



Specialized Early Upper Palaeolithic Hunters in Southwestern France?

Donald K. Grayson

Department of Anthropology, Box 353100, University of Washington, Seattle WA 98195, U.S.A.

Françoise Delpech

Institut de Préhistoire et de Géologie du Quaternaire, UMR 5808 du CNRS, Avenue des Facultés, Université Bordeaux I, 33405 Talence, France

(Received 7 November 2001, revised manuscript accepted 4 January 2002)

Paul Mellars has long used cave and rockshelter ungulate faunal assemblages from southwestern France to argue that the early Upper Palaeolithic people of this region focused their hunting on reindeer (*Rangifer tarandus*), and that such specialized hunting distinguishes the Upper from the Middle Palaeolithic in at least this region. We examine this argument quantitatively, using a sample of 133 Mousterian, Châtelperronian, and Aurignacian ungulate assemblages. We show that only five Aurignacian assemblages, from three sites, stand out in terms of the degree to which their ungulate faunas are dominated by a single taxon. We also show that some Mousterian cave and rock shelter ungulate assemblages are more heavily dominated by large bovids than Aurignacian assemblages are dominated by reindeer, and that Mellars' argument is highly dependent on the exclusion of open sites from the analysis and on the numerical threshold he has selected to indicate hunting specialization. © 2002 Published by Elsevier Science Ltd. All rights reserved.

Keywords: MOUSTERIAN, AURIGNACIAN, CHÂTELPERRONIAN, NEANDERTALS, PLEISTOCENE, REINDEER, FRANCE.

Introduction

Paul Mellars' 1973 examination of the nature of the Middle-to-Upper Palaeolithic transition in southwestern France has had a substantial impact on archaeological approaches to understanding this complex period of time. By focusing on a small set of apparently relevant attributes—for instance, changing stone tool morphology, the use of bone, antler and ivory for tool manufacture, the appearance of personal ornaments, and the long distance transport of raw materials—he produced a powerful synthesis that closely matched what others were concluding from the analysis of Mousterian and Upper Palaeolithic materials across Europe (e.g., Klein, 1973). His efforts in this realm helped set the stage for what was to follow and remain at the centre of the current debate on the fate of the Neanderthals (e.g., White, 1982; Klein, 1989, 1992, 1995, 1999, 2000; Potts, 1998; McBrearty & Brooks, 2000).

Here, we address one of the issues that Mellars raised in 1973, “that the highly specialized hunting of one species of animal was particularly characteristic of the upper Palaeolithic period” (1973: 261), and that such hunting distinguishes the Upper from the Middle

Palaeolithic in at least this region. Although, as Mellars (1973) carefully noted, this was not a novel argument (e.g., Braidwood & Reed, 1957; Binford & Binford, 1966; Binford, 1968), he amassed far more data to support it than had his predecessors.

It is also an argument that Mellars has continued to make, and to refine, over the years (e.g., Mellars, 1989, 1992, 1993, 1996). Recently, for instance, he has suggested that Châtelperronian “Neandertal goups practiced a relatively broad spectrum foraging pattern, usually involving substantial exploitation of at least three or four different species . . . by contrast, most of the faunas recovered from early Aurignacian levels in the same region show a striking specialization on reindeer, with reindeer often comprising more than 90% of the documented remains” (Mellars, 1998: 500).

To be sure, Mellars (1998) recognizes that the differences he sees in southwestern France between Mousterian and Châtelperronian faunal assemblages on the one hand, and those provided by Aurignacian ones on the other, may simply reflect changing climatic conditions. However, he has also argued that “regardless of whether certain Mousterian groups practiced a significant element of deliberate economic specialization in the exploitation of particular animal species, it

is clear that these patterns became more sharply defined, and more widespread, during the earliest stages of the Upper Palaeolithic" (Mellars, 1996: 201). Although Mellars (1998) argues that "most" early Aurignacian assemblages show such specialization, he routinely calls on just four sites to make the case (Mellars, 1989, 1996, 1998): Abri Pataud, Roc de Combe, Le Piage, and La Gravette.

Mellars' arguments concerning early Upper Palaeolithic subsistence specialization in western Europe have not been widely accepted. While some whose geographic specialities fall outside of Europe have repeated the argument (e.g., Potts, 1998), the same is not the case for those familiar with the details of the archaeological record of the region. Freeman (1971, 1973), Straus (e.g., 1977, 1985, 1987, 1992), Clark (e.g., 1987, 1997; Clark & Yi, 1983; Clark & Lindly, 1989), and others have shown that no such phenomenon exists in northern Spain. Chase (1987, 1989), Simek & Snyder (1988), Rigaud (1989, 1993) and Otte (1990) reject the argument for more northerly parts of Europe, and Stiner (1994, 2001) rejects it for Italy and other parts of Eurasia.

We revisit this issue with the analyses that follow. This we do not simply because Mellars continues to make the argument, but because we are able to show with some precision how and why this argument is incorrect in its southwestern French homeland.

The Analysis

Our analysis of Mellars' argument is based on a large sample of Mousterian and Aurignacian faunal assemblages, along with an unfortunately small set of Châtelperronian ones. That sample is provided in Table 1, and includes all Mousterian, Châtelperronian, and Aurignacian assemblages known to us that: (1) are from rockshelters and caves in southwestern France, since these are the kinds of sites, and the area, on which Mellars focuses; (2) are associated with a Mousterian, Châtelperronian, or Aurignacian lithic assemblage; (3) have specimen counts available (and not just percentage values or MNI counts); and, (4) have at least 20 identified specimens. In addition, we have excluded all Mousterian assemblages that predate oxygen isotope stage 5 (thus, for instance, the faunal assemblages from Grotte Vaufrey strata IV through VIII are not included in our sample; see Rigaud, 1988). This process has provided us with 30 Aurignacian, 6 Châtelperronian, and 95 Mousterian cave and rock shelter assemblages (Table 1). Table 1 also includes data for two Mousterian open sites, Mauran and La Borde, for which NISP counts are available; these sites are discussed separately below.

Mellars (1996) has used a 50-specimen minimum limit for his examination of Mousterian ungulate assemblages, but his analysis of the Aurignacian also includes assemblages for which neither specimen nor

MNI counts are available (for instance, La Gravette). The 20-specimen limit we employ is both low and arbitrary. As will be seen, however, this does not matter since, ultimately, no sites with specimen counts this low play a significant role in our conclusions. We have not excluded faunas that lack a detailed taphonomic assessment, nor have we excluded assemblages that some have suggested may to some extent be mixed (e.g., Rigaud, 1996, 2000). As a result, we have no way of guaranteeing that aspects of our results do not reflect the impact of either multiple depositional mechanisms or mixing. Including only assemblages that had been vetted in detail in this way would not have provided a sufficiently large sample to conduct the analyses that we conduct. Mellars' approach is identical to ours in this regard.

Mellars is quite explicit as to what he means by hunting "specialization". To be considered as reflecting specialized hunting, a faunal assemblage must be numerically dominated by one particular species, with that species selected from a wider range of taxa available to the hunters (Mellars, 1996: 196). Thus, his argument requires that the faunal assemblages left behind by the people who created Aurignacian assemblages in southwestern France be dominated by a single taxon, that other taxa were available but not utilized to the same extent, and that this pattern contrast with that found in Châtelperronian and Mousterian assemblages. Even though Mellars specifies that the target taxon during the early Upper Palaeolithic was reindeer (*Rangifer tarandus*), the particular taxon involved is immaterial. It matters only that Aurignacian assemblages be dominated by one taxon, that such dominance not be driven by the fact that little else was available on the landscape, and that earlier assemblages be different in this regard.

Quantitative measures appropriate to assessing these issues now have a lengthy history in zooarchaeology (Grayson, 1984). Here, we have chosen to focus our analyses on the evenness of the ungulate assemblages involved. We measure evenness as $-\sum p_i \ln p_i / \ln S$, with S taken to be the number of non-overlapping taxa in the assemblage and p the proportion of specimens in the i th species. This measure, E , can vary from 0 to 1; the lower the value, the less even the assemblage (Magurran, 1988).

We have also calculated Simpson's Index for each assemblage ($D = \sum n_i[n_i - 1] / N[N - 1]$, where n_i = the number of specimens in the i th species and N = the total number of specimens). We chose this index because it more sensitively reflects the dominance of an assemblage by a single species than does E . The values we report are the inverse of Simpson's Index: the lower the resultant value, the more the assemblage involved is dominated by a single taxon (Magurran, 1988). Because the values of both of these indices may vary with sample size, we present all of our results as scattergrams with NISP as the independent, and the index values as the dependent, variable.

Specialized Early Upper Palaeolithic Hunters in Southwestern France? 1441

Table 1. Faunal assemblages included in the analysis (*NISP_{dom}*=*NISP* of most abundant taxon; *NTAXA*=number of taxa; *E*=evenness; *I/D*=dominance; *BB*=*Bos sp.* or *Bison sp.*; *BI*=*Bison sp.*; *BO*=*Bos sp.*; *CP*=*Capra sp.*; *CE*=*Cervus elaphus*; *CL*=*Capreolus capreolus*; *CS*=*Cervus simplicidens*; *EQ*=*Equus caballus*; *RT*=*Rangifer tarandus*; *TIE*=two most-abundant taxa have identical *NISP* values). The two open sites, Mauran and La Borde, are marked by bold letters

Assemblage	NISP	NISP _{dom} -Taxon	NTAXA	E	I/D	Reference(s)
<i>Aurignacian</i>						
Abri Pataud 7	567	395-RT	9	0.4651	1.9376	Bouchud, 1975
Abri Pataud 8	20	5-TIE	6	0.9470	6.5531	Bouchud, 1975
Abri Pataud 11	966	599-RT	6	0.3982	1.9150	Bouchud, 1975
Abri Pataud 12	174	129-RT	4	0.5119	1.6832	Bouchud, 1975
Abri Pataud 13	224	221-RT	2	0.1026	1.0273	Bouchud, 1975
Abri Pataud 14	1495	1481-RT	5	0.0383	1.0190	Bouchud, 1975
Caminade-Est F	22	9-RT	5	0.8600	3.8521	Delpech, 1970
Grotte XVI AIB	239	154-RT	8	0.5816	2.2497	Grayson <i>et al.</i> , 2001
Grotte XVI ABB	1051	677-RT	9	0.5629	2.2543	Grayson <i>et al.</i> , 2001
La Chevre 3	287	228-RT	5	0.4011	1.5239	Bouchud, 1964
La Chevre 4	221	108-BB	6	0.6781	2.8273	Bouchud, 1964
La Ferrassie F	58	37-CE	10	0.5979	2.3923	Delpech <i>et al.</i> , 2000
La Ferrassie G front	87	32-RT	7	0.7948	4.0667	Delpech <i>et al.</i> , 2000
La Ferrassie H	73	25-RT	8	0.7807	4.2499	Delpech <i>et al.</i> , 2000
La Ferrassie I	120	59-BB	10	0.6670	3.2938	Delpech <i>et al.</i> , 2000
La Ferrassie J	56	29-BB	7	0.7628	3.2648	Delpech <i>et al.</i> , 2000
La Ferrassie K1-3	105	53-BB	8	0.6689	3.0921	Delpech <i>et al.</i> , 2000
La Ferrassie K4	24	12-RT	3	0.8360	2.4649	Delpech <i>et al.</i> , 2000
La Ferrassie K5	186	152-RT	5	0.3869	1.4590	Delpech <i>et al.</i> , 2000
Le Flageolet I VIII	461	240-RT	9	0.6041	2.8074	Delpech <i>et al.</i> , 2000; Grayson & Delpech, 1998
Le Flageolet I IX	681	468-RT	11	0.4854	2.0239	Delpech <i>et al.</i> , 2000; Grayson & Delpech, 1998
Le Flageolet I XI	651	511-RT	6	0.4458	1.5860	Delpech <i>et al.</i> , 2000; Grayson & Delpech, 1998
Le Piage F	363	242-RT	4	0.6321	2.0020	Beckouche, 1981
Le Piage G-I	636	328-CP	6	0.6612	2.7663	Beckouche, 1981
Le Piage J	705	666-RT	4	0.1935	1.1193	Beckouche, 1981
Le Piage K	527	458-RT	6	0.3024	1.3139	Beckouche, 1981
Maldidier 5	31	12-RT	5	0.9126	4.3048	Delpech, 1983
Roc de Combe 5	1199	1109-RT	7	0.1801	1.1652	Delpech, 1983; Delpech <i>et al.</i> , 2000
Roc de Combe 6	183	153-RT	9	0.3361	1.4227	Delpech, 1983; Delpech <i>et al.</i> , 2000
Roc de Combe 7*	918	873-RT	7	0.1346	1.1050	Delpech, 1983; Delpech <i>et al.</i> , 2000
<i>Châtelperronian</i>						
Arcy s/Cure Renne Xc	2590	2132-RT	7	0.3384	1.4510	David & Poulain, 1990
Grotte XVI B	187	88-RT	9	0.6617	3.2701	Grayson <i>et al.</i> , 2001
La Ferrassie L3ab	70	38-RT	6	0.6507	2.5994	Delpech <i>et al.</i> , 2000
Le Piage F1	60	44-RT	5	0.5329	1.7787	Beckouche, 1981
Roc de Combe 8	166	68-RT	6	0.6678	2.9206	Delpech, 1983; Delpech <i>et al.</i> , 2000
St. Cesaire EJOP	469	236-RT	9	0.6759	3.1576	Patou-Mathis, 1993
<i>Mousterian</i>						
Arcy s/Cure Renne XI	1343	857-RT	7	0.4914	2.0799	David & Poulain, 1990
Bourgeois-Delaunay 8	48	27-EQ	6	0.6872	2.6911	Armand, 1998a
Bourgeois-Delaunay 8'	139	78-EQ	8	0.6469	2.7360	Armand, 1998a
Bourgeois-Delaunay 9	348	196-EQ	12	0.5684	2.7442	Armand, 1998a
Bourgeois-Delaunay 9'	55	30-EQ	5	0.7719	2.8137	Armand, 1998a
Bourgeois-Delaunay 10	132	90-EQ	7	0.5271	2.0109	Armand, 1998a
Combe Grenal 6	55	24-RT	6	0.7802	3.4771	Guadelli, 1987
Combe Grenal 7	54	30-RT	6	0.6406	2.5780	Guadelli, 1987
Combe Grenal 8	23	9-TIE	4	0.8744	3.3278	Guadelli, 1987
Combe Grenal 9	34	24-CE	5	0.5483	1.8889	Guadelli, 1987
Combe Grenal 10	31	11-BI	4	0.9082	3.6036	Guadelli, 1987
Combe Grenal 11	158	56.5-BI	8	0.8410	4.8544	Guadelli, 1987
Combe Grenal 12	85	25-EQ	7	0.8623	4.9900	Guadelli, 1987
Combe Grenal 13	171	107-EQ	6	0.6787	2.3568	Guadelli, 1987
Combe Grenal 14	537	375-EQ	8	0.4852	1.9264	Guadelli, 1987
Combe Grenal 15-16	93	56-EQ	6	0.6655	2.4600	Guadelli, 1987
Combe Grenal 17	148	79-RT	7	0.5882	2.5562	Guadelli, 1987
Combe Grenal 18	49	26-RT	5	0.7987	2.9762	Guadelli, 1987
Combe Grenal 19	103	68-RT	4	0.6888	2.0825	Guadelli, 1987
Combe Grenal 20	192	92-RT	8	0.6673	3.1776	Guadelli, 1987
Combe Grenal 21	270	132-RT	8	0.6705	3.1486	Guadelli, 1987

Table 1. Continued

Assemblage	NISP	NISP _{dom} -Taxon	NTAXA	E	1/D	Reference(s)
Combe Grenal 22	982	642-RT	7	0.5131	2.0458	Guadelli, 1987
Combe Grenal 23	1101	782-RT	6	0.4883	1.8298	Guadelli, 1987
Combe Grenal 24	285	195-RT	6	0.5169	1.9600	Guadelli, 1987
Combe Grenal 25	284	181-RT	6	0.5512	2.1358	Guadelli, 1987
Combe Grenal 26	105	69-RT	4	0.7236	2.1304	Guadelli, 1987
Combe Grenal 27	296	163-RT	8	0.5440	2.4679	Guadelli, 1987
Combe Grenal 28	122	73-RT	5	0.6126	2.2065	Guadelli, 1987
Combe Grenal 29	224	81-RT	8	0.7045	3.5932	Guadelli, 1987
Combe Grenal 30	77	36-RT	6	0.7048	3.0647	Guadelli, 1987
Combe Grenal 31	85	52-RT	7	0.6488	2.4643	Guadelli, 1987
Combe Grenal 32	153	54-RT	7	0.7396	3.8066	Guadelli, 1987
Combe Grenal 33	54	31-BI	6	0.6985	2.6652	Guadelli, 1987
Combe Grenal 34	20	8-CE	6	0.8285	4.3178	Guadelli, 1987
Combe Grenal 35	331	165-CE	9	0.6748	3.2468	Guadelli, 1987
Combe Grenal 36	78	43-CS	5	0.7998	2.8498	Laquay, 1981; Delpech 1996
Combe Grenal 37	56	30-CS	4	0.7756	2.5974	Laquay, 1981; Delpech 1996
Combe Grenal 38	80	34-CS	7	0.8414	4.1859	Laquay, 1981; Delpech 1996
Combe Grenal 40/39	126	89-CS	8	0.5267	1.9444	Laquay, 1981; Delpech 1996
Combe Grenal 41	59	36-CS	5	0.7367	2.4722	Laquay, 1981; Delpech 1996
Combe Grenal 43/42	149	115-CS	5	0.4371	1.5954	Laquay, 1981; Delpech 1996
Combe Grenal 45/44	31	17-CS	5	0.7757	2.9053	Laquay, 1981; Delpech 1996
Combe Grenal 47/46	71	43-CS	5	0.7063	2.4079	Laquay, 1981; Delpech 1996
Combe Grenal 49/48	60	31-CS	6	0.7661	3.1211	Laquay, 1981; Delpech 1996
Combe Grenal 50	818	680-CS	9	0.3009	1.4241	Laquay, 1981; Delpech 1996
Combe Grenal 50A	342	262-CS	8	0.3975	1.6410	Laquay, 1981; Delpech 1996
Combe Grenal 51	73	47-CS	7	0.5353	2.1418	Laquay, 1981; Delpech 1996
Combe Grenal 52	854	655-CS	9	0.4184	1.6656	Laquay, 1981; Delpech 1996
Combe Grenal 53	41	29-CS	5	0.6096	1.9478	Laquay, 1981; Delpech 1996
Combe Grenal 54	282	209-CS	9	0.4308	1.7596	Laquay, 1981; Delpech 1996
Grotte XVI C	431	162-RT	8	0.8173	4.3384	Delpech unpublished
La Borde	430	410-BO	4	0.1604	1.0988	Jaubert <i>et al.</i> 1990
La Quina 2A	56	33-EQ	3	0.7267	2.0838	Armand, 1998b
La Quina 2B	437	302-EQ	4	0.5861	1.8762	Armand, 1998b
La Quina 4A	74	45-EQ	4	0.7138	2.3026	Armand, 1998b
La Quina 4B	885	508-EQ	5	0.5895	2.2936	Armand, 1998b
La Quina 6A	972	611-BB	6	0.5350	2.1377	Armand, 1998b
La Quina 6B	22	19-BB	3	0.4416	1.3430	Armand, 1998b
La Quina 6C	271	225-BB	4	0.4596	1.4318	Armand, 1998b
La Quina 6D	151	70-BB	5	0.7864	3.1279	Armand, 1998b
La Quina 8	2560	2304-RT	6	0.2232	1.2265	Armand, 1998b
Les Fieux J	56	37-BI	8	0.5208	2.1008	Champagne <i>et al.</i> , 1990; J.-L. Guadelli, pers. comm.
Les Fieux K	79	69-BI	4	0.3680	1.3057	Champagne <i>et al.</i> , 1990; J.-L. Guadelli, pers. comm.
Mauran**	4192	4150-BI	3	0.0543	1.0202	Farizy <i>et al.</i> , 1994
Pech de l'Azé IB 4	331	201-CE	8	0.5802	2.4155	Laparra, 2000
Pech de l'Azé II 2E	66	35-RT	5	0.6986	2.5687	Laquay, 1981; Delpech, 1997
Pech de l'Azé II 2G	88	54-CE	7	0.6756	2.4931	Laquay, 1981; Delpech, 1997
Pech de l'Azé II 2G'	36	17-CE	7	0.7869	3.7495	Laquay, 1981; Delpech, 1997
Pech de l'Azé II 3	173	78-CE	11	0.7504	4.0128	Laquay, 1981; Delpech, 1997
Pech de l'Azé II 4A	92	69-EQ	5	0.5242	1.7194	Laquay, 1981; Delpech, 1997
Pech de l'Azé II 4A2	33	12-CE	6	0.8286	4.2248	Laquay, 1981; Delpech, 1997
Pech de l'Azé II 4B4	315	155-CE	10	0.5368	2.6434	Laquay, 1981; Delpech, 1997
Pech de l'Azé II 4C1	38	26-CE	5	0.6087	2.0321	Laquay, 1981; Delpech, 1997
Pech de l'Azé II 4C2	492	387-CE	7	0.4057	1.5770	Laquay, 1981; Delpech, 1997
Pech de l'Azé II 4E	31	10-CE	8	0.8118	4.9456	Laquay, 1981; Delpech, 1997
Pech de l'Azé II 5	21	10-EQ	5	0.8102	3.3864	Laquay, 1981; Delpech, 1997
Pech de l'Azé IV G	61	57-RT	4	0.2238	1.1460	Laquay, 1981
Pech de l'Azé IV H1	57	47-RT	4	0.4553	1.4537	Laquay, 1981
Pech de l'Azé IV H2	102	85-RT	5	0.3961	1.4229	Laquay, 1981
Pech de l'Azé IV I1	247	216-RT	5	0.3299	1.3006	Laquay, 1981
Pech de l'Azé IV I2	539	332-RT	7	0.5535	2.2655	Laquay, 1981
Pech de l'Azé IV J1	63	29-RT	4	0.8981	3.2175	Laquay, 1981
Pech de l'Azé IV J2	75	31-CE	5	0.8304	3.3190	Laquay, 1981
Pech de l'Azé IV J3	1283	659-CE	12	0.5329	2.7886	Laquay, 1981

Table 1. Continued

Assemblage	NISP	NISP _{dom} -Taxon	NTAXA	E	1/D	Reference(s)
Pech de l'Azé IV J4	185	85-CL	6	0.6547	2.7130	Laquay, 1981
Pech de l'Azé IV X	252	183-CE	5	0.5743	1.8212	Laquay, 1981
Pech de l'Azé IV Y	156	125-CE	6	0.3994	1.5244	Laquay, 1981
Pech de l'Azé IV Z	66	52-CE	4	0.5189	1.5758	Laquay, 1981
Regourdou 2	416	269-RT	7	0.5490	2.1636	Delpech, 1996
Regourdou 3	63	31-CS	5	0.8226	3.2134	Delpech, 1996
Regourdou 4	121	61-CS	6	0.7462	3.0713	Delpech, 1996
Regourdou 5	57	36-CS	7	0.5969	2.2994	Delpech, 1996
Regourdou 7	35	17-CL	3	0.8786	2.5536	Delpech, 1996
St. Césaire EGC	98	68-BI	7	0.6640	2.0202	Ferrier, 2001
St. Césaire EGPF	1205	584-BI	8	0.5897	2.7196	Ferrier, 2001
Vaufrey I	140	116-RT	6	0.3701	1.4388	Delpech, 1988, 1996
Vaufrey II	104	46-RT	5	0.7470	2.9674	Delpech, 1988, 1996

*We have treated Roc de Combe 7 as a coherent stratigraphic unit, even though the ^{14}C determinations for this unit make it clear that Roc de Combe 7a is significantly younger than Roc de Combe 7b and 7c (Delpech *et al.*, 2000). Although some specimens from this unit can be assigned to the subdivisions of which it is composed, the majority cannot (Delpech, 1983).

**The Mauran monograph (Farizy *et al.*, 1994) does not provide complete specimen counts for the ungulates represented at this site. The monograph does, however, provide a total specimen count and the percentage abundances of each ungulate (Farizy *et al.*, 1994: 46). We applied the latter to the former to derive taxon-by taxon NISP values.

Finally, to make our results easily comparable to those provided by Mellars, we follow him in also presenting an analysis that is percentage-based.

With one exception, our calculation of non-overlapping taxa follows the protocol we have used in earlier publications (e.g., Grayson & Delpech, 1998, Grayson *et al.*, 2001). The one exception involves the calculation of abundances for taxa identified at multiple taxonomic levels. For Combe Grenal stratum 11, for instance, Guadelli (1987) identified 47 specimens of *Bos/Bison*, 2 of *Bos*, and 15 of *Bison*. In this case, we distributed 2/17 of the 47 *Bos/Bison* specimens to *Bos*, the remainder to *Bison*. This procedure is identical to that which we have used in the past, except for the fact that we have not rounded the results to the nearest whole number. Thus, in Table 1, the abundance of *Bison* is reported as 56.5 specimens (15+47[15/17]). All relevant data are presented in Table 1.

Evenness and dominance

Figure 1 presents the relationship between evenness (E) and sample size for the Aurignacian assemblages in our sample. The correlation between these two variables is quite significant ($r = -0.77$, $P < 0.001$), but, as the figure shows, the regression equation that emerges from this relationship overpredicts the evenness values of the five least-even assemblages: Abri Pataud 13 (the only two standard deviation outlier in the Aurignacian set), Abri Pataud 14, Le Piage J, Roc de Combe 5, and Roc de Combe 7. These five assemblages come from three of the four sites that Mellars has used to support his argument that most faunas from early Aurignacian levels in southwestern France are heavily dominated by a single taxon. Mellars' fourth site, La Gravette, has not been included in our analysis because specimen counts are not available.

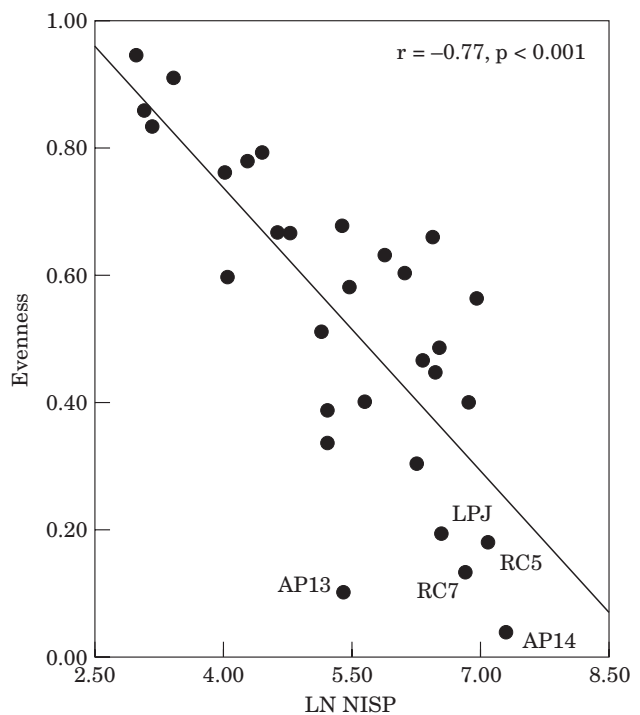


Figure 1. Aurignacian ungulate assemblage evenness values (AP=Abri Pataud; LP=Le Piage; RC=Roc de Combe).

Figure 2 provides the comparable relationship for the Mousterian cave and rockshelter assemblages in our sample. Although the relationship between evenness and sample size is weaker here than it is for the Aurignacian assemblages, presumably in part because this sample covers a much greater span of time, it is still significant ($r = -0.62$, $P < 0.001$). In this relationship, three assemblages have evenness values that fall

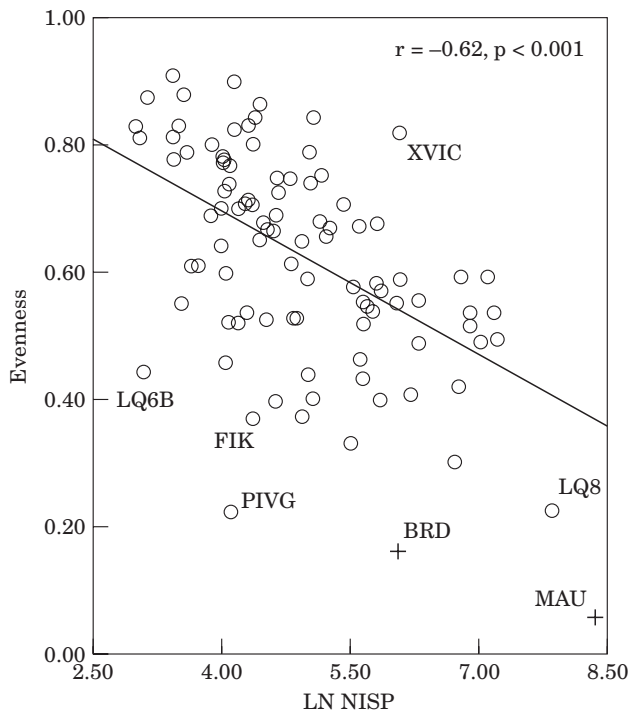


Figure 2. Mousterian ungulate assemblage evenness values (BRD=La Borde; FI=Les Fieux; LQ=La Quina; MAU=Mauran; PIV=Pech de l'Azé IV; XVI=Grotte XVI; Mauran and La Borde, indicated by crosses, were not used to calculate the regression statistics).

more than two standard deviations beneath the predicted value (Les Fieux K, La Quina 6B and Pech de l'Azé IV G); one, Grotte XVI C, has an evenness value significantly greater than expected. Mellars' arguments, however, focus not on deviations between predicted and expected values, but instead on lack of evenness *per se*. Two assemblages stand out in this regard: Pech de l'Azé IV G and La Quina 8.

Figure 2 also shows the position of two Mousterian sites that do not play a role in Mellars' arguments concerning the advent of specialized hunting during the Upper Palaeolithic: Mauran, an open-air site marked by a substantial fauna composed almost entirely of *Bison priscus* (Farizy *et al.*, 1994), and La Borde, whose fauna, excavated from an aven, is dominated by *Bos primigenius* (Jaubert *et al.*, 1990). We discuss these sites separately below; unless otherwise indicated, they have been excluded from the calculation of the composite statistics we provide.

The Aurignacian and Mousterian data are combined, and the Châtelperronian data added, in Figure 3. In this figure, we have also identified all assemblages with evenness values beneath 0.25. Among the caves and rock shelters, Abri Pataud 13 and 14, Le Piage J, and Roc de Combe 5 and 7 emerge as the least even assemblages in our set, with Pech IV G and La Quina 8 not far behind. The faunas of all seven assemblages are dominated by reindeer. We observe that if the

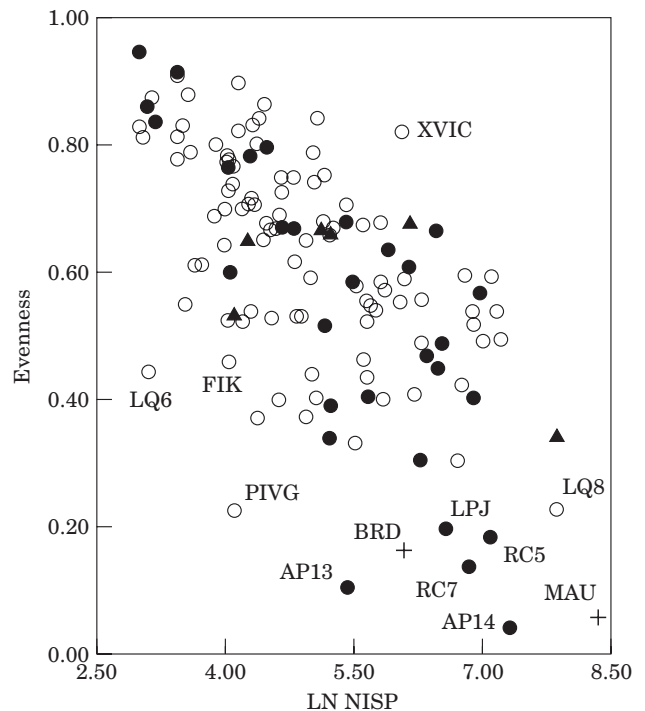


Figure 3. Composite Aurignacian, Châtelperronian, and Mousterian ungulate assemblage evenness values (●=Aurignacian; ▲=Châtelperronian; ○=Mousterian; see Figures 1 and 2 for site abbreviations).

entire set of cave and rockshelter assemblages is treated as a composite, regression analysis shows Abri Pataud 13 and 14, Roc de Combe 7, and Pech IV G to be two standard deviation outliers in the low evenness group; among more even assemblages, Les Fieux K, La Quina 6B and Grotte XVI C emerge as two standard deviation outliers.

We dwell at less length on the results of the dominance (1/D) analysis. As Figure 4 shows, the same seven cave and rock shelter assemblages emerge as those most dominated by a single taxon. Beyond this, and as with the evenness analysis, there is almost complete overlap between Mousterian, Châtelperronian, and Aurignacian assemblages.

Percentage-based analyses

Mellars based his arguments for early Upper Palaeolithic hunting specialization on the analysis of taxonomic relative abundances expressed as percentages, and we follow his lead here. Figure 5 replicates his approach with our data set, arraying sample size against the percentage of each assemblage that is provided by the most abundant taxon. The same assemblages emerge here as emerged from the examination of evenness and dominance.

Finally, Figure 6 provides a histogram of the assemblages in our sample according to the degree to which they are dominated by a single taxon, using the same

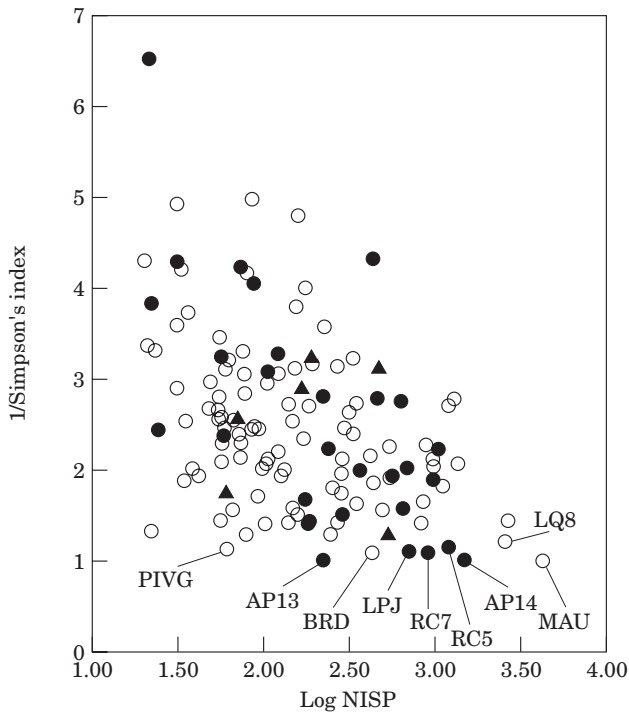


Figure 4. Inverse Simpson's Index values for all ungulate assemblages (●=Aurignacian; ▲=Châtelperronian; ○=Mousterian; see Figures 1 and 2 for site abbreviations).

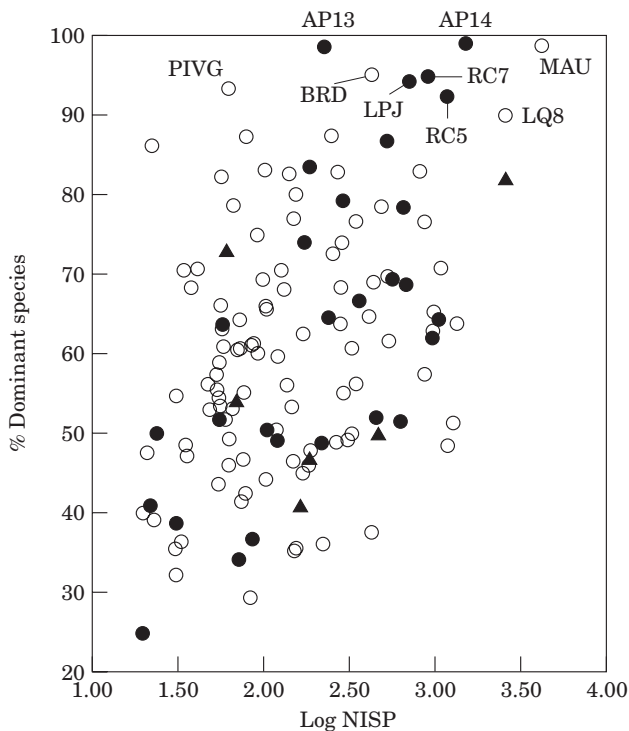


Figure 5. The percentage by which ungulate assemblages are dominated by a single taxon (see Figures 1 and 2 for site abbreviations).

5% intervals used by Mellars (1996). Mellars (1996: 201) has observed that the dominant species in Mousterian cave and rock shelter faunal assemblages

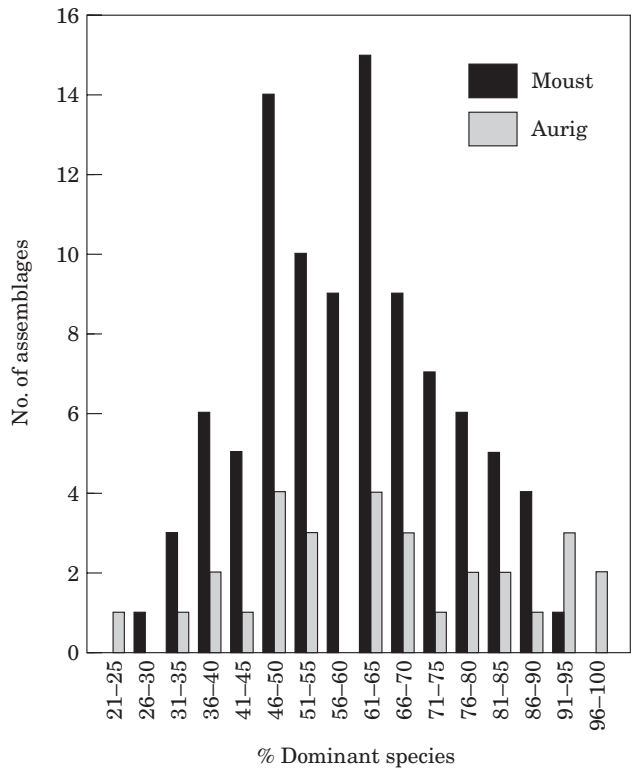


Figure 6. The distribution of percentage dominance values by 5% intervals for Mousterian and Aurignacian ungulate assemblages.

usually accounts for 60–70% of those assemblages, and our data are in accord with this observation. However, the Aurignacian modal decile value falls in exactly the same interval. In fact, chi-square analysis of these distributions shows that they are not significantly different from one another (chi-square=19.39, $P > 0.20$). Analysis of single-cell residuals (Everitt, 1977) shows that Mousterian values differ significantly from Aurignacian ones in two instances: there are more Aurignacian assemblages in the 91–95% and 96–100% classes than can be accounted for by chance (adjusted residuals=2.54 and 2.43, respectively; $P < 0.02$). Not surprisingly, these intervals contain the Aurignacian assemblages from Abri Pataud 13 and 14, Le Piage J, and Roc de Combe 5 and 7, as well as the Mousterian fauna from Pech de l'Azé IV G.

If Mauran and La Borde are added to the analysis, not only is the composite chi-square value reduced (14.04, $P > 0.20$), but there are no significant (i.e., $P < 0.05$) single-cell differences in the distribution of assemblages across percentage classes (see Table 2). That is, taking the same approach used by Mellars to make his argument concerning early Upper Palaeolithic subsistence specialization but treating Mauran and La Borde as part of our sample, removes the basis of the argument entirely.

Mellars could respond to this latter observation with a chi-square test of his own. After all, his argument is that “most of the faunas recovered from early

Table 2. Adjusted residuals for the distribution of Aurignacian assemblages across 5% dominance classes, Mauran and La Borde included (Mousterian values have reversed signs but are otherwise identical)

Percentage class	N of Assemblages		Aurignacian adjusted residual
	Mousterian	Aurignacian	
96–100	1	2	+1.78
91–95	2	3	+1.95
86–90	4	1	–0.19
81–85	5	2	+0.32
76–80	6	2	+0.09
71–75	7	1	–0.77
66–70	9	3	+0.12
61–65	15	4	–0.29
56–60	9	0	–1.73
51–55	10	3	–0.05
46–50	14	4	–0.15
41–45	5	1	–0.41
36–40	6	2	+0.09
31–35	3	1	+0.07
26–30	1	0	–0.55
21–25	0	1	+1.81

Aurignacian levels” have “reindeer often comprising more than 90% of the documented remains” (Mellars, 1998: 500). Clearly, most early Aurignacian faunas do not meet this requirement, but it is nonetheless true that five do. Even if we include Mauran and La Borde, there are significantly more Aurignacian assemblages whose most abundant taxon comprises more than 90% “of the documented remains” (5/30) than is the case in our Mousterian sample (3/97; chi-square=7.15, $P<0.01$). In particular, there are three more Aurignacian assemblages in this interval than this distribution predicts. Were Mellars to argue this way, part of his position would be salvaged, although not impressively so.

Of course, there is nothing magical about Mellars 90% figure. It was clearly inductively derived from an examination of the distribution of taxonomic abundances in the faunas available to him, then selected because it maximized the distinction between the Aurignacian and Mousterian. Indeed, much the same could be said about the full range of archaeological phenomena that have been used to define “behaviorally modern” in this part of the world: the entire set has been derived inductively by looking for differences, and then using those differences to define modernity (for an approach to a corrective, see [McBrearty & Brooks, 2000](#)). Given this approach, and given that there is no reason to assume that a fauna that has resulted from specialized hunting can only be marked by taxonomic abundances above 90%, we observe that had a different figure been chosen, Mellars’ argument could not have been made. If, for instance, we select 81% as the threshold figure and include Mauran and La Borde in the analysis, the resultant difference (8 of 30 Aurignacian assemblages compared to 12 of 97 Mousterian ones) is not statistically significant (chi-square=3.53, $P>0.05$; see [Table 2](#)).

Discussion

Our analyses question two important aspects of Mellars’ argument, and we discuss each of these aspects in turn.

1. All the analyses we have presented show that the differences in cave and rock shelter assemblages targeted by Mellars reside in a very small subset of Aurignacian assemblages that have specimen counts: Abri Pataud 13 and 14, Le Piage J, and Roc de Combe 5 and 7. It is, in fact, simple to make the distinct nature of these assemblages even more obvious.

Of the 30 Aurignacian assemblages in our sample, 23 have reindeer as the most abundant taxon. Of the 11,114 specimens in these 23 assemblages, 8846, or 79.6%, are of reindeer (see [Tables 1 and 3A](#)). Of the 95 Mousterian cave and rock shelter assemblages in our sample, 31 have reindeer as the most abundant taxon. These 31 have a total of 10,714 specimens, of which 7334, or 68.5%, are reindeer. This difference is highly significant (chi-square=353.02, $P<0.001$).

If we exclude Abri Pataud 13 and 14, Le Piage J, and Roc de Combe 5 and 7 from the Aurignacian list, we are left with 25 Aurignacian assemblages of which 18 are dominated by reindeer ([Table 3B](#)). Of the 6573 specimens in these reindeer-dominated assemblages, 4496 are of reindeer. That is, excluding the Aurignacian assemblages that our analyses identify as providing the only potentially relevant support for Mellars’ position, 68.4% (4496/6573) of the reindeer-dominated Aurignacian assemblages are composed of reindeer—virtually identical to the 68.5% figure provided by the Mousterian assemblages. This difference, of course, is not significant (chi-square=0.01, $P>0.50$).

Although most Aurignacian assemblages in our sample are dominated by reindeer, some have red deer (*Cervus elaphus*), *Capra* sp., or large bovids (*Bos* and/or *Bison*) as the most abundant taxon. Mousterian and Aurignacian assemblages dominated by the first two of these taxa do not differ significantly from one another in the relative abundances of the most abundant taxon (for red deer, chi-square=0.72, $P>0.50$; for *Capra* sp., chi-square=1.77, $P>0.10$; see [Table 3C and D](#)).

This is not the case, however, for assemblages dominated by large bovids ([Table 3E](#)). Large bovids are the most abundant taxon in 11 Mousterian cave and rock shelter assemblages, compared to four such Aurignacian assemblages. The former have significantly more large bovids than do the latter (chi-square=11.03, $P<0.001$). If Mauran and La Borde are included in the analysis, the difference becomes comparable to that for reindeer (chi-square=314.14, $P<0.001$; see [Table 3F](#)). In fact, the 13 Mousterian assemblages whose most abundant taxon is *Bos* or *Bison* are more heavily dominated by those animals than the 23 reindeer-dominated Aurignacian assemblages are dominated by reindeer (chi-square=19.14, $P<0.001$; see [Table 3G](#)).

2. The distinctive nature of the five Aurignacian assemblages (Abri Pataud 13 and 14, Le Piage J, and

Table 3. Aurignacian and Mousterian NISP values for the most abundant taxa in Aurignacian faunas (number of assemblages in parentheses)

A. Reindeer dominated assemblages	Reindeer NISP	All other taxa	ΣNISP
Aurignacian (23)	8846	2268	11,114
Mousterian (31)	7334	3380	10,714
Chi-square=353.02 ($P<0.001$)			
B. Reindeer dominated assemblages: Abri Pataud 13 and 14, Le Piage J, and Roc de Combe 5 and 7 excluded	Reindeer NISP	All other taxa	ΣNISP
Aurignacian (18)	4496	2077	6573
Mousterian (31)	7334	3380	10,714
Chi-square=0.01 ($P>0.50$)			
C. Red deer dominated assemblages	Red deer	All other taxa	ΣNISP
Aurignacian (1)	37	21	58
Mousterian (17)	2187	1567	3754
Chi-square=0.72 ($P>0.50$)			
D. <i>Capra</i> sp. dominated assemblages	<i>Capra</i> sp. NISP	All other taxa	ΣNISP
Aurignacian (1)	328	308	636
Mousterian (2)	102	118	220
Chi-square=1.77 ($P>0.10$)			
E. Large bovid dominated assemblages	Large bovid NISP	All other taxa	ΣNISP
Aurignacian (4)	249	253	502
Mousterian (11)	1781.5	1315.5	3097
Chi-square=11.03 ($P<0.001$)			
F. Large bovid dominated assemblages, including Mauran and La Borde	Large bovid NISP	All other taxa	ΣNISP
Aurignacian (4)	249	253	502
Mousterian (13)	6341.5	1377.5	7719
Chi-square=314.14 ($P<0.001$)			
G. Aurignacian reindeer dominated versus Mousterian large bovid dominated assemblages	NISP of dominant taxon	All other taxa	ΣNISP
Aurignacian (23)	8846	2268	11,114
Mousterian (13)	6341.5	1377.5	7719
Chi-square=19.14 ($P<0.001$)			

Roc de Combe 5 and 7) revealed by our analysis stems from Mellars' decision to include only cave and rock shelter faunas in his analysis and from his designation of 91% single-taxon dominance as tagging a "specialized" fauna.

Once open sites are included in the sample, very simple quantitative analysis reveals that there are no significant differences in the distribution of Aurignacian and Mousterian assemblages across the

same 5% intervals used by Mellars (1996) in his analysis. If we divide these assemblages into two dominance-based percentage classes, those at or above 91% and those beneath this figure, there are more Aurignacian assemblages in the 91–100% interval than can be accounted for by chance (three, to be exact). However, since the 91% figure was inductively selected to emphasize the potential differences between the assemblages involved, and since we are aware of no conceptual

arguments that equate specialized hunting with taxonomic abundances of 91% or more, even this weak positive result does not provide much support for Mellars' position. As we have noted, if 81% is selected as the threshold and open sites are included in the analysis, no significant differences emerge between the Aurignacian and Mousterian in terms of taxonomic dominance.

Mellars (1996) very correctly observes that the term "specialized hunting" implies, among other things, the selection of a subset of taxa as a hunting target from a broader array of potential prey taxa on the landscape. Mellars, we note, has not shown that during the times his "specialized" faunas accumulated, there was a broader array of acceptable, yet relatively ignored, species on the landscape in the vicinity of the sites that he targets as critical to his argument.

We do not address this issue here. We see no reason to, since we see no compelling evidence in Mellars' analysis or in the data that we have amassed to suggest that specialized hunting was being practiced to any greater extent during the Aurignacian than it was during the Mousterian. In concluding this, of course, we are saying no more than what many other analysts have already concluded (see the discussion above). We hope, however, that the approach we have taken here clarifies how and why Mellars has been led astray.

Acknowledgements

Our sincere thanks to Kristine M. Bovy, Richard G. Klein, Jean-Philippe Rigaud, and Lawrence G. Straus for help along the way, including insightful comments on an earlier version of this manuscript. The data from Grotte XVI reported in this manuscript result from work supported by the National Science Foundation (SBR98-04692) and the Sous Direction de l'Archéologie et Direction des Musées de France (Ministère de la Culture).

References

- Armand, D. (1998a). La faune de la grotte Bourgeois-Delaunay, Commune de La Chaise de Vouthon (Charente): Résultats préliminaires. *Paléo* **10**, 77–86.
- Armand, D. (1998b). Sur la présence d'*Equus caballus gallicus* dans les niveaux supérieurs de la station Amont de La Quina (Charente). *Quaternaire* **9**, 345–353.
- Beckouche, S. (1981). Les grands mammifères du Paléolithique supérieur du Piage (Lot). In (F. Champagne & R. Espalié, Eds) *Le Piage: Site préhistorique du Lot*. Mémoires de la Société Préhistorique Française **15**, pp. 165–191.
- Binford, L. R. & Binford, S. R. (1966). The predatory revolution: A consideration of the evidence for a new subsistence level. *American Anthropologist* **68**, 508–512.
- Binford, S. R. (1968). Early Upper Pleistocene adaptations in the Levant. *American Anthropologist* **70**, 707–717.
- Bouchud, J. (1964). Etude sommaire de la faune de gisement de la Chèvre. In (R. Arambourou & P. E. Jude, Eds) *Le Gisement de la Chèvre à Bourdeilles* (Dordogne). Périgueux: Magne, pp. 115–120.
- Bouchud, J. (1975). Etude de la faune de l'Abri Pataud. In (H. L. Movius, Jr, Ed.) *Excavation of the Abri Pataud, Les Eyzies (Dordogne)*. American School of Prehistoric Research Bulletin **30**, pp. 69–153.
- Braidwood, R. J. & Reed, C. A. (1957). The achievement and consequences of food-production: A consideration of the archaeological and natural-historical evidence. *Cold Spring Harbor Symposium on Quantitative Biology* **22**, 19–31.
- Champagne, F., Champagne, C., Jauzon, F. & Novel, P. (1990). Le site préhistorique des Fieux à Miers (Lot). *Gallia Préhistoire* **32**, 1–28.
- Chase, P. G. (1987). Spécialisation de la chasse et transition vers le Paléolithique supérieur. *L'Anthropologie* **91**, 175–178.
- Chase, P. G. (1989). How different was Middle Paleolithic subsistence? A zooarchaeological perspective on the Middle to Upper Paleolithic transition. In (P. Mellars & C. Stringer, Eds) *The Human Revolution: Behavioral and Biological Perspectives on the Origins of Modern Humans*. Princeton: Princeton University Press, pp. 321–337.
- Clark, G. A. (1987). From the Mousterian to the Metal ages. In (O. Soffer, Ed.) *The Pleistocene Old World: Regional Perspectives*. New York: Plenum Press, pp. 293–316.
- Clark, G. A. (1997). The Middle-Upper Paleolithic Transition in Europe: An American Perspective. *Norwegian Archaeological Review* **30**, 25–53.
- Clark, G. A. & Lindly, J. M. (1989). The case of continuity: Observations on the biocultural transition in Europe and western Asia. In (P. Mellars & C. Stringer, Eds) *The Human Revolution: Behavioral and Biological Perspectives on the Origins of Modern Humans*. Princeton: Princeton University Press, pp. 626–676.
- Clark, G. A. & Yi, S. (1983). Niche-width variation in Cantabrian archaeofaunas: A diachronic study. In (A. R. Hands & D. R. Walker, Eds) *Animals and Archaeology: 1. Hunters and their Prey*. BAR International Series **S163**, pp. 183–206.
- David, F. & Poulain, T. (1990). La faune de grands mammifères des niveaux XI and Xc de la Grotte du Renne à Arcy-sur-Cure (Yonne). In (C. Farizy, Ed.) *Paléolithique moyen récent et Paléolithique supérieur ancien en Europe*. Mémoires du Musée de Préhistoire d'Île-de-France **3**, pp. 319–323.
- Delpech, F. (1970). Faune aurignacienne de Caminade-Est, commune de La Canéda (Dordogne). *Quaternaria* **13**, 137–140.
- Delpech, F. (1983). Les faunes du Paléolithique supérieur dans le Sud-Ouest de la France. *Cahiers du Quaternaire* **6**.
- Delpech, F. (1988). Les grands mammifères de la grotte Vaufrey, à l'exception des Ursidés. In (J.-Ph. Rigaud, Ed.) *La Grotte Vaufrey à Cénac et Saint-Julien (Dordogne): Paléoenvironnements, chronologie, et activités humaines*. Mémoires de la Société Préhistorique Française **19**, pp. 213–289.
- Delpech, F. (1996). L'environnement animal des Moustériens Quina du Périgord. *Paléo* **8**, 31–46.
- Delpech, F. (1997). *Rapport 1997 sur les travaux de paléontologie effectués sur les faunes du Pech-de-l'Azé IIB (commune de Carsac, Dordogne)*. Unpublished manuscript on file at the Institut de Préhistoire et de Géologie du Quaternaire, Université Bordeaux I.
- 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). *Paléo* **12**, 97–126.
- Everitt, B. S. (1977). *The Analysis of Contingency Tables*. New York: Wiley and Sons.
- Farizy, C., David, F., Jaubert, J., Eisenmann, V., Girard, M., Grün, R., Krier, V., Leclerc, J., Miskovsky, J.-C. & Simmonet, R. (1994). Hommes et bisons du Paléolithique moyen à Mauran. *Gallia Préhistoire, Supplément* **30**, 1–269.
- Ferrier, J.-G. (2001). *La faune des niveaux Paléolithique moyen de Saint-Césaire. Paléontologie et observations archéozoologiques*. Mémoire de DEA d'Anthropologie, option Paléontologie, Université Bordeaux I.
- Freeman, L. G. (1971). Significado ecológico de los restos de animales. In (J. González Echeagaray, L. G. Freeman, K. W.

- Butzer, A. Leroi-Gourhan, J. Altuna, B. Madariaga & J. M. Apellániz) *Cueva Morin: Excavaciones 1966–1968*. Santander: Patronato de las Cuevas Prehistóricas, pp. 419–437.
- Freeman, L. G. (1973). The significance of mammalian faunas from Paleolithic occupations in Cantabrian Spain. *American Antiquity* **38**, 3–44.
- Grayson, D. K. (1984). *Quantitative Zooarchaeology*. New York: Academic Press.
- Grayson, D. K. & Delpech, F. (1998). Changing diet breadth in the early Upper Paleolithic of southwestern France. *Journal of Archaeological Science* **25**, 1119–1130.
- Grayson, D. K., Delpech, F., Rigaud, J.-Ph. & Simek, J. (2001). Explaining the development of dietary dominance by a single ungulate taxon at Grotte XVI, Dordogne, France. *Journal of Archaeological Science* **28**, 115–125.
- Guadelli, J.-L. (1987). *Contribution à l'étude des zoocénoses préhistoriques en Aquitaine (Würm ancien et interstade würmien)*. Thèse de l'Université Bordeaux I, No. 148.
- Jaubert, J., Lorblanchet, M., Laville, H., Slott-Moller, R., Turq, A. & Brugal, J.-Ph. (1990). *Les chasseurs d'aurochs de La Borde*. Documents d'Archéologie française 27. Paris: La Maison des Sciences de l'Homme.
- Klein, R. G. (1973). *Ice-Age Hunters of the Ukraine*. Chicago: University of Chicago Press.
- Klein, R. G. (1989). *The Human Career*. Chicago: University of Chicago Press.
- Klein, R. G. (1992). The archaeology of modern human origins. *Evolutionary Anthropology* **1**(1), 5–14.
- Klein, R. G. (1995). Anatomy, behavior, and modern human origins. *Journal of World Prehistory* **9**, 167–198.
- Klein, R. G. (1999). *The Human Career*. Second edition. Chicago: University of Chicago Press.
- Klein, R. G. (2000). Archaeology and the evolution of human behavior. *Evolutionary Anthropology* **9**(1), 17–36.
- Laparra, C. (2000). *Etude paléontologique, taphonomique et archéozoologique de la couche 4 de Pech de l'Azé Ib (Dordogne)*. DEA d'Anthropologie biologique. Université Bordeaux I.
- Laquay, G. (1981). *Recherches sur les faunes de Würm I en Périgord*. Thèse de Doctorat de troisième cycle, Université de Bordeaux I, No. 1596.
- Magurran, A. E. (1988). *Ecological Diversity and its Measurement*. Princeton: Princeton University Press.
- McBrearty, S. & Brooks, A. S. (2000). The revolution that wasn't: A new interpretation of the origin of modern human behavior. *Journal of Human Evolution* **39**, 453–563.
- Mellars, P. A. (1973). The character of the Middle-Upper Paleolithic transition in south-west France. In (C. Renfrew, Ed.) *The Explanation of Culture Change: Models in Prehistory*. London: Duckworth, pp. 255–276.
- Mellars, P. (1989). Major issues in the emergence of modern humans. *Current Anthropology* **30**, 349–385.
- Mellars, P. A. (1992). Archaeology and modern human origins in Europe. *Proceedings of the British Academy* **82**, 1–35.
- Mellars, P. A. (1993). Archaeology and the population-dispersal hypothesis of modern human origins in Europe. In (M. J. Aitken, C. B. Stringer & P. A. Mellars, Eds) *The Origin of Modern Humans and the Impact of Chronometric Dating*. Princeton: Princeton University Press, pp. 196–216.
- Mellars, P. (1996). *The Neanderthal Legacy*. Princeton: Princeton University Press.
- Mellars, P. (1998). The impact of climatic changes on the demography of later Neanderthal and early anatomically modern populations in Europe. In (T. Akazawa, K. Aoki & O. Bar-Yosef, Eds) *Neandertals and Modern Humans in Western Asia*. New York: Plenum Press, pp. 493–507.
- Otte, M. (1990). Les processus de transition du Paléolithique moyen au supérieur. In (C. Farizy, Ed.) *Paléolithique moyen récent et Paléolithique supérieur ancien en Europe*. Mémoires de Musée de Préhistoire d'Ile-de-France **3**, pp. 145–149.
- Patou-Mathis, M. (1993). A taphonomic and paleoethnographic study of the fauna associated with the Neanderthal of Saint-Césaire. In (F. Lévêque, A. M. Backer & M. Guilbaud, Eds) *Context of a Late Neanderthal*. Monographs in World Archaeology **16**. Madison: Prehistory Press, pp. 79–102.
- Potts, R. (1998). Environmental hypotheses of hominin evolution. *Yearbook of Physical Anthropology* **41**, 93–136.
- Rigaud, J.-Ph. (Ed.) (1988). La Grotte Vaufrey à Cénac et Saint-Julien (Dordogne): Paléoenvironnements, chronologie, et activités humaines. *Mémoires de la Société Préhistorique Française* **19**.
- Rigaud, J.-Ph. (1989). From the Middle to the Upper Paleolithic: Transition or convergence? In (E. Trinkaus, Ed.) *The Emergence of Modern Humans: Biocultural Adaptations in the Later Pleistocene*. Cambridge: Cambridge University Press, pp. 142–153.
- Rigaud, J.-Ph. (1993). Passages et transitions du Paléolithique moyen au Paléolithique supérieur. In (V. Cabrera Valdes, Ed.) *El origen del hombre moderno en el suroeste de Europa*. Madrid: UNED, pp. 117–126.
- Rigaud, J.-Ph. (1996). L'émergence du Paléolithique supérieur en Europe occidentale. Le rôle du Castelperronien. In (O. Bar-Yosef, L. L. Cavalli-Sforza, R. J. March & M. Piperno, Eds) *The Origin of Modern Humans*. Colloquia of the 13th International Congress of Prehistoric and Protohistoric Sciences **5**, pp. 219–223.
- Rigaud, J.-Ph. (2000). Human adaptation to the climatic deterioration of the last Pleniglacial in southwestern France. In (W. Roebroeks, M. Mussi, J. Svoboda & K. Fennema, Eds) *Hunters of the Golden Age: The Mid Upper Paleolithic of Eurasia, 30,000–20,000 BP*. Leiden: University of Leiden, pp. 325–336.
- Simek, J. F. & Snyder, L. M. (1988). Changing assemblage diversity in Périgord archaeofaunas. In (H. L. Dibble & A. Montet-White, Eds) *Upper Pleistocene Prehistory of Western Eurasia*. Philadelphia: University of Pennsylvania Museum, pp. 321–332.
- Stiner, M. C. (1994). *Honor among Thieves: A Zooarchaeological Study of Neanderthal Ecology*. Princeton: Princeton University Press.
- Stiner, M. C. (2001). Thirty years on the “Broad Spectrum Revolution” and Paleolithic demography. *Proceedings of the National Academy of Sciences* **98**, 6993–6996.
- Straus, L. G. (1977). Of deerslayers and mountain men: Paleolithic faunal exploitation in Cantabrian Spain. In (L. R. Binford, Ed.) *For Theory Building in Archaeology*. New York: Academic Press, pp. 41–76.
- Straus, L. G. (1985). Stone Age prehistory in northern Spain. *Science* **230**, 501–507.
- Straus, L. G. (1987). Hunting in late Upper Paleolithic western Europe. In (M. H. Nitecki & D. V. Nitecki, Eds) *The Evolution of Hunting*. New York: Plenum Press, pp. 147–176.
- Straus, L. G. (1992). *Iberia before the Iberians: The Stone Age Prehistory of Cantabrian Spain*. Albuquerque: University of New Mexico Press.
- White, R. (1982). Rethinking the Middle/Upper Paleolithic transition. *Current Anthropology* **23**, 169–192.