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Stone Tool Assemblage Richness during the Middle and Early Upper Palaeolithic in France

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Regression-based analysis of 164 French Mousterian, Chatelperronian and Aurignacian stone tool assemblages reveals that most of the perceived difference in typological richness between the Mousterian and Aurignacian is associated with differences in assemblage size. Within the framework of the classification systems involved, this discovery diminishes the importance of stone tool kit richness as a character that distinguishes between the Mousterian and Aurignacian. It also heightens the importance of explaining why assemblage sizes differ between these two industries. Even given that distinct classification systems are used to analyse Chatelperronian and Mousterian lithic assemblages, the Chatelperronian shows distinct similarities in richness to the Mousterian of Acheulian Tradition, the Mousterian facies that has often been argued to be its most likely immediate ancestor.

Keywords: MOUSTERIAN, CHATELPERRONIAN, AURIGNACIAN, MIDDLE PALAEOLITHIC, UPPER PALAEOLITHIC, FRANCE, NEANDERTHALS.

Introduction

It has become commonplace to observe that the archaeological record for the early Upper Palaeolithic of western Europe appears in many ways to be distinctly different from what came before. For instance, bone, antler and ivory are now routinely worked into standardized tool forms, objects that have been reasonably interpreted as items of personal adornment become common, and remarkably sophisticated art is added to the documented human behavioural repertoire (White, 1982, 1983, 1989, 1993; Klein, 1989, 1992, 1994, 1995; Mellars, 1989, 1993, 1996; Chauvet, Deschamps & Hillaire, 1996). The list is easily elaborated (see Klein, 1995), and most Palaeolithic archaeologists would seem to agree with Mellars' characterization of the period between 50,000 and 30,000 years ago as containing "a major revolution in human behaviour coinciding with the conventional transition from the Middle to the Upper Palaeolithic stages in Europe" (Mellars, 1996: 401).

Nonetheless, as Straus (1983, 1994, 1995) has argued, there is good reason to think that much biological and cultural change during this "transition" was mosaic in form. Detailed, objective analyses of assemblage variability are essential, Straus (1995) has observed, if we are to understand the cultural aspects of this change. In what follows, we heed this call and examine the frequent suggestion that one of the prime markers of the Middle-to-Upper Palaeolithic transition in western Europe is an increase in the diversity of artefact types (Klein, 1995: 168) during the Upper Palaeolithic.

Stone Tool Assemblage Richness

The term "diversity" is potentially quite confusing, since it has three distinct meanings (Peet, 1974; Magurran, 1988). In what is perhaps its most common application, "diversity" is used to refer to the number of classes in a sample or population. Here, we follow standard practice in ecology and refer to this variable as "richness". "Diversity" can also refer to the structure of the distribution of individuals or objects across classes, a variable we will refer to as "evenness". Finally, measures can also be built that incorporate both richness and evenness simultaneously. This more complex meaning of diversity is often referred to as "heterogeneity".

It is quite clear that by "diversity", Klein means richness. In general, he notes, "late-Pleistocene artifact

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Table 1. Mousterian assemblages used in the analysis

Site	Assemblages	Reference
Biache	DI, IIA, IIB	Meignen, 1981
Bourgeois-Delauney	8, 8′, 9, 10	Delagnes, 1992
Brugas	4	Meignen, 1981
Busigny	—	Tuffreau & Vaillant, 1984
Caminade Est	M1b, M1s, M2b, M2s, M3b, M3s, M3s+	Sonneville-Bordes, 1969
Combe Grenal	22, 29, 35	Turq, 1992
Combe-Capelle Bas	All (19 assemblages)	Dibble & Lenoir, 1995
Coudoulous I	4	Turq, 1992
Fonseigner	Dmi, E, F, H, I	Geneste, 1985
Grotte à Melon	1, 3	Bordes, 1957; Pradel, 1957
Rigabe	G	Escalon de Fonton & de Lumley, 1960
Bison	E, G	Girard, 1982
Mas-Viel	—	Niederlender *et al.*, 1956
L'Ermitage	—	Bordes, 1954*a*; Pradel & Pradel, 1954
La Borde	—	Turq, 1992
La Rochette	7, 10	Delporte, 1962
Les Festons	—	Geneste, 1985
Les Fieux	I, K	Turq, 1992
Pech de l'Azé I	3, 4f, 5si, 6sm, 7ss, Asi, Bs2, Cs3	Bordes, 1954*b*, 1955
Rescoundudou	C1	Jaubert, 1983
Roc de Marsal	IX, IXa, IXb, IXm, VII, VIII, X, XI, XII, XIa, XIb	Turq, 1992
Saint-Suliac	—	Giot & Bordes, 1955
Suard	51, 52, 53	Delagnes, 1992
Vaufrey	I–VIII	Rigaud, 1988

assemblages contain a much wider range of recognizable artifact types than do earlier ones'' (1989: 369), a point made as well by Mellars (1989, 1996) and others. Klein also implies that the Aurignacian, ''the earliest undeniable Upper Palaeolithic culture or culture complex in Europe'' (1995: 185), contains richer artefact assemblages than earlier Mousterian assemblages in the same area.

Mellars (1989: 353), however, explicitly questions whether particular Upper Palaeolithic taxonomic units are in fact richer than any Middle Palaeolithic ones. ''It is doubtful'', he suggests, ''whether the extent of morphological or functional complexity displayed in the majority of *individual* Upper Palaeolithic industries is very much greater than that displayed in the majority of Middle Palaeolithic assemblages''.

Sackett (1988) raises a very similar issue, suggesting that the great magnitude of typological variation often attributed to Upper Palaeolithic industries in comparison to Middle Palaeolithic ones has been exaggerated. In addition, he observes that Upper Palaeolithic industries are often dominated by a small number of artefact classes. That is, he suggests that while Upper Palaeolithic industries may not differ significantly from Middle Palaeolithic ones in terms of richness, they may differ in terms of evenness, or the distribution of artefacts across artefact classes.

Fortunately, there are simple statistical tools available for comparing the richness of Middle and Upper Palaeolithic industries. As is now well recognized, however, archaeological assemblage diversity, no matter how defined, is routinely correlated with, and thus potentially dependent upon, assemblage size (Grayson, 1981, 1984, 1991; Kintigh, 1984; Jones, Beck & Grayson, 1989). Here, we provide an assessment of the richness of French Mousterian, Chatelperronian and Aurignacian stone tool assemblages that takes differential assemblage size into account.

We are not the first to attempt such an analysis with western European Middle and Upper Palaeolithic stone tool assemblages: Simek & Price (1990) covered very similar ground a number of years ago. Because the goals, procedures and results of our study and theirs differ substantially, we consider their analysis after presenting our results.

The Analysed Sample

In assembling the sample for this analysis, we restricted our geographical focus to France but, within France, included all published assemblages accessible to us that provided numbers of artefacts per Bordesian artefact class (see below). All surface assemblages were excluded from consideration, as were all excavated assemblages felt to be mixed, or potentially mixed, by the excavators or by those who subsequently analysed the collections. This procedure provided 89 Mousterian (Table 1), 58 Aurignacian (Table 2) and 17 Chatelperronian assemblages (Table 3).

We have no way of assessing whether our sample is representative of all French Mousterian, Aurignacian and Chatelperronian assemblages, or even of all published such sites. For historical reasons, the Périgord is

Table 2. Aurignacian assemblages used in the analysis

Site	Assemblages	Reference
Bassaler-Nord	—	Couchard & Sonneville-Bordes, 1960
Blanchard	—	Sonneville-Bordes, 1960
Caminade-Est	G, F, E, D2i, D2s	Sonneville-Bordes, 1970
Caminade-Ouest	inf., sup.	Sonneville-Bordes, 1960
Castanet	I, II	Sonneville-Bordes, 1960
Cellier	I, II	Sonneville-Bordes, 1960
Chanlat	I, II	Sonneville-Bordes, 1960
Chasseur	A1, A2, A3	Perpère, 1975
Dufour	—	Sonneville-Bordes, 1960
Facteur	15, 19, 21	Delporte, 1968
Font-Yves	—	Sonneville-Bordes, 1960
Fontenioux	—	Perpère, 1973
Grotte Noir	A, B, C	Rigaud, 1982
La Ferrassie	F, H, H′, H″	Sonneville-Bordes, 1960
La Gravette	—	Delporte, 1972
Lartet	—	Sonneville-Bordes, 1960
Laugerie-Haute Ouest	—	Sonneville-Bordes, 1960
Le Moustier	—	Sonneville-Bordes, 1960
Le Piage	F, G-1, J, K	Champagne & Espitalié, 1981
Les Cottés	3, 4	Perpère, 1973
Les Roches	5, 7	Perpère, 1973
Les Rois	A1, A2, B	Perpère, 1975
Métairie	—	Sonneville-Bordes, 1960
Patary	—	Sonneville-Bordes, 1960
Pataud	6, 7, 8, 11, 12, 13, 14	Brooks, 1995
Poisson	—	Sonneville-Bordes, 1960
Pont-Neuf	—	Perpère, 1975
Renne	—	Sonneville-Bordes, 1960

Table 3. Chatelperronian assemblages used in the analysis

Site	Assemblages	Reference
Châtelperron	B	Harrold, 1978
Grotte du Loup	3, 4, 5	Harrold, 1978
La Côte	III	Harrold, 1978
Le Basté	3bm	Harrold, 1978
Le Piage	F1	Champagne & Espitalié, 1981
Les Tambourets	Méroc, 3(1)	Méroc & Bricker, 1984
Les Cottés	G	Harrold, 1978
Fontenioux	B	Harrold, 1978
Roc de Combe	8, 10	Harrold, 1978
Trou de la Chèvre	1, 1a, 2, 2a	Harrold, 1978

greatly over-represented in our sample. On the other hand, the Denticulate Mousterian, with four assemblages, is poorly represented. As a result, while we find our results intriguing, this is all we find them to be. We would welcome attempts to verify our results with larger, or even different, samples. Even more, we would welcome attempts to analyse similar data sets with different classification systems.

Most analyses of typological diversity within the French Middle and Upper Palaeolithic have used the Bordes classification for the Mousterian and the Sonneville-Bordes & Perrot classification for the Upper Palaeolithic (see Bordes, 1981 and Sonneville-Bordes, 1975 and references therein). We recognize that for all the dramatic benefits these systems have brought, they are also quite problematical in may ways (e.g. Sackett, 1988; Kolpakov & Vishnyatsky, 1989; Reynolds, 1990; Débeńath & Dibble, 1994; Kuhn, 1995). The associated difficulties range from the haziness of many class definitions, through the lack of compelling functional analyses of most of the classes involved (e.g. Beyries, 1987; Sackett, 1988; Anderson-Gerfaud, 1990), to the interaction between intensity of tool use and resultant tool morphology and thus position in the classification system (e.g. Rolland, 1981, 1990*a*, 1990*b*; Dibble, 1987, 1988, 1989, 1995; Rolland & Dibble, 1990; see also Kuhn, 1995).

In addition, analyses of diversity, no matter how measured, should utilize the same classification system throughout, as is routinely done in ecology and zooarchaeology. Bobrowsky & Ball (1989) are correct in exhorting that discrepant classification systems not be used in any such analysis. However, such an approach would require that a new systematics be built (e.g. Sackett, 1988), and all previously analysed assemblages be reanalysed within this new framework.

We have eliminated a few Bordesian classes from our analyses. Both the Middle and Upper Palaeolithic classification systems have a class, ‘‘*divers*’’, for miscellaneous retouched objects that do not fit elsewhere within the systems. Since this category includes a wide range of artefacts that are essentially ‘‘unidentified’’, we have excluded it from the analysis. The Middle Palaeolithic classification also includes unretouched Levallois objects (classes 1–3) as well as a series of classes (45–50) that can be produced accidentally. Bordes eliminated these from most of his analyses, producing what he called the ‘‘essential’’ type list, and many analyses of Mousterian assemblages either do not provide information on these classes, or treat them as composite groups. As a result, we have also dropped these classes from our analysis. We have retained all other classes in the two lists, including those often combined in the production of the cumulative curves central to the Bordes method (e.g. types 1 and 2 in the Upper Palaeolithic classification). This was done in order to keep the analysis as transparent as possible, and to stand aside from debates over whether particular classes are, or are not, acceptable.

These procedures provide us with a Mousterian classification that includes 53 flaked tool classes plus 21 biface forms, for a total of 74 possible classes, and with an Upper Palaeolithic classification that includes 91 classes.

While the use of two different classification systems in our analysis is problematical, and the systems themselves problematical, we note that all previous detailed discussions of differences in richness between Middle and Upper Palaeolithic assemblages share this limitation (for an instructive attempt to cross-classify Mousterian and Upper Palaeolithic assemblages, see Harrold, 1978). As a result, it has not been clear whether any differences that have been detected in this realm reflect true differences in the nature of the assemblages themselves, or simply differences in the classificatory systems that have been used to study them.

Accordingly, the questions that we ask here must be posed in a particular, and perhaps peculiar, way. Given current classification systems, do Mousterian, Aurignacian and Chatelperronian assemblages differ in richness? If they do differ, do those differences support statements that have been made about such differences on a more subjective basis? Do any such differences shed light on the nature of similarities and differences across the Middle-to-Upper Palaeolithic ''transition'' that can be divorced from the fact that the classification systems themselves change across this transition?

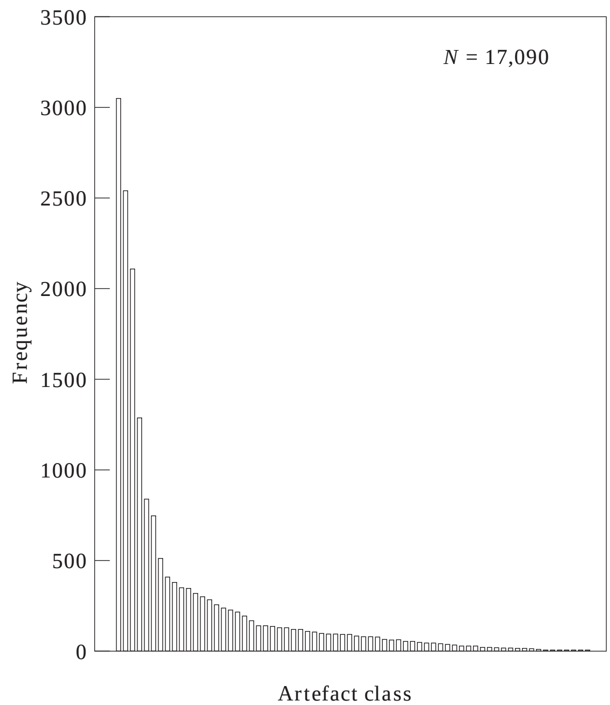

Figure 1. The distribution of artefact frequencies across classes: Mousterian.

Table 4. The ten most common Mousterian classes

Class	*N*	Percentage of total
10 (single convex scraper)	3041	17·8
43 (denticulate)	2533	14·8
42 (notch)	2098	12·3
9 (single straight scraper)	1282	7·5
23 (convex transverse scraper)	824	4·8
38 (naturally backed knife)	739	4·3
19 (convex convergent scraper)	501	2·9
11 (single concave scraper)	395	2·3
21 (déjeté scraper)	367	2·2
5 (pseudo-levallois point)	337	2·0

Mousterian and Aurignacian Assemblage Richness

The 89 Mousterian assemblages in our sample contain 17,090 artefacts distributed across 68 artefact classes (Figure 1). The ten most common classes in this sample account for 70·9% of the total number of artefacts (Table 4). Figure 2 provides the best-fit relationship between assemblage size and richness across the 89 assemblages; this relationship is log-linear and highly significant ($r = 0{\cdot}93$, $P < 0{\cdot}001$).

The relationship between richness and assemblage size is likewise highly significant within each industrial variant of the Mousterian (Table 5). Of these five variants, the relationships for the Typical, Quina and Ferrassie industries are very similar to one another, but have lower slopes and higher intercepts than the relationships for the Mousterian of Acheulian Tradition (MTA) and Denticulate industries, which are in turn similar to one another (Figure 3). These differences in slope and intercept account for the fact that all six of the outliers ($P < 0{\cdot}05$) in the general Mousterian richness-assemblage size relationship belong to either the MTA (4 outliers) or the Denticulate (2) industries (see Figure 2 and Table 6).

The 58 Aurignacian assemblages in our sample contain 36,534 artefacts distributed across 81 artefact classes (Figure 4). The ten most common classes in this sample account for 54·6% of the total number of artefacts (Table 7). Figure 5 provides the best-fit relationship between assemblage size and richness across these assemblages; again, this relationship is log-linear and highly significant ($r = 0{\cdot}90$, $P < 0{\cdot}001$).

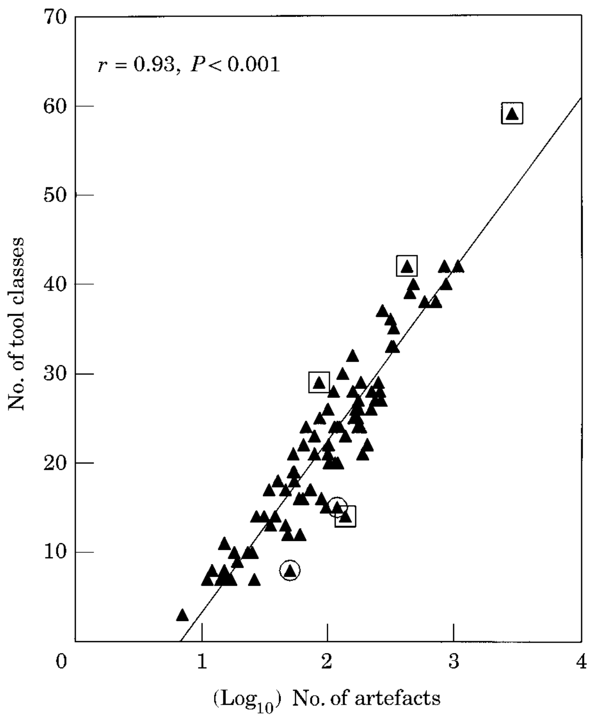

Figure 2. The relationship between assemblage size and richness within the Mousterian sample (□, MTA outliers; ○, Denticulate Mousterian outliers).

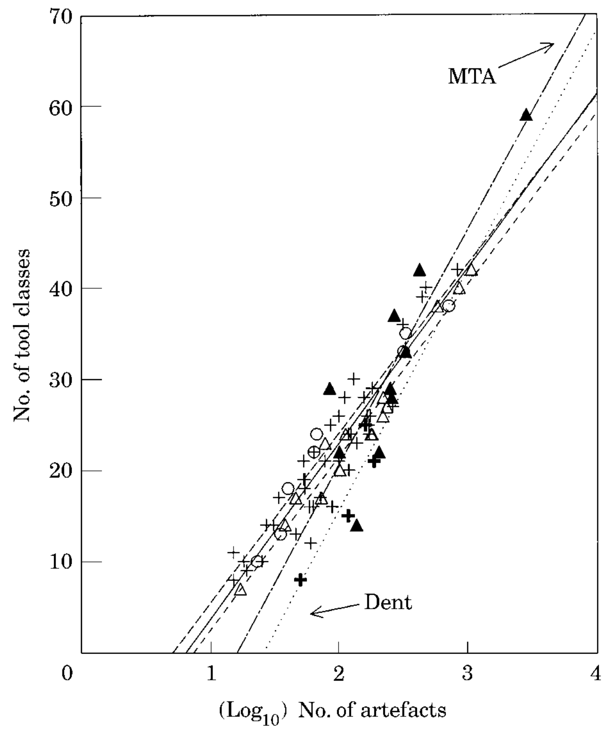

Figure 3. The relationship between assemblage size and richness within the Mousterian industrial variants. (+, Typical; △, Quina; ○, Ferrassie; ✚, Denticulate; ▲, MTA).

Table 5. Correlation coefficients for the sample size-richness relationship: Mousterian industries

Industry	Pearson's *r* (*P*)	No. of assemblages
Typical	+0·935 ($P<0·001$)	40
Quina	+0·981 ($P<0·001$)	15
Ferrassie	+0·979 ($P<0·001$)	8
MTA	+0·877 ($P<0·001$)	10
Denticulate	+0·918 ($P=0·08$)	4

Table 6. Mousterian richness relationship: Outliers

Affiliation	Assemblage (level)	Standardized residual
MTA	La Rochette	−2·93
	Pech de l'Azé (4fp)	+2.26
	Pech de l'Azé (Asi)	+2·07
	Saint-Suliac	+1·97
Denticulate	Grotte à Melon (3)	−2·34
	Biache (DI)	−2·28

$P<0·05$

Given that the Mousterian composite has far fewer artefacts, but far more assemblages, than the Aurignacian composite, it is obvious that the average Mousterian assemblage size in our sample (192·0 objects) is far smaller than the average Aurignacian assemblage size (629·9 objects). Since assemblage size is tightly correlated with richness, it follows that Aurignacian assemblages should also have much higher richness values and this is indeed the case (Table 8). The issue, of course, now becomes the degree to which these differences persist once differing sample sizes have been taken into account.

The equations for the assemblage size-richness relationships within the Aurignacian and Mousterian samples are provided in Table 9. Also presented in Table 9 are predicted Mousterian and Aurignacian richness values for assemblages ranging in size from 50 to 4000 classified artefacts. The predicted differences in richness range from 4·9 classes for assemblages with 50 classified objects to 7·3 classes for assemblages with 4000 classified objects (the largest sample in our sample has 4019 objects, provided by the La Ferrassie level H Aurignacian assemblage). Thus, Aurignacian assemblages are richer than Mousterian ones, though this difference, on the order of about 6 classes, is far less than one might infer were sample size not taken into account.

Unfortunately, there is no way of knowing whether this difference is of any significance in understanding the Middle-to-Upper Palaeolithic transition (or anything else). The real question to ask is not whether this difference is statistically significant, but whether it is significant in terms of the selective pressures operating on the populations that made these tools (e.g. Grayson, 1991). These are quite different things, and we are without conceptual guidance to help us here. Likewise, it is impossible even to address the question

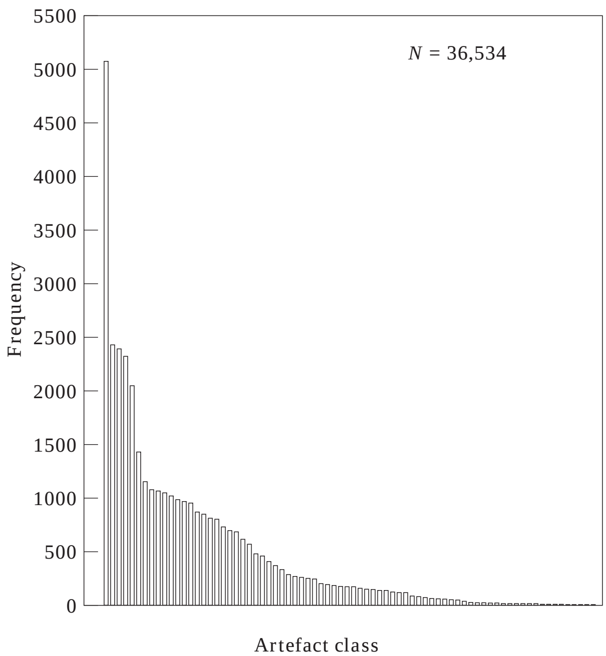

Figure 4. The distribution of artefact frequencies across classes: Aurignacian.

Table 7. The 10 most common Aurignacian classes

Class	*N*	Percentage of total
1 (single endscraper)	5072	13·9
13 (thick nosed endscraper)	2419	6·6
65 (continuous retouch, one edge)	2383	6·5
5 (endscraper on retouched blade)	2315	6·3
11 (carinated endscraper)	2038	5·6
6 (endscraper on Aurignacian blade)	1420	3·9
75 (denticulate)	1139	3·1
67 (Aurignacian blade)	1066	2·9
14 (flat nosed endscraper)	1053	2·9
66 (continuous retouch, two edges)	1036	2·8

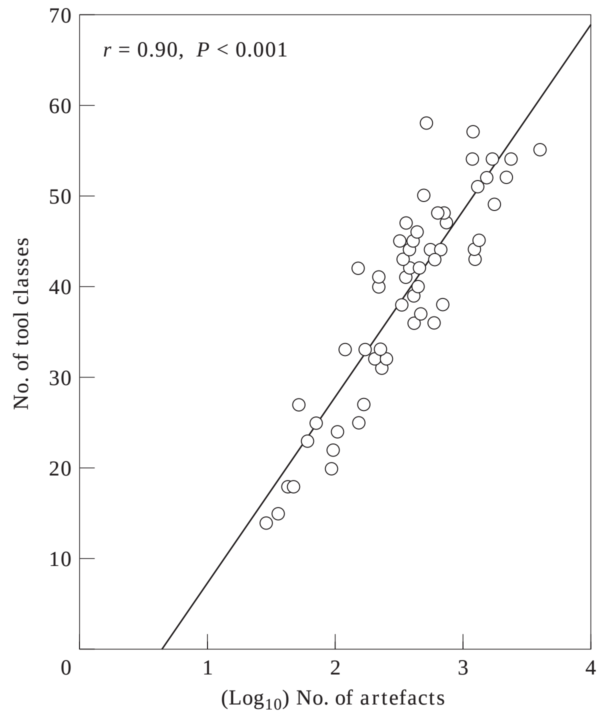

Figure 5. The relationship between assemblage size and richness within the Aurignacian sample.

Table 8. Average assemblage size and richness: Mousterian and Aurignacian

	Assemblage size	Richness
Mousterian	192·0	22·1
Aurignacian	629·9	39·2

of whether this difference matches predictions made by either the Replacement or Multiregional hypotheses, since those hypotheses make no attempt to operate at this level. It is clear, though, that most of the perceived difference between Mousterian and Aurignacian assemblage richness values are associated with differences in assemblage size.

This does not necessarily mean that differing assemblage sizes *per se* have caused this difference, since it is fully possible that whatever is causing differences in assemblage size is also causing differences in richness values (Grayson, 1984). Pronounced differences in the sizes of Mousterian and Upper Palaeolithic assemblages have, of course, been noticed many times before (e.g. Harrold, 1978; Mellars, 1996; Simek & Price, 1990). Several explanations for these differences have been forwarded, including the possibility that group sizes were larger or residence times longer during the Aurignacian. Other explanations could certainly be built: changing assemblage sizes might, for instance, reflect changing relationships between functional diversification within tool kits and the numbers of tools manufactured per functional tool class. However, an appropriate explanation for these differences in assemblage size must be found before the causes of differences in assemblage richness can be understood. This assumes, of course, that our results have not been caused by differences in the classification systems that are applied to Mousterian and Aurignacian assemblages in the first place. If this is the case, then true richness differences may be even less than those we report here.

Chatelperronian Assemblage Richness

Long ago, technological similarities between the ''Upper Palaeolithic'' Chatelperronian and the latest MTA led Bordes (1958) to argue that the latter represents the direct cultural ancestor of the former. Subsequently, Klein (1973) noted that the stratigraphical

Table 9. Regression equations and predicted richness values for Mousterian and Aurignacian assemblages varying in size from 50–4000 classified artefacts

A. Regression equations
Mousterian: Richness = − 15·899 + 19·183 (log assemblage size)
Aurignacian: Richness = − 13·251 + 20·476 (log assemblage size)

B. Predicted richness values

	Assemblage size						
	50	100	500	1000	2000	3000	4000
Mousterian	16·69	22·47	35·88	41·65	47·42	50·80	53·20
Aurignacian	21·54	27·70	42·01	48·18	54·34	57·95	60·50
Difference	4·85	5·23	6·13	6·53	6·92	7·15	7·30

sequences at Roc de Combe (e.g. Bordes & Labrot, 1967; see also Pelegrin, 1995) and Le Piage (e.g. Champagne & Espitalié, 1967; see also Champagne & Espitalié, 1981) demonstrated contemporaneity between the peoples responsible for the Chatelperronian and Aurignacian industries. Accordingly, he suggested that the Upper Palaeolithic attributes of the Chatelperronian might be accounted for by diffusion from the Aurignacian, which he argues ultimately supplanted it. To many, this view seemed to receive tremendous support from the discovery, in 1979, of a Neanderthal skeleton in association with a Chatelperronian industry at Saint-Césaire (Lévêque & Vandermeersch, 1980; see also Lévêque, Backer & Guilbaud, 1993). Not only did this discovery lead to the increased popularity of the acculturation argument, but it even led to the conclusion, in the absence of reanalysis, that the fragmentary human material associated with the Chatelperronian at Arcy-sur-Cure (Leroi-Gourhan, 1959) was, in fact, Neanderthal (Vandermeersch, 1989; for confirmation of a Neanderthal presence here, see Hublin *et al.*, 1996).

Tillier (1990) and Straus (1993) have both appropriately objected to this set of typological assumptions. Following Lévêque (1993) and Guilbaud (1993), Straus (1993) notes that there appears to be significant variability within the Chatelperronian. Tillier (1990) and Straus (1993) also observe that there is no indication that all Chatelperronian assemblages were manufactured by Neanderthals, and that we do not even know who made the earliest Aurignacian assemblages in this region. They object as well to the argument that the distinct nature of the Chatelperronian should simply be attributed to acculturation in the absence of a detailed explanation as to why and how this might have happened. Klein (1995) himself has raised similar concerns.

Pelegrin (1995) also doubts that the Chatelperronian can be attributed to ‘‘influence’’ from the Aurignacian, arguing instead that the Chatelperronian developed from the MTA (and perhaps other facies of Mousterian; see Farizy, 1990) as a result of technological innovations within that industry. Only the appearance of formal bone tools and ornamental items, as at Arcy, he argues, might be accounted for by diffusion. The apparent abruptness of the appearance of the Chatelperronian, at times seen as support for the acculturation model (e.g. Harrold, 1989), might thus be attributed to the rapid spread of a successful set of innovations. However, it is also true as Pelegrin (1995) has discussed, that we lack continuous, stratified sequences running from the late Mousterian to the Chatelperronian (but see Rigaud, Simek & Gé, 1995, and, for a significant caution, Rigaud, 1996).

If the Chatelperronian developed directly from the MTA, and is unrelated to the Aurignacian, might the similarities and differences that have led to this conclusion also be reflected in the richness of Chatelperronian assemblages?

In his series of extremely valuable analyses of the Chatelperronian, Harrold (1978, 1981, 1983, 1989) has addressed a closely related issue, although in a different manner. Harrold (1989) attempted to classify four Mousterian assemblages using the Upper Palaeolithic classification system, and then compared the results to those for 14 Chatelperronian assemblages and 13 Early Aurignacian ones. He found, as have we and others, that Mousterian mean assemblage size is far smaller than mean Aurignacian assemblage size (in his sample, 121·5 versus 617·6 tools), and that Mousterian assemblages had a mean of only 14 Upper Palaeolithic tool types, compared to 42·1 for his early Aurignacian sample. The Chatelperronian assemblages in his sample were intermediate between the Mousterian and Aurignacian assemblages as regards both variables: 33·6 and 281·8 tools.

Because Harrold (1989) found that many Mousterian artefacts could not be classified within the Upper Palaeolithic system, it follows that his Mousterian assemblages would have fewer Upper Palaeolithic classes represented, regardless of differences in assemblage sizes, as Harrold was, of course, aware. Here, relying heavily on the Chatelperronian data provided by Harrold (1978), we compare a series of 17 French Chatelperronian assemblages with our sample of 89 Mousterian and 58 Aurignacian assemblages using the traditional classification schemes for each.

Our Chatelperronian sample (Table 3; Figure 6) contains 7136 classified artefacts, or 419·8 objects per

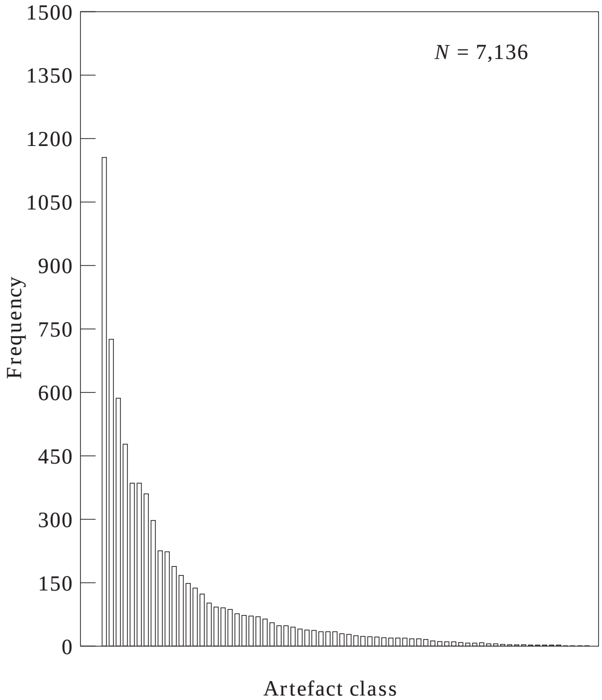

Figure 6. The distribution of artefact frequencies across classes: Chatelperronian.

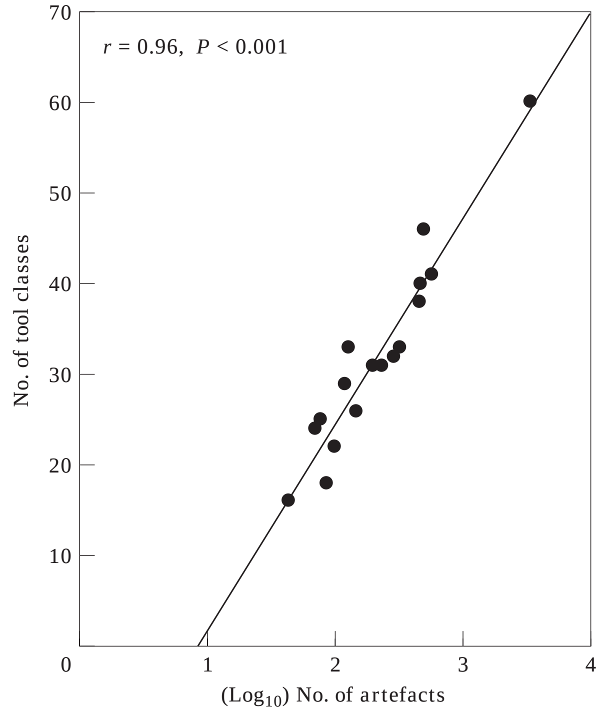

Figure 7. The relationship between assemblage size and richness within the Chatelperronian sample.

Table 10. The 10 most common Chatelperronian classes

Class	*N*	Percentage of total
74 (notch)	1151	16·1
46 (Chatelperron point)	721	10·1
76 (scaled piece)	582	8·2
75 (denticulate)	475	6·7
65 (continuous retouch, one edge)	385	5·4
47 (atypical Chatelperron point)	385	5·4
2 (atypical endscraper)	360	5·1
77 (sidescraper)	298	4·2
1 (single endscraper)	227	3·2
61 (oblique truncation)	225	3·2

assemblage; average richness for these assemblages is 32·1. We thus find, as did Harrold (1989), that Chatelperronian assemblages are intermediate in size and richness between those of the Mousterian and the Aurignacian. There are 74 classes in our sample, again intermediate between the Mousterian and Aurignacian values, as might follow simply from differential sample sizes.

The 10 most common classes in our Chatelperronian sample are provided in Table 10, and account for 67·4% of the entire artefact sample. Because our sample does differ from that used by Harrold (1978), it is worth noting that he also found notches and denticulates to be among the most common artefacts in his sample, along with Chatelperronian points and end-scrapers. The huge increase in the number of notched artefacts in our sample compared to that amassed by Harrold (1978) is accounted for primarily by the large numbers of these implements reported from Les Tambourets (Méroc & Bricker, 1984) subsequent to his analysis.

The relationship between assemblage size and richness in our Chatelperronian sample is log-linear and highly significant ($r = 0{\cdot}96$, $P < 0{\cdot}001$; see Figure 7). This relationship has a higher slope and lower intercept (richness $= -20{\cdot}698 + 23{\cdot}665$ [log assemblage size]) than both the Mousterian and Aurignacian samples (Figure 8).

As we have discussed, however, the relationships between sample size and richness within the MTA and Denticulate Mousterian have lower intercepts and higher slopes than those of the remaining Mousterian variants (Figure 3). In fact, the richness relationship for the Chatelperronian is extremely similar to that for the MTA, even though the assemblages involved have been classified using very different systems (Figure 9). We do not pursue similarities with the Denticulate Mousterian here, since our sample incorporates only four Denticulate assemblages.

In short, and withholding judgement on the Denticulate Mousterian, the assemblage size-richness relationship that marks the Chatelperronian is distinctly different from that which marks the Aurignacian, but is distinctly similar to that displayed by the MTA, the industry that Bordes (1958) and Pelegrin (1995; see also Pelegrin, 1990) have argued is immediately ancestral to it.

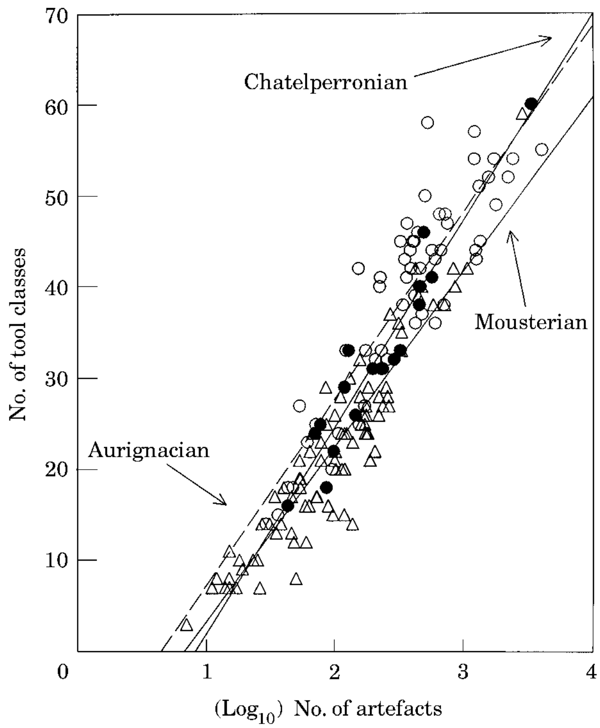

Figure 8. The comparative relationship between assemblage size and richness within the Mousterian (△), Chatelperronian (●) and Aurignacian (○) samples.

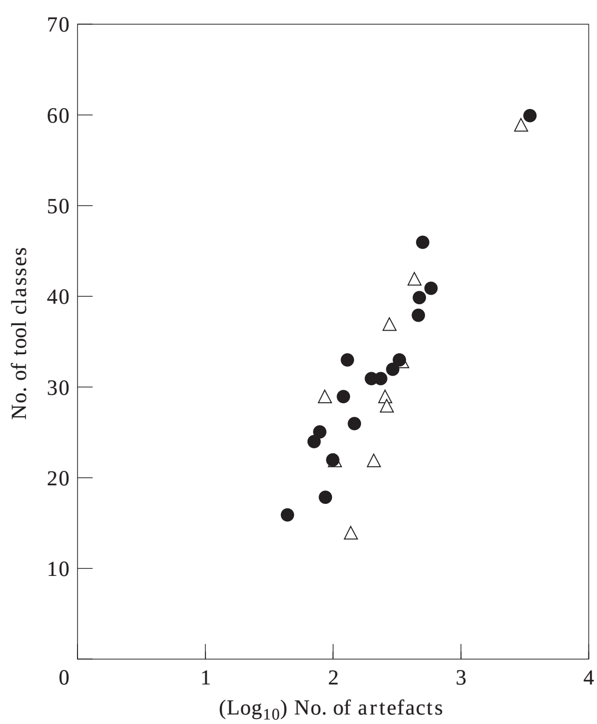

Figure 9. The relationship between assemblage size and richness within the MTA (△) and Chatelperronian (●) samples.

Comparisons with Simek & Price (1990)

The analysis of Palaeolithic assemblage richness provided by Simek & Price (1990) differs substantially from the one we have presented here. On the empirical level, we have focused on Mousterian, Chatelperronian and Aurignacian assemblages from France, while they examined assemblages ranging from the Mousterian through the Upper Palaeolithic (Chatelperronian to Azilian) from the Périgord alone. They also treated the Mousterian as an undifferentiated unit, while we have examined industrial variants within the Mousterian as well. Since we have incorporated data from a wider geographical region and have been able to use data that appeared subsequent to their analysis (e.g. Brooks, 1995; Dibble & Lenoir, 1995), we have also included a larger number of Mousterian, Chatelperronian and Aurignacian assemblages (164) than did they (116).

These empirical differences follow largely from the different questions that shaped the two sets of analyses. In addition, however, the methods we have used differ from theirs. To investigate the relationship between sample size and richness, Simek & Price (1990) used the simulation approach introduced by Kintigh (1984), while we have used a regression-based approach originally applied to the analysis of archaeological faunas (Grayson, 1984). Both approaches attempt to control for the effects of sample size on artefact richness, but do so in very different ways. Kintigh's method creates a single, composite population by summing all assemblages felt to belong to that population, and then manipulating the resulting composite (for instance, Simek & Price (1990) summed all Upper Palaeolithic assemblages). The regression-based approach enters each assemblage separately, and then uses standard regression procedures to analyse the relationship between size and richness.

As Rhode (1988; see also Cowgill, 1989; McCartney & Glass, 1990) has discussed, not only do these approaches have different strengths and weaknesses, but they also provide different results. Most important from our perspective is the fact that the simulation approach assumes that the composite frequency distribution built by summing across assemblages can be appropriately applied to each member of the summed set. For instance, it assumes that the frequency distribution derived from all six Upper Palaeolithic industries examined by Simek & Price (1990) is appropriate for assessing the behaviour of assemblages drawn from each of those industries. Since we prefer to avoid this assumption, we have used the regression-based approach here.

The two studies have also taken different approaches to tabulating classes. With the exceptions noted above, we tabulated all types present in a given assemblage and used that figure to calculate richness. Simek & Price (1990: 247), on the other hand, entered "only those diagnostic types relevant to a single assemblage's profile", as well as what they termed "mundane types" to ensure that ''the resulting set of classes reflects a given tradition's assemblage profile''.

Not surprisingly, the composite Mousterian, Chatelperronian and Aurignacian data sets used by Simek & Price (1990) show smaller assemblage sizes for the Mousterian (416·6 artefacts) than for the Aurignacian (697·6 artefacts), but the average size of their Chatelperronian assemblages is quite similar to their Mousterian value (414·2).* Likewise, they found much lower average richness values (uncorrected for sample size) for the Mousterian (27·0 classes) than for the Aurignacian (40·0), but found the Chatelperronian quite similar to the Mousterian in this regard (28·9 classes; Simek & Price, 1990: Table 8.2).

Simek & Price's simulation-based analysis of richness examined the Mousterian composite on the one hand, and the Upper Palaeolithic composite on the other. They concluded from this analysis that richness is not sample-size dependent within their samples. However, inspection of their figures 8·1 (Mousterian) and 8·2 (Upper Palaeolithic) shows clearly that richness responds strongly to assemblage size within their samples. Accordingly, we have concerns about their subsequent analyses of assemblage richness.

Having concluded that richness is not correlated with sample size across their assemblages, Simek & Price (1990) conducted two additional analyses of this variable. The first of these used regression techniques to examine changes in richness through time, with temporal position assigned on the basis of Laville's chronostratigraphical sequence (Laville, 1975; see also Laville, Rigaud & Sackett, 1980). This analysis suggested gradual change in richness through time, reaching a predicted maximum during the Solutrean. Their second approach used analysis of variance to examine changes in richness across Palaeolithic industries. Here, their results suggested a ''break'' in richness between the Chatelperronian and Aurignacian. Unfortunately, because they did not indicate which lithic classes of Chatelperronian assemblages they had included in their analysis, we are unable to assess these results in any meaningful way. However, because of the clear assemblage-size response in their data, we are wary of the results of both their analyses.

Conclusions

In short, we find that Aurignacian industries are richer than Mousterian ones, but not very much so. Whether these differences are ''significant'' is not possible to assess, given the differences in classification systems involved and given that there is no theoretical framework within which to evaluate differences of this sort. However, this recognition does diminish the importance of stone tool kit assemblage richness as a character that distinguishes the Mousterian from the Aurignacian. At the same time, our results heighten the importance of understanding why average assemblage sizes differ substantially between the Mousterian and Aurignacian. We also find that even given the fact that two distinct classification systems are applied to the Mousterian and the Chatelperronian, this latter industry shows distinct similarities in richness to the MTA, the Mousterian facies that, for several decades, has been seen as its most likely immediate ancestor.

*These assemblage size values have been determined from the information provided in Simek and Price's Table 8.1. In that table, the values for numbers of Chatelperronian sites (given as 23) and assemblages (given as 17) have been reversed; we have used the correct value to determine the average Chatelperronian assemblage size reported here.

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