	I	Magdalénien sans harpons	
Magdalénien I- niveau des éclats à retouches abruptes	I'	10 (F4) 12 14 (F5) 16 (F5) 18 (F1) 20 (F2)	Magdalénien Id Magdalénien Ic Magdalénien Ib Magdalénien Ia Magdalénien 0-2 Magdalénien 0-1	5		
Solutréen - niveau à pointes à cran	7...	21 (couche jaune sableuse) 22 (couche brune granuleuse) 23 (couche grise) 25 (F3) 26 (F3/cj/F6) 27 (F4) 28 (F4/cj/F5)	Solutréen final Solutréen supérieur	1 2 3 # 5 6 %	7... Solutréen - niveau à pointes à cran	
Solutréen - niveau à feuilles de laurier	7..	29 (F5) 30 (F5/cj/F6- F5')	Solutréen moyen : Solutréen moyen	8 10 11	7.. Solutréen - niveau à feuilles de laurier	
Solutréen - niveau à pointes à face plane	7.	31 (F6)	Solutréen inférieur	11A (2) 12a 12b 12c 12d	7. Solutréen - niveau à pointes à face plane	
			Protosolutréen	14	< Protosolutréen	
		33	Aurignacien V (3)	17	= Aurignacien V	
Protomagdalénien	6	36 (F8)	Protomagdalénien (3)			
Périgordien III	B	38 (F9) 40 (F10) 42 (F11)	Périgordien VI	25 21 22 23	B Périgordien III	

(1) informations qui m'ont été transmises par François Bordes en 1966 ;
 (2) le niveau 11A signalé par Ph. Smith n'a pas été retrouvé par H. Laville
 (3) le niveau avec Aurignacien V serait sus-jacent au niveau avec Protomagdalénien et non le contraire comme le pensait Peyrony (in Bordes, 1958)

The fauna from the Solutrean levels³ and “the Laugerie Interstadial”

- 7 In the Solutrean levels H', H'' et H''' (Peyrony excavations), the reindeer is the dominant taxon, followed by the horse and several ungulates: red deer, ibex, bovines, mammoth, rarer than the first two and varying in frequency in the different levels. The wolf and the common fox left behind some canines in H''' and Ovibos is represented by a molar (determinations by H.G. Stehlin *in* Peyrony and Peyrony 1938). Since then, this bovid was identified in H'' (Castel and Madelaine 2006) and six Saiga antelope remains were identified in H''' (Madelaine 1989).

The faunal remains from the Bordes excavations and the Bordes and Smith excavations in the east and the west of the site were first studied by F. Prat (*in* Laville 1964 - p. 48; Prat 1968) and then by myself for my PhD thesis (Delpech 1975, 1983). François Bordes showed me the correspondences that he had worked out at Laugerie-Haute-Est, between the layers from profile II and those from the main profile (tab 1). Using this information, I made up the three batches of bones which were radiocarbon dated in Lyon (Ly 972 for the Magdalenian complex 0, Ly 973 for the Magdalenian complex II, Ly 974 for the Magdalenian complex III). The dates for the Magdalenian 0 and the Magdalenian III were accepted without debate but those for the Magdalenian II were considered “too old” and were rejected. This cast a doubt on data collection methods and tended to negate the existence of the Magdalenian II.

Table 2 - Laugerie-Haute-Est (Bordes excavations, Bordes and Smith excavations). Number of identified specimens by stratigraphic unit and taxon.

	Magdal. III I et 2 fn à fl	Magdal. II 4, 6 et 8 fk à fl ; fl à f3	Magdal. I 10 à 16 f4 à f5	Magd. 0 18 et 20 F1 et F2	Solutrén final 22 et 23	Solutrén supérieur 25 à 28	Solutrén moyen 29	Solutrén moyen 30	Solutrén inférieur 31	Protomagd. 36	Périgordien VI 36, 38 et 40
Artiodactyles											
Bouquetin	9	3	12			1	3	2	6	18	
Bovins	17	1	6	7				1	2	2	
Cerf	13	8	1	4					2	33	5
Chamois	12	3	6	22					2	9	1
Renne	2143	508	1188	258	38	134	128	129	319	273	100
Saiga	34	13		5							
Périssoactyle											
Cheval	104	23	34	104	13	23	7	2	23	2	
Proboscidiens											
Mammouth	1										

Table 3 - Laugerie-Haute-Ouest (Bordes excavations, Bordes and Smith excavations). Number of identified specimens by stratigraphic unit and taxon.

Couches	Solutrén final		Solutrén supérieur				Solutrén moyen				Solutrén inférieur				
	2	3	4	5	6	7	8	9	10	11	11A	12a	12b	12c	12d
Artiodactyles															
Bouquetin							1	1			1		2		
Bovins														1	
Cerf													1		
Chamois										1					
Renne	236	139	194	432	190	198	199	87	146	5	121	576	509	382	155
Périssoactyle															
Cheval	3	1	3	2	2	1	4		16	2	12	12	15	6	4
Proboscidiens															
Mammouth	20			1			1	21	24		11	5	1	2	5
Carnivores															
Ours			2								2		1		
Loup		1	1					1			1		2		
Renard	6			11	1	1	2		2		1	3			
Lagomorphe															
Lièvre	3	1		3					5				1		1

- 8 As indicated by D. and E. Peyrony according to the information provided by H.G. Stehlin, the reindeer is predominant in all the Solutrean levels, followed by the horse which is much less frequent. All the other species are only episodically represented by

sparse remains (tab. 2 and 3). In levels 22 to 28 in Laugerie-Haute-Est with the Upper and Final Solutrean, F. Prat noted a lesser abundance of the reindeer than in underlying levels. This decrease in the percentage of reindeer corroborated, according to H Laville (1973, 1975), the climatic interpretation that he advanced for the same levels, that is an amelioration assimilated to the “Würm III-Würm IV Interstadial” or the “Laugerie Interstadial” (see also Paquereau 1978). However the decrease in reindeer remains cannot be interpreted in this way. Indeed, when the climate becomes milder and wetter, the decrease in the percentage of reindeer is accompanied by an increase in ungulates from humid fields and forests. However, this is not the case at Laugerie-Haute, where the Horse becomes more abundant. Yet, this ungulate adapts even better than the reindeer to cold and dry conditions in periglacial Europe (cf. *infra*). Moreover, the *Ovibos* molar from the upper Solutrean complex H”, (Stehlin *in* Peyrony and Peyrony 1938; Castel and Madelaine 2006) confers a glacial note on this complex: the *Ovibos* occupies the northernmost zones of the northern hemisphere today. It is also noteworthy that F. Prat and then this author identified the Saiga antelope in the levels overlying the Solutrean levels, those which contained Bordes’ Magdalenian 0, Magdalenian II and Magdalenian III (respectively levels 20 and 18, 8 to 4, 2 and 1 at Laugerie-Haute-Est). S. Madelaine also identified the Saiga antelope in the Peyrony excavations of the Solutrean complex at Laugerie-Haute-Ouest. We cannot therefore exclude the possibility of an association of these remains with the Magdalenian 0 (which wasn’t recognized by Peyrony). However, if we admit their contemporaneity with the Solutrean, which is possible as other sites have yielded such associations (Castel et Madelaine 2006), then we have an additional element discrediting the hypothesis of a relatively humid climatic environment: the Saiga antelope lives in arid, semi-desertic steppe zones today. Other elements, such as the biometric study of the reindeer, also contribute to rejecting the hypothesis of the “Laugerie Interstadial”. This study was carried out in 1970 in order to test J. Bouchud’s hypothesis (1975), stating that during the Upper Palaeolithic, varying proportions of Tundra reindeer and forest reindeer were responsible for the size variations presented by this taxon. The results of this study showed that size variations occurred within the same species in response to environmental changes and that the modest size of the Solutrean reindeer and the Magdalenian reindeer in Laugerie denotes a particularly constraining environment (Delpech 1975, 1983, 1986; Delpech *et al.* 2000). Osteometric research conducted by Delphine Kuntz (2011) corroborates this hypothesis. These constraints are those of the Last Glacial Maximum, with severe climatic conditions, expanding cold deserts in boreal zones and a decreasing habitable zone (Delpech 1999). It is also important to recall that the existence of a “Laugerie Interstadial” (like the “Lascaux Interstadial”, which is later but close in time) (Leroi-Gourhan 1980) was refuted by palynologists in the 1980s (Beaulieu and Reille 1984) and more recently (Elanga *et al.* 2000; Sanchez Goni 1991, 1994). It is unfortunate that the environmentally characteristic ungulate associations were used to support the hypothesis of the existence of an interstadial, as this goes against what these associations are supposed to represent.

Which environmental changes occur during the course of the Solutrean⁴?

- 9 Apart from the onset of severe climatic conditions, is it possible to perceive any climatic evolution or change during the formation of the Solutrean complex? In order to tackle this question, I will use data issued from the François Bordes and Philip Smith excavations with numerous stratigraphic subdivisions and associated faunal taxonomic samples. There are two datasets, from the east and the west of the site. On both sides, environmental phenomena have conditioned the formation of archaeological levels. Let us therefore try to discern any possible changes by using markers from both the east and the west of the site.
- 10 At the west of the site, 14 levels have yielded enough material to be taken into consideration, whereas at the east, seven levels make up five complexes as the remains discovered in levels 22 and 23 on the one hand and 25 to 28 on the other, were regrouped before we undertook our identification study. This study (Delpech 1975, 1983) brought to light a majority of ungulate remains (tab. 2 and 3). In both loci, the reindeer dominates. If differences exist between the two loci, they thus have to be sought out elsewhere.
- 11 At Laugerie-Haute-Est (or LHE) the ungulate associations evolve in an orderly fashion from the base to the summit; the horse increases regularly while the reindeer decreases (tab. 2, fig. 2a), which is perfectly logical from a palaeoenvironmental point of view with the approaching Last Glacial Maximum. The horse is a very ubiquitous ungulate, adapting faster than any other species to the most diversified conditions, even the most severe. The horse was present during the Upper Pleistocene in Aquitaine, a perennially occupied region, during the coldest and driest periods and also during the least rigorous conditions. Of all the other European ungulates, only the red deer could compete with the horse in terms of adaptation, but during the most severe climatic conditions, the horse is always “more apt to adapt” than the red deer and there always appear to be more horses than deer (Delpech *et al.* 1983; Delpech 1999). In the LHE stratigraphic sequence, the Solutrean complex is quite clearly differentiated from the underlying Protomagdalenian, in which the reindeer is dominant, the horse is very rare and red deer and mountain ungulates are relatively well represented (fig. 3a). The Solutrean complex only differs from the first Magdalenian complex (levels containing the Magdalenian 0) which overlies it, by the presence of several mountain ungulates and *Ovibos*, represented by a molar discovered during the Peyrony excavations. This molar could however, like the sculpture of an *Ovibos* head found in the Hauser spoil (Peyrony and Peyrony 1938 - pl. III, fig. 2), come from the Magdalenian complex 0 and the overlying Magdalenian levels where the horse is rare. Thus, at LHE, the process of the development of the horse seems to begin in the lower levels with the Solutrean and end in the Magdalenian level 0.
- 12 At Laugerie-Haute-Ouest (or LHO), the mammoth is quite well represented in levels 11A, 10 and 9 as well as in level 2, whereas it is absent from LHE⁵ (tab. 3; fig. 2b). These mammoth remains are mainly made up of incisor fragments⁶ which could be linked to ivory working at the west of the site. From an environmental point of view, their presence indicates a cold climate with an abundant plant biomass on which the largest of the Pleistocene ungulates could feed. Still on the west side, there is a relatively strong increase in horse remains in levels 11A and 10, i.e., in the levels with Lower and

Middle Solutrean remains. The gradual increase documented at the east of the site, presented as an evolutionary process beginning at the base of the Solutrean sequence and continuing until the summit is not duplicated here. How is it thus possible to establish links between the Solutrean sequence in the east and in the west of the site? Let us examine the question from a biostratigraphic viewpoint.

Figure 3 - Biostratigraphic units. 2a, Laugerie-Haute-Est ; 2b, Laugerie-Haute-Ouest (Bordes excavations, Bordes and Smith excavations).

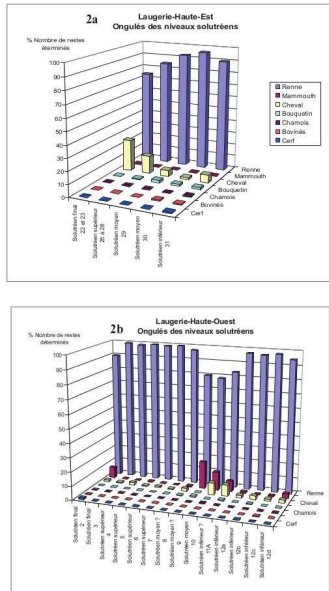
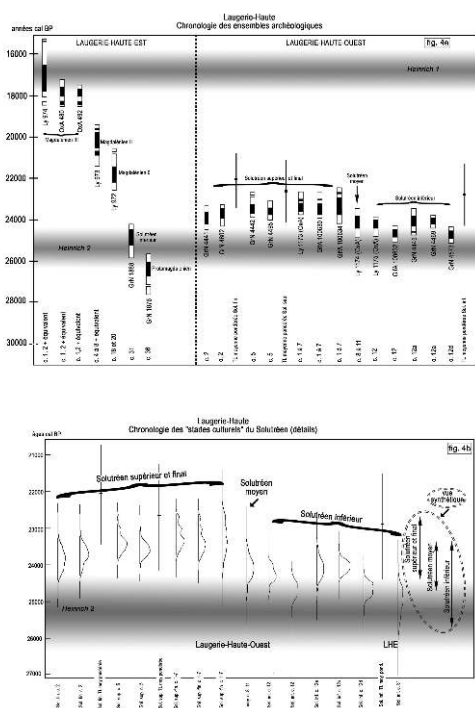


Figure 2

Figure 4 - Laugerie-Haute, ¹⁴C Chronology (years cal BP). 1a, the whole archaeological sequence; 1b, the Solutrean cultural sequence.



Biostratigraphic units of the Solutrean complexes and chronology

- 13 To define these units, we took into consideration all the stratigraphic sequences of the site concerning the Solutrean in LHO and the Perigordian VI, the Protomagdalenian, the Solutrean and the Magdalenian in LHE. These units were established according to the principles developed in the work of diverse authors (cf. notably Guérin 1982; Cordy 1982), whereby the associations of ungulates and characteristic species serve as guidelines. As this particular sequence was formed during a short period of the Pleistocene, it is hardly surprising that the species characteristic of these guidelines were not used much here (Delpech 2007). Indeed, these taxa, *Equus caballus gallicus* (Prat 1968) for the horse and a small-sized reindeer (Delpech 1975, 1986; Delpech *et al.* 2000; Kuntz 2011), are present throughout the sequence and thus provide no discriminatory element for the levels in question.
- 14 In LHE, we identified 5 biostratigraphic units (fig. 3a); one of which regroups three levels with similar associations (unit A which corresponds to levels bearing Magdalenian III, II and I); three others each correspond to a single level with a specific association (this is the case for units B, D and E with Magdalenian 0, Protomagdalenian and Perigordian VI); the last unit (unit C) regroups all the Solutrean levels. Each of these has yielded a slightly different association, but from one level to another, the horse increases regularly and progressively, while at the same time, diversity decreases: the red deer and the bovines disappear first, followed by the ibex. From the base to the summit, the LHE biostratigraphic units allow us to chart a logical

environmental evolution (cf. preceding §). No biostratigraphical arguments have challenged the chronological succession of the Solutrean unit, made up of five superposed complexes, which is part of this sequence.

- 15 At LHO, all the levels have yielded Solutrean finds. From a faunal association viewpoint, these levels are differentiated from those of the east by the presence of the mammoth. This cannot be used to establish correlations between LHE and LHO as it is a specific characteristic of LHO. From a biostratigraphic point of view, five units called C, can be retained (fig. 3b). Unit C3 is characterized by the presence of mammoth. In two other units, C5 and C2, the reindeer leaves very little room for other ungulates, mostly represented by the horse. There are only slight variations in their representation which appear to be random. However, the presence of red deer in unit C5 (level 12b) and bovines (level 12c) allows us to establish a link between the two loci. At LHO and at LHE, these two taxa are represented at the base of the stratigraphic complex yielding Solutrean remains. Unit C1, which corresponds to the summit of level 2, is characterized by a wide taxonomic diversity (number of ungulates = 5) and by the presence of the horse, bovines and the deer, like in the LHO base unit C5 (level 12b) and the LHE base unit C. There thus appears to be a link between units C1 and C5 in LHO on one hand and the base unit C in LHE on the other. Lastly, unit C4 is characterized by a clear, although not a very strong increase in horse (then mammoth). It is worth recalling that the increase in horse remains in the Solutrean levels at LHE justifies the sequencing of the archaeological levels; at LHO it is in unit C4 that the horse is better represented than elsewhere (cf. fig. 2b and fig. 3b).
- 16 The correlations established between LHE and LHO clearly show that the LHO units are not laid out in a normal chronological order. Indeed, the C unit formation in the east (levels 31 to 22) corresponds successively in the west to units C5 (level 12) and C1 (level 2), then to unit C2 (levels 8 to 3) and lastly to unit C4 (levels 10 and 11A), which would be the most recent. The closeness in time between the formation periods of levels 12 and 2 was suggested by the dates: in LHO, the oldest dates for Upper and Final Solutrean levels were those from layer 2 (fig. 4b). However, given the upheaval that these slight variations would provoke, it appears to be more reasonable to regroup all of the LHO Solutrean levels in a single biostratigraphic unit.

Chronology and dates

- 17 Biostratigraphy thus leads to the validation of the chronological order of the LHE Solutrean levels 31 to 22 but not that of levels 12 to 2 at LHO. These latter levels should thus be considered globally for any study based on chronologically ordered data.
- 18 Other studies carried out on the Solutrean levels in the west of the site have reached conclusions which support these points of view. In this way, the Solutrean levels clearly appear to have been deposited by solifluxion which can lead to the formation of “*pseudo-stratified levels*” in the same archaeological level “*and cause significant perturbations in layers of remains*” (Texier 2009 - p.140). Moreover, in the context of a joint TL/¹⁴C program, “*the comparison of results from the different stratigraphic levels shows that the old breakdown of the Laugerie-Haute sequence*” (west side), “*based on tools, is not associated with any significant chronological differences... When using these dates, prehistorians should take account of the “blur” resulting from the physical uncertainties of the date*” (Roque et al. 2001 - p. 231, fig. 6). Figure 4 regroups all the radiocarbon dates obtained for the

east and the west of the site, and the TL dates in the west and sheds light on the question. Globally, the dates are coherent: from the base to the summit of the sequence the chronology progresses (fig. 4a) but in the west, for the Solutrean, it is impossible to give an age for each stage of the technocomplex (fig. 4b). It is noteworthy that the Laugerie-Haute Solutrean sequence formed after the Heinrich 2 event which lasted for about 2.2 millennia and would have started about 26,400 years ago (Sanchez-Goni M.F. and Harrison S.P. 2010).

Conclusion

- 19 At Laugerie-Haute, the fauna associated with the Solutrean characterizes a generally cold and dry climate. This interpretation was already advanced in 1975 (Delpech 1975 - p. 296, 1983 - p. 279), and was, at that time, in disagreement with the hypothesis of a warming considered as an interstadial, defended by palynologists and sedimentologists (Paquereau 1978; Leroi-Gourhan 1980; Laville 1964, 1973 and 1975). The latter were following the conclusions of D. and E. Peyrony who thought that a warming occurred during the Solutrean (Peyrony and Peyrony 1938 - p. 77). Today, the Solutrean has become definitively “cold”. This paper contains several paleontological arguments. Moreover, moving upwards through the stratigraphic sequence in Laugerie-Haute-Est, everything points towards a gradation of the severity of the climate, as if the Last Glacial Maximum was approaching and the coldest phase was reached during the formation of the Magdalenian 0 complex. This gradual progression supports the hypothesis that the fossiliferous Solutrean levels are stratigraphic entities ordered in time. But this progression is only visible at the east of the site; at the west there are no traces of gradual evolution. The biostratigraphy also shows that there is a chronological disorganization of the levels and that it is thus indispensable to regroup them for any work relying on chronologically classified data. Other authors in other research domains also call for the same precautions (Roque *et al.* 2001; Texier *et al.* 1999; Texier *et al.* 2004; Texier 2009). An archaeostratigraphic revision appears to be necessary as Laugerie-Haute is the site where the Solutrean industry was characterized and the different phases of the Solutrean were defined. Ph. Smith presents Laugerie-Haute as “the central pillar of the reconstitution of the French Solutrean” (Smith 1966 - p. 57). If this pillar is to resist the ravages of time, it needs to be bolstered by an archaeostratigraphic study with chronological anchors at the east side, rather than at the west of the site. But that is only the point of view of the biostratigrapher!

BIBLIOGRAPHY

- BEAULIEU J.L. (de) and REILLE M. 1984 - A long Upper Pleistocene pollen record from Les Echets, near Lyon, France. *Boreas*, 13, 2, p. 111-132.
- BORDES F. 1958 - Nouvelles fouilles à Laugerie-Haute-Est. Premiers résultats. *L'Anthropologie*, 62, p. 205-244.

- BOUCHUD J. 1975 - *Essai sur le Renne et la climatologie du Paléolithique supérieur*. Imprimerie Magne, Périgueux
- CASTEL J.-C. and MADELAINE S. 2006 - Quelques éléments remarquables de la faune du Solutréen de Laugerie-Haute (Les Eyzies-de-Tayac, Dordogne). *Paleo*, 18 p. 275-284.
- CORDY J.-M. 1982 - Biozonation du Quaternaire postvillafanchien continental d'Europe occidentale à partir des grands mammifères. *Annales de la Société géologique de Belgique (Liège)*, 105 p. 303-314.
- DELPECH F. 1975 - *Les faunes du Paléolithique supérieur dans le Sud-Ouest de la France*. Thèse de Doctorat ès Sciences naturelles, n° 479, 374 p.
- DELPECH F. 1983 - Les faunes du Paléolithique supérieur dans le Sud-Ouest de la France. *Cahiers du Quaternaire*, Editions du CNRS, n° 6, 453 p.
- DELPECH F. 1986 - Les rennes du grand abi de Laugerie-Haute en Dordogne (fouilles F. Bordes). *Arqueologia, Porto*, 13 p. 66-71. -
- DELPECH F. 1999 - Biomasse d'Ongulés au Paléolithique et inférences démographiques. *Paleo*, vol. 11 - p.19-42.
- DELPECH F. 2005 - Utilité et utilisation de la biostratigraphie en archéologie préhistorique. *Bulletin de la Société préhistorique française*, t. 102, 4 p. 749-755.
- DELPECH F. 2007 - Le grand abri de La Ferrassie, source de réflexion sur la biostratigraphie d'un court moment du Pléistocène. In R. Desbrosse et A. Thévenin coords. *Arts et cultures de la préhistoire*, Paris, Éd. du CTHS, *Documents préhistoriques*, 24, p. 303-314.
- DELPECH F., DONARD E., GILBERT A., GUADELLI J.-L., LE GALL O., MARTINI-JACQUIN A., PAQUEREAU M.-M., PRAT F., TOURNEPICHE J.-F. 1983 - Contribution à la lecture des paléoclimats quaternaires d'après les données de la paléontologie en milieu continental. In *Paléoclimats, Bulletin de l'Institut géologique du Bassin d'Aquitaine*, 34 et *Cahiers du Quaternaire*, n° spécial p. 165-177.
- DELPECH F., GRAYSON D. K., RIGAUD J.-Ph. 2000 - Biostratigraphie et paléoenvironnements du début du Würm récent d'après les grands mammifères de l'abri du Flageolet I (Dordogne, France). *Paleo*, 12, p. 97-126.
- DELPECH F., TEXIER J.-P. 2007 - Approche stratigraphique des temps gravettiens : l'éclairage aquitain. In Rigaud J.Ph. (ed.), *Le Gravettien : entités régionales d'une paléoculture européenne*, Table Ronde - Les Eyzies - juillet 2004, *Paleo*, 19, p. 15-29.
- ELANGA H., PEYRON O., BONNEFILLE R., JOLLY D., CHEDDADI R., GUIOT J., ANDRIEU V., BOTTEMA S., BUCHET G., BEAULIEU J. (de), HAMILTON A.C., MALEY J., MARCHANT R., PEREZ-OBOL R., REILLE M., RIOLLET G., SCOTT L., STRAKA H., TAYLOR D., VAN CAMPO E., VINCENS A., LAARIF F., JONSON H. 2000 - Pollen-based biomer reconstruction for southern Europe and Africa 18,000 yr BP. *Journal of Biogeography*, 27, p. 621-634.
- GUÉRIN C. 1982 - Première biozonation du Pléistocène européen, principal résultat biostratigraphique de l'étude des *Rhinocerotidae* (*Mammalia, Perissodactyla*), du Miocène terminal au Pléistocène supérieur d'Europe occidentale. *Geobios*, 15, 4, p. 593-598.
- GUÉRIN C., PATOU-MATHIS M. 1996 - Limites et problèmes de chronologie. In : Guérin, Cl., Patou-Mathis, M.(eds), *Les grands mammifères plio-pléistocènes d'Europe*, Paris, Masson (Collection préhistoire) p. 1-11.
- HEDBERG H. 1979 - *Guide stratigraphique international. Classification, terminologie et règles de procédure*. Paris, Doin, 233 p.

- KUNTZ D. 2011 - *Ostéométrie et migration(s) du Renne (Rangifer tarandus) dans le Sud-Ouest de la France au cours du dernier Pléni-glaciaire et du Tardiglaciaire (21500-13000 cal. BP)*. Thèse de Doctorat en Préhistoire, Université de Toulouse 2 Le Mirail, 476 p.
- LAVILLE H. 1964 - Recherches sédimentologiques sur la paléoclimatologie du Würmien récent en Périgord. *L'Anthropologie (Paris)*, t. 68, p. 1-48 ; p. 219-252.
- LAVILLE H. 1973 -. *Climatologie et chronologie du Paléolithique en Périgord. Etude sédimentologique de dépôts en grotte et sous abris*. Thèse de doctorat ès Sciences naturelles. Bordeaux, n° 400, 720 p.
- LAVILLE H. 1975 - Climatologie et chronologie du Paléolithique en Périgord : étude sédimentologique de dépôts en grotte et sous abris. *Etudes quaternaires*, mém. n° 4, Université de Provence, 422 p.
- LEROI-GOURHAN Arl. 1980 - Interstades würmiens : Laugerie et Lascaux. *Bulletin de l'Association française pour l'Etude du Quaternaire*, 3, p. 95-100.
- MADELAINE S. 1989 - Contribution des anciennes fouilles à la connaissance des ongulés et de leurs milieux durant le Würm récent en Dordogne. *Paleo*, 1, p. 3646.
- MEIN P. 1975 - *Résultats du groupe de travail des vertébrés. Report on activity on the RCMNS working groups (1971-1975)*. Bratislava, UGS regional committee on Mediterranean Neogene stratigraphy, p. 78-81.
- PAQUEREAU M.-M. 1978 - Flores et climats du Würm III dans le Sud-Ouest de la France. *Quaternaria, Roma*, XX, p.123-164.
- PEYRONY D. and PEYRONY E. 1938 - Laugerie-Haute près des Eyzies (Dordogne). *Archives de l'Institut de Paléontologie Humaine*, 19, 84 p.
- PRAT F. 1968 - *Recherches sur les Équidés pléistocènes en France*. Thèse de doctorat ès Sciences naturelles. Bordeaux n° 226, 622 p.
- ROQUE C., GUIBERT P., VARTANIAN E., BECHTEL F., OBERLIN C., EVIN J., MERCIER N., VALLADAS H., TEXIER J.-P., RIGAUD J.-PH., DELPECH F., CLEYET-MERLE J.-J., TURQ A. 2001 - Une expérience de croisement de datations TL/¹⁴C pour la séquence solutréenne de Laugerie-Haute, Dordogne, In Barrandon J.-N., Guibert P., Michel V. (éds) *Datation, XXI^e Rencontres Internationales d'Archéologie et d'Histoire d'Antibes*, Editions APDCA, Antibes, p. 217-232.
- SANCHEZ GONI M.F. 1991 - On the Last Glacial Maximum and interstadials during the Solutrean: a contradiction? *Current Anthropology*, 32, 5, p. 573-575.
- SANCHEZ GONI M.F. 1994 - The identification of European Upper Palaeolithic interstadials from cave sequences. *AASP Contributions Series*, 29, p. 161-182.
- SANCHEZ-GONI M.F., HARRISON S.P. 2010 - Millennial-scale climate variability and végétation changes during the Last Glacial : concepts and terminology. *Quaternary Science Reviews*, 29, p. 2823-2827.
- SMITH P.E.L. 1966 - *Le Solutréen en France*. Bordeaux (France) Delmas, publications de l'Institut de Préhistoire de l'Université de Bordeaux, 4, 449 p.
- TARDIEU C. 2011 - La bonne orthographe du mot Taxinomie : un concept important dont l'orthographe est malmenée. *Paleo*, n° 22, p. 331-334.
- TEXIER J.-P. 2007 - Anciennes et nouvelles lectures géologiques de sites paléolithiques de référence du Périgord : évolution des concepts. In "Un siècle de construction du discours scientifique en Préhistoire", actes du 26^{ème} congrès préhistorique de France, Avignon, 21-25 septembre 2004, p. 47-53.

TEXIER J.-P. 2009 - *Histoire géologique de sites préhistoriques classiques du Périgord : une vision réactualisée*. Documents préhistoriques n° 25, éditions du CTHS, Paris 2009, 193 p.

TEXIER J.-P., DELPECH F., RIGAUD J. Ph. 1999 - *Rapport final de synthèse du PCR : "Révision litho- et biostratigraphique de quelques sites de références périgourdins"*, Bordeaux, SRA Aquitaine.

TEXIER J.-P., KERVAZO B., LENOBLE A., NESPOULET R. 2004 - *Sédimentogénèse de sites préhistoriques du Périgord*. Association des Sédimentologues Français (éd.), 69

NOTES

1. "The Solutrean, 40 years after Smith" 66, 28-31 October 2007, organiser: SERAP association Vallée de la Claise.
2. I have retained the denomination "Magdalenian" used at the time of excavation (and afterwards); today we refer to the "Badegoulian".
3. The Protosolutrean complex (layer G from the Peyrony excavations, layer 14 from the Bordes excavations) yielded very few faunal remains and will not be considered here.
4. The Solutrean is not a "period" but a technocomplex, the Solutrean referred to here designates the period during which the Laugerie-Haute Solutrean "levels" formed.
5. We only identified a mammoth's molar fragment in the complex with Magdalenian III.
6. All the mammoth remains from the west of the site (n = 91) are incisor fragments (in ivory) apart from 14 of them which are molar fragments (1 in 5, 1 in 9, 11 in 10 and 1 in 12c).

ABSTRACTS

Biostratigraphic analysis applied to prehistoric archaeological contexts can establish chronological ties between strata at different sites and document stratigraphic perturbations within a given site. This paper provides such an analysis for the Solutrean levels of Laugerie-Haute (Les Eyzies, Dordogne). I first address the stratigraphy of the site as a whole and then the environmental significance of the faunal associations found there, including the role that these associations have played in supporting the reality of the famous Laugerie Interstadial. The results of this work support the chronological order of Solutrean levels 31 to 22 at Laugerie-Haute-Est but reject that of levels 12 to 2 at Laugerie-Haute-Ouest. These latter levels should be considered as a single unit in all future chronological analyses. As a result, archaeostratigraphic analyses of the *Laugerie-Haute* Solutrean should only be based on the sequence from Laugerie-Haute-Est.

INDEX

Keywords: Laugerie-Haute-Est, Laugerie-Haute-Ouest, Solutrean, biostratigraphic units, archaeostratigraphic units, Solutrean chronology

AUTHOR

FRANÇOISE DELPECH

Université Bordeaux 1, PACEA-PPP-UMR 5199, Bâtiment B18, avenue des Facultés, 33405 Talence,
France - francoise67.delpech@orange.fr