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CURRENT PROBLEMS IN RESEARCH

Mousterian Cultures in France

Artifacts from recent excavation dispel some popular misconceptions about Neanderthal man.

François Bordes

One of the stages in the history of mankind in which there has been most popular interest is that linked with Neanderthal man. The imagination is caught by this being, close enough to *Homo sapiens* to be called a man, but distant enough, in shape as well as in time, to appear in a way an "alien" in the sense in which the word is used by science fiction writers. Hence, many misconceptions are to be found in popular books, even textbooks, the most common being the one about the "brutish Neanderthals." Reconstructions show him as only a little better off than the big apes, and his tools (Mousterian) are described as "crude" by people who would not, to save their lives, be able to make them. The truth is, indeed, quite different.

In the long story of man's evolution, the people of the Mousterian are very near us. If we suppose that the first to make tools, thus bridging the gap between apes and man, were the Australopithecinae, we must put them very early—about 600,000 years ago. On the other hand, the last of the Mousterian peoples lived about 35 to 40 thousand years ago (in France) and probably much later in Africa. Their culture is also much closer to that of the first Upper Paleolithic men than is generally believed, and the "gap" between Middle and Upper Paleolithic does not exist. It was merely the result of insufficient data.

First, let us have a look at the geological, chronological, and ecological setting of Mousterian man. The Pleistocene period witnessed, four times at least, the advance of huge sheets of ice in northern Europe and in the mountains of central Europe. These glaciations are known in Europe under the names of Günz, Mindel, Riss, and Würm (from the oldest to the latest). The exact correspondence with the North American glaciations is yet to be worked out. Within each of these glaciations were periods of less severe climate, the interstadials. Between the glaciations were long periods of fairly warm conditions, the interglacials. There are no special names for these European interglacials, as there are for interglacials in the United States; we identify them in terms of the glacial period which preceded and of that which followed them.

The roots of some Mousterian cultures can be found during the Riss glaciation in the Clactonian complex, an assemblage of cultures without hand axes. The roots of others are found in the Acheulean complex. During the Last Interglacial (Riss/Würm) there are already some assemblages which can be called Mousterian, but it is in the Last Glacial period, the Würm, that the true Mousterian evolved. This Last Glacial period is divided into substages, the number of which is given variously by different authors. Some authors give two subdivisions, others three, but now, in France, most Pleistocene geologists agree that there were four: Würm I, II, III, and IV. However, in central Europe only three are usually recognized. Hence, Würm I and II of the French classification correspond to Würm I of the German classification. We need not bother about who is right, for the question has little bearing on the subject of this discussion.

Sites and Climate

As a general rule, Mousterian peoples in France lived in two different environments—caves and rock shelters in the valleys of southern and eastern France and open-air sites on the great loessic plains of the northwest and the plateaus of the south. This led to differences in their ways of life and had certain influences on assemblages of tools. Except, possibly, during an interstadial, Mousterian men lived under cold climatic conditions. The climate at the beginning of the Last Glacial was probably more damp than truly cold, but in due course the average yearly temperature fell far lower than that of today in the same areas. (However, we must not make the mistake of imagining the Mousterian environment to have been the barren ground or even the tundra of present-day northern countries. The latitude was the same as today, and the summers must have been fairly long and warm.) As a consequence of the severe cold the limestone of the shelters flaked off; the cultural remains were, accordingly, covered with congelifracts when the shelter was deserted by man, so the different layers are separated and give a good basis for the determination of stratigraphy.

The fauna was a "cold" fauna—reindeer, arctic fox, and arctic hare—but there was a great abundance of big game: bison, wild oxen, horses, several kinds of deer, mammoth, rhinoceros, and so on. The carnivores included bears, lions, panthers, hyenas, and wolves.

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Typological Subdivisions

For a long time it was thought that the Mousterian was a single culture which evolved in the following fashion. First, logically following the Acheulean, came the Mousterian of Acheulean tradition, with many hand axes. Then came the Typical Mousterian, without hand axes. Then came the Evolved Mousterian, without hand axes and with special types of scrapers (as in La Quina, Charente, southwestern France). Doubt was first cast on the validity of this straightforward scheme by the great French prehistorian Denis Peyrony. In the lower shelter at the classic site of Le Moustier (Dordogne, southwestern France), he found several layers of Mousterian of Acheulean tradition *between* two layers of Typical Mousterian. The picture has been further complicated as a result of my own studies of Mousterian assemblages, made by statistical methods. It is now known that the term *Mousterian* encompasses a complex of cultural groups, some closely related, others not so closely related or even of different origin. The following different groups are recognized.

1) *Mousterian of Acheulean tradition.* Contrary to what is often stated, this is not always an "old" Mousterian, and it can be found in Würm II as well as in Würm I. But an evolution is clearly to be seen. First there is a phase (type A) in which there are numerous hand axes (from 8 to 40 percent of the artifacts), among which are triangular forms (Fig. 1, No. 14), together with heart-shaped axes (cordiforms) (No. 12). These are associated with fairly numerous side scrapers (from 20 to 40 percent) (No. 2), denticulate tools (about 10 to 15 percent) (No. 7), some points (No. 1), and knives made on a flake on which one of the edges has been blunted by abrupt retouch (No. 5). The side scrapers, generally flat, are of several types. The backed knives, together with the hand axes, are typical of this Mousterian of Acheulean tradition. There are also other tools, some of Upper Paleolithic type, such as end scrapers (Nos. 3 and 9), gravers (No. 8), borers (Nos. 10 and 11), and truncated flakes or blades (No. 6).

After the Würm I/Würm II interstadial, this Mousterian of Acheulean tradition passes into an evolved phase (type B). The hand axes are far less numerous than in the type A phase (seldom more than 4 or 5 percent), and none is triangular. There is a corresponding drop in the number of side scrapers (down to 4 to 10 percent). The number of knives increases (sometimes up to 20 percent), and these are more elongated, being made on blades as well as on flakes (Fig. 1, No. 4) and suggesting the Chatelperron knife of the early Upper Paleolithic (Périgordian I). There is a similar increase in the number of denticulate tools (up to 25 percent and more). The flaking technique is more laminar, and even little blades appear, as is shown by the appearance of bladelet cores (No. 13).

It is in fact very difficult to distinguish between a very late Mousterian of Acheulean tradition and an early Périgordian I. From the point of view of tools in the assemblage there is really no distinction between the two.

At the beginning, Périgordian I has a basic tool kit of Mousterian tools, with, however, more blades, more burins and end scrapers, and a special type of backed knife, the Chatelperron knife, which, even if foreshadowed by the Mousterian backed knives, is generally more elongated. Mousterian types of backed knives do survive. Very quickly, this Périgordian I evolves toward the Upper Périgordian (or Gravettian), losing the Mousterian types of tools, developing end scrapers and many types of burins; the back of the knives, instead of being curved as in the Mousterian or the Chatelperron types, tend

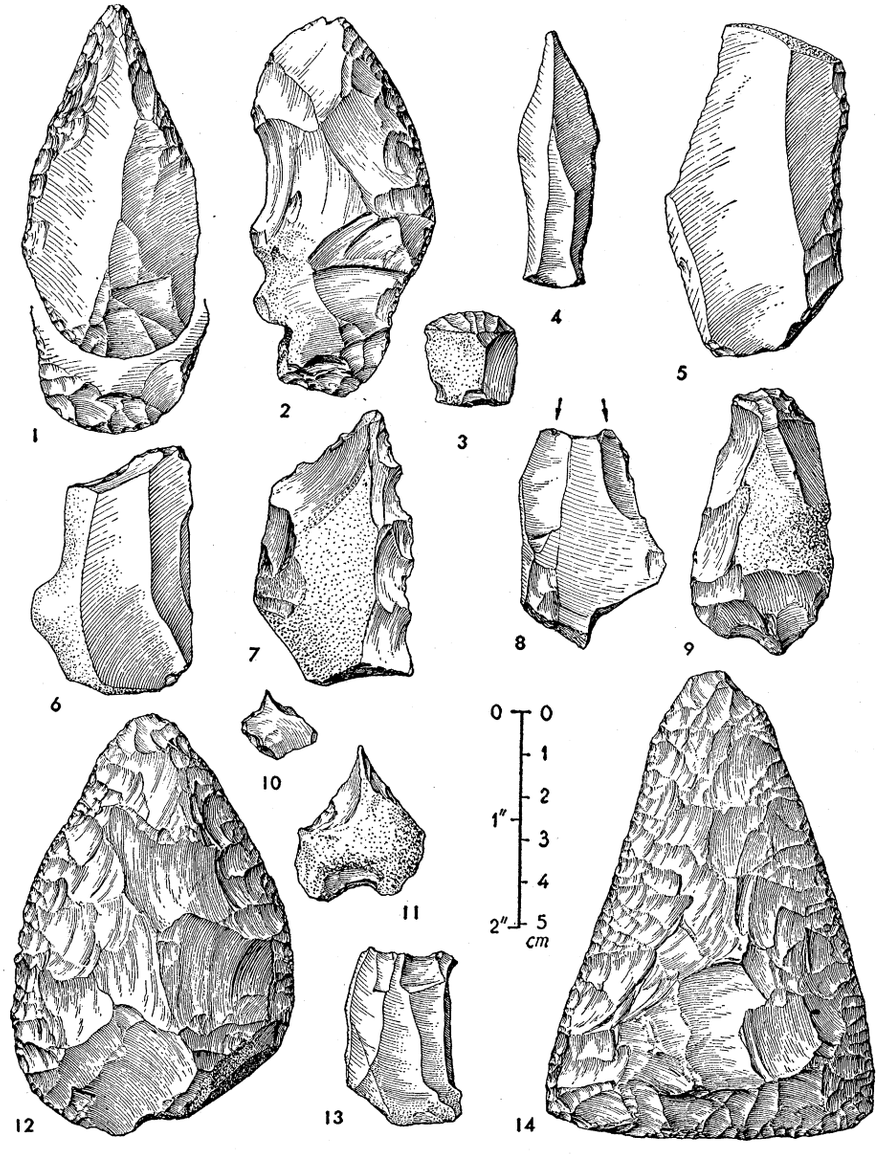

Fig. 1. Mousterian of Acheulean tradition: 1, point; 2, side scraper; 3, end scraper; 5, backed knife; 7, denticulate tool; 10, 11, borers; 12, cordiform hand axe; 14, triangular hand axe. Evolved Mousterian of Acheulean tradition: 4, backed knife; 6, truncated flake; 8, double burin; 9, end scraper; 13, bladelet core.

to be straight. At the same time, bone tools are more numerous and better made.

2) *Typical Mousterian* (Fig. 2, Nos. 1–7). The Typical Mousterian at first seems very much like the Mousterian of Acheulean tradition (type A). There are side scrapers (rather flat) (25 to 55 percent), some denticulates and notched tools, and well-made points. But there are few or no hand axes or backed knives (0.5 percent at most). Some thick side scrapers of La Quina type (see below) are to be found (as in the Mousterian of Acheulean tradition), but these are so few (at most, 1 percent) as probably not to be truly significant. (When one undertakes to make a side scraper on a thick flake, the odds are good that he will make a Quina-like tool without trying to.)

So, the main difference between Mousterian of Acheulean tradition (type A) and Typical Mousterian lies in the fact that hand axes and knives are found in the former and not in the latter. This is a truly significant difference.

3) *Denticulate Mousterian* (Fig. 2, Nos. 8–17). In this group there are no hand axes (at least typical ones) or backed knives. There are few or no points and very few scrapers. If you are willing to call any flake with some working on the edge a "scraper," the figure may be as high as 13 percent, but if you insist on a narrow definition of the scraper, it is very unlikely that the figure will be more than 3 to 7 percent. But there are notched tools and denticulate tools galore. In some layers the two types, taken together, comprise nearly 80 percent of the assemblage; side scrapers, end scrapers, burins, borers, and so on constitute the remainder.

4) *Quina-type Mousterian* (Fig. 3). Here the picture is definitely different. Very few or no hand axes and backed knives are found, but there are many more side scrapers (up to 75 percent or more), often magnificent ones. And among them, side by side with the ordinary types, are special ones—scrapers of the Quina type. These are made on thick flakes, usually have a convex working edge, and have a special type of retouch, like the overlapping scales of a fish (Fig. 3, No. 1). Such scrapers may be either side scrapers or scrapers of the transverse variety, with the edge opposite the butt of the flake (No. 8). There are also bifacial scrapers (No. 3), not to be mistaken for hand axes. On one side the flaking is very shallow and flat, on the other there is scalar retouch. One edge is often left unworked, or is more crudely worked than the other, but sometimes the two edges are retouched equally well, and then it is easy to mistake these tools for hand axes. There are also some denticulates, some notched tools, and some burins, borers, and end scrapers; these latter may be either of the carinate or of the nosed types (Fig. 3, No. 7). Another tool found in relative abundance is the "limace" (shaped like a slug) (No. 4). This is not unknown, however, in the Typical Mousterian.

The relative proportions of Quina-type scrapers (with respect to scrapers in general) in the different Mousterian groups are summarized in Table 1.

Levallois Technique

Such are the four main typological subdivisions of the Mousterian. Cutting across this typological division is a technical division. There was, in the Middle Paleolithic, a special method of producing flakes, called the Levallois technique after a suburb of Paris where this special type of flaking was first found, in the last century. To make a Levallois flake you take a flint nodule (Fig. 4, No. 1) and flake it off all around the margins (No. 2). Then, using each of these flake scars in turn as a striking platform, you flake away the upper surface of the nodule (No. 3). Then you prepare a special striking platform (either plain or faceted) at one end and you strike off a large flat flake (No. 5);

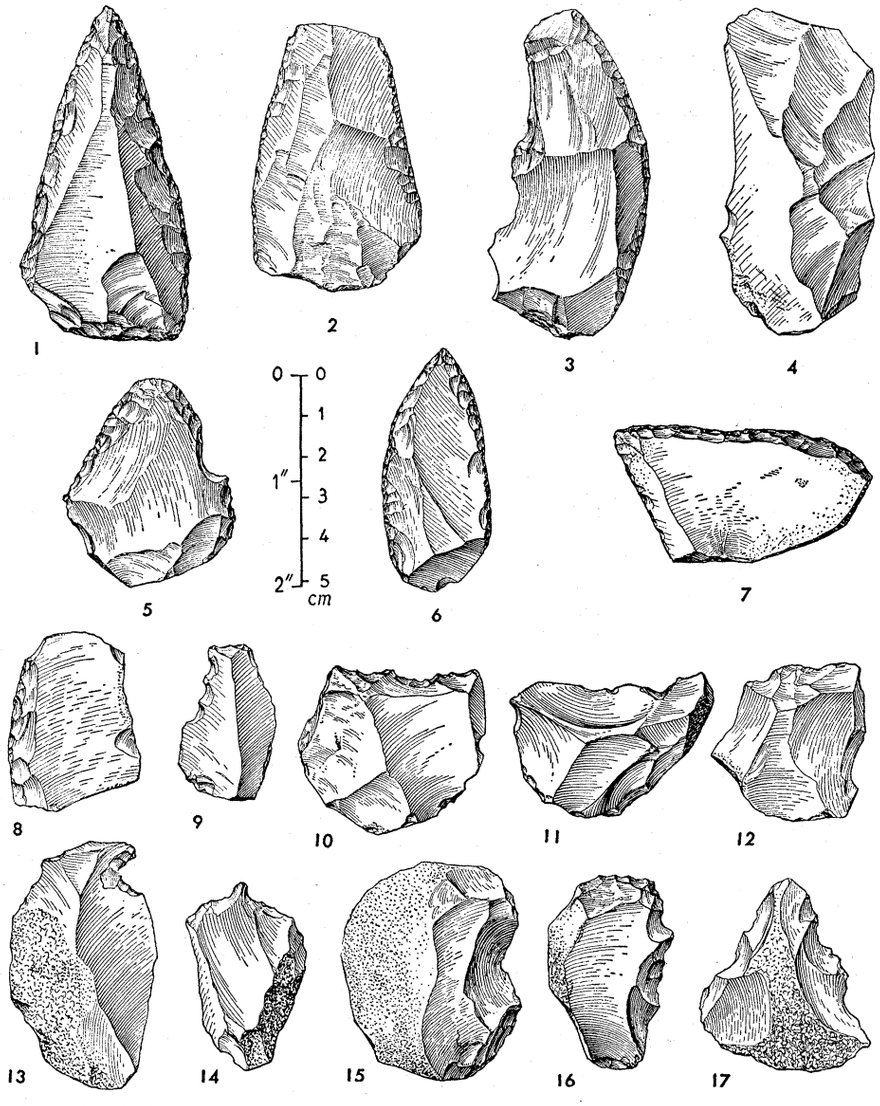

Fig. 2. Typical Mousterian: 1, point; 2, double side scraper; 3, side scraper; 4, Levallois flake; 5, end scraper on a flake; 6, point; 7, transverse scraper. Denticulate Mousterian: 8, side scraper; 9, 10, denticulate tools; 11–13, notches; 14, borer; 15, notch; 16, 17, denticulate tools.

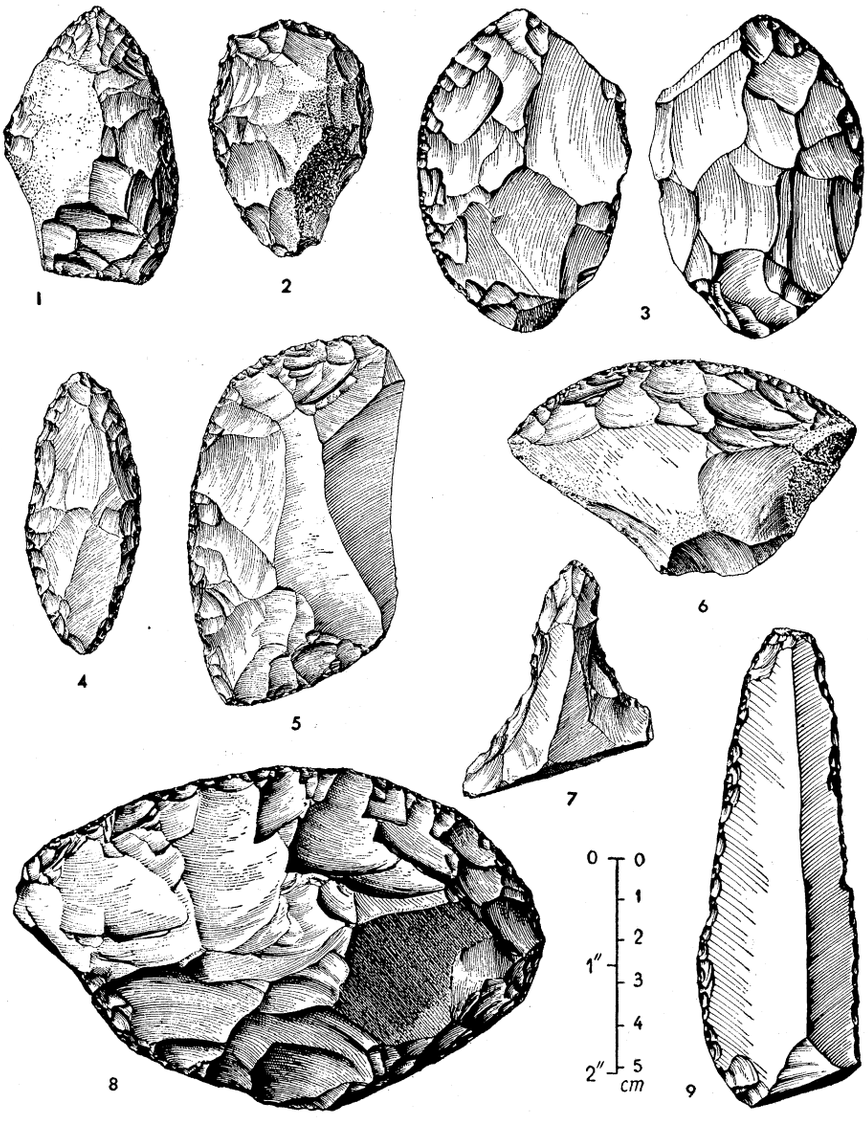

Fig. 3. Quina-type Mousterian: 1, side scraper, Quina-type; 2, end scraper; 3, bifacial scraper; 4, "limace"; 5, side scraper; 6, transverse scraper, Quina type; 7, nosed end scraper (Aurignacian type); 8, transverse scraper, Quina type; 9, retouched blade (Aurignacian type).

the shape of the flake is predetermined by the previous shaping of the core (No. 6).

This technique, developed, in Europe, by the peoples of the Middle Acheulean, was used until the end of the Mousterian and even later. It was not used by every Mousterian tribe, however. For instance, there is a Mousterian of Acheulean tradition with Levallois flaking (as in Le Moustier) and there is another with little such flaking (as in the Pech de l'Azé cave, Dordogne). The same is true for the Typical Mousterian and for the Denticulate Mousterian. But in the case of the Quina-type Mousterian, things are a little more complicated. Assemblages of the Quina-type Mousterian that show use of the Levallois technique are known as Ferrassie-type Mousterian (from La Ferrassie, Dordogne). The use of the Levallois technique has the effect of lowering the percentage of Quina-type scrapers, since Levallois flakes are flat, and Quina-type scrapers can only be made on thick flakes (Table 1). Also, in the Ferrassie-type Mousterian there are fewer transverse scrapers than in the Quina-type Mousterian, for Levallois flakes, being rather elongate, are not suitable for use as transverse scrapers.

The existence of a special "culture," the Levalloisian, characterized by the existence of numerous unretouched Levallois flakes, has been proposed by some prehistorians. Actually, such findings represent only a facies of various Mousterian groups, found in places where flint was plentiful and readily available—mainly in open-air sites where a nomadic way of life prevailed.

The question arises, of course, whether the different types of Mousterian represent distinctive cultures, or whether, like the Levalloisian, they are merely facies of the same culture. They might be the result of cultural evolution or only of seasonal variations. This question probably can be clearly answered in the present stage of our knowledge.

Hypothesis of Seasonal Variation

The hypothesis of seasonal variation seems unacceptable for several reasons. It is difficult to accept the idea that the peoples of the Mousterian changed their tool assemblage four times a year, according to season. Moreover, the thickness of occupation layers in the caves and shelters argues against a one-season stay. Each layer indicates a stay of considerable length. One might suppose that there were spring, summer, autumn, and winter caves, occupied only at a particular time of year, but it is difficult to imagine the existence of a kind of convention among all the Mousterian tribes, governing the use of a cave, assuring that a given cave would be kept as a "spring cave" and that no summer or winter cultural material would be mixed with the spring tools. Moreover, we have very good reason to think that these caves were occupied all year round. It is possible to tell, from a study of a reindeer's antlers and teeth, how old the animal was when it was killed, and as a consequence, since the typical birth season of the reindeer is known, we can tell at what time of year a reindeer was killed. It appears that reindeer were killed at all times of the year by the occupants of these caves—proof that man occupied the caves all year round.

Hypothesis of Cultural Evolution

As I said earlier, doubt was cast long ago on the validity of the hypothesis of cultural evolution when Peyrony excavated the lower shelter at Le Moustier and found three layers of Mousterian of Acheulean tradition between two

layers of Typical Mousterian. Actually, the sequence at Le Moustier is even more complex than this (see Fig. 5). The sequence is substantiated and the evidence is supplemented by findings from other caves and shelters—for instance, the cave at Combe-Grenal, near Domme (Dordogne), in which I have been making excavations since 1953.

The cultural sequence in the Combe-Grenal cave, from top to bottom, is as follows (Fig. 6): (i) Mousterian of Acheulean tradition (here in terminal position); (ii) several layers of unidentifiable Mousterian (*A*2, *A*3, *B*1, *B*2); (iii) two layers of Typical Mousterian with Levallois flaking (*B*3 and *B*4); (iv) a poor layer (*C*), which is probably Denticulate Mousterian; (v) layer *D*1, probably Denticulate Mousterian with Levallois flaking; (vi) layer *D*2, probably Typical Mousterian with Levallois flaking; (vii) two layers (*E*1 and *E*2) of Denticulate Mousterian, the first with Levallois flaking, the other with less Levallois flaking; (viii) three layers of Denticulate Mousterian (*F*, *G*, *H*1) without Levallois flaking; (ix) layer *H*2, also Denticulate Mousterian but with Levallois flaking; (x) layer *I*, Quina-type Mousterian; (xi) layer *J*, Denticulate Mousterian without Levallois flaking; (xii) layers *K*, *L*, *M*, *N*, *N*1, Quina-type Mousterian; (xiii) layer *P*, Ferrassie-type Mousterian; (xiv) layers *Q*, *R*, *R*1, Typical Mousterian with Levallois flaking; (xv) layers *U*1, *U*2, *W*, *X*, *Y*, all Ferrassie-type Mousterian; (xvi) layer *Z*, Typical Mousterian with Levallois flaking; and (xvii) layer α, Denticulate Mousterian with Levallois flaking. (It should be understood that "without Levallois" flaking does not mean that there are no Levallois flakes in the assemblage but means only that there are very few.) Under layer α are several other layers only now being excavated. It is difficult as yet to tell what they are, but they do not seem to be Denticulate Mousterian.

So, at Combe-Grenal we can clearly see, interstratified, almost all types of Mousterian. Elsewhere in the Dordogne, as at Combe-Capelle (lower site), Quina-type Mousterian lies below Ferrassie-type Mousterian, not above it as at Combe-Grenal. At Combe-Capelle, too, the Mousterian of Acheulean tradition is in a terminal position. However, in the upper shelter at Le Moustier the Quina-type Mousterian lies above the Mousterian of Acheulean tradition.

Another hypothesis links these variations in tool assemblages to the environment. But it is easy to show that Mousterian people who lived under very different environmental conditions had the same type of tool assemblage; the site of Aïn Meterchem, in Tunisia, yields a Mousterian assemblage which is very close to that found at La Ferrassie. On the other hand, in the same geological layer, and thus representative of people living under very similar climatic conditions, one sometimes finds two very different cultural horizons, as at Pech de l'Azé, cave II (Dordogne).

So, the existence of different cultures within the Mousterian complex appears to be an established fact. The question then arises, What were the origins of these cultures?

Cultural Origins

The Mousterian of Acheulean tradition poses no serious problem. It is logically derived from the Upper Acheulean. The only question is whether it passed through an intermediate Micoquian stage or whether it evolved directly, the Micoquian being in part contemporaneous with the Old Mousterian of Acheulean tradition. The latter theory would not necessarily exclude the possibility of a Micoquian stage as well. The Quina-type Mousterian has a possible antecedent in the so-called "Tayacian" assemblage of layer 3 (of Riss Glacial age) at La Micoque near Les Eyzies (Dordogne) or in the High Lodge type of Clactonian industry in England. The Ferrassie-type Mousterian might have its roots in layer 4 (Riss Glacial age) of La Micoque, or in cultures like that found at Ehringsdorf (near Weimar, Germany), which dates from the Last Interglacial.

Table 1. Relative proportions of Quina-type scrapers (with respect to scrapers in general) in the various cultural groups of the Mousterian.

Cultural group	Proportion (%)
Mousterian of Acheulean tradition	0 to 0.9
Denticulate Mousterian	0 to 0.1
Typical Mousterian	0 to 1
Quina-type Mousterian	15 to 25
Ferrassie-type Mousterian	6 to 9

But when one comes to consider the origin of Denticulate Mousterian or Typical Mousterian one is almost at a loss. Of course some cultural horizons at La Micoque might be antecedents of the former but unhappily these layers have been so thoroughly crushed by frost heaving (cryoturbation) that it is difficult to differentiate between true denticulate tools and other artifacts. As yet the origins of the Denticulate Mousterian are not known but Denticulate Mousterian is present at the very beginning of the Last Glacial and extends to the end of the Mousterian.

The Typical Mousterian is also a

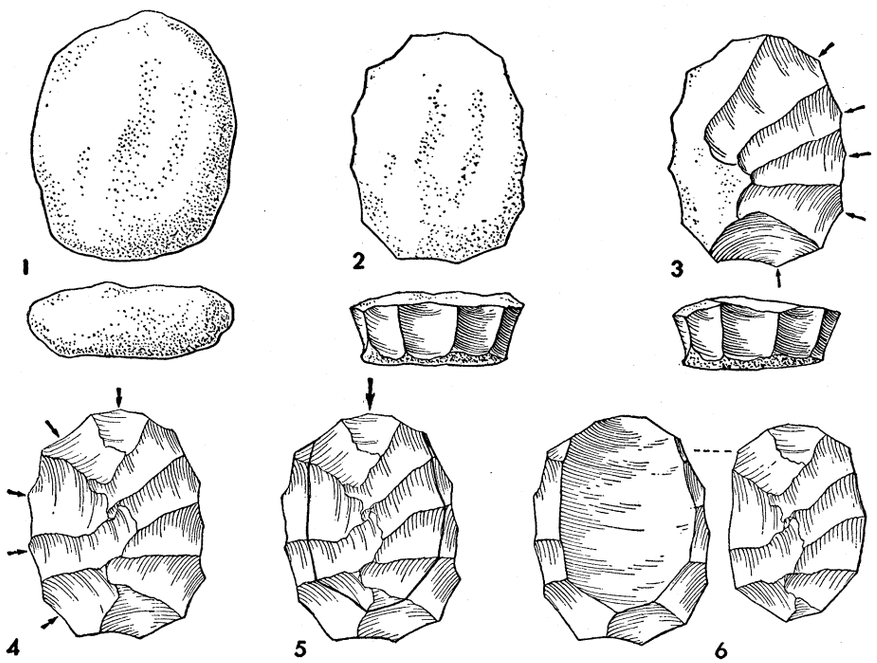

Fig. 4. Steps in the making of a Levallois flake.

problem. It closely resembles the Mousterian of Acheulean tradition (type A) but lacks hand axes and backed knives. However, since some of the Mousterian of Acheulean tradition is fairly poor in hand axes and knives it is possible that Typical Mousterian does derive from it.

What happened to these different Mousterian cultures in Würm III? There is little question that the Mousterian of Acheulean tradition must have developed into the Périgordian I. This poses a nice problem for those anthropologists who believe that all the peoples of the Mousterian in France were of the "western Neanderthal" variety and hence that these strains were dead ends from the standpoint of evolution. Actually, very little is known about the peoples who made the Mousterian hand axes. The skull of a young child from Pech de l'Azé cave (a child so young that the skull tells us little) and some cranial fragments from other sites are all that we have. However, there is no other possible origin, culturally speaking, for the early Périgordian, and physical anthropologists must accept this fact. The early Périgordian is a western culture and is unknown outside of France and Spain (and perhaps Germany). Distribution maps of the early Périgordian and of the Mousterian of Acheulean tradition are very similar except for a small zone of the latter in the Middle East (Palestine).

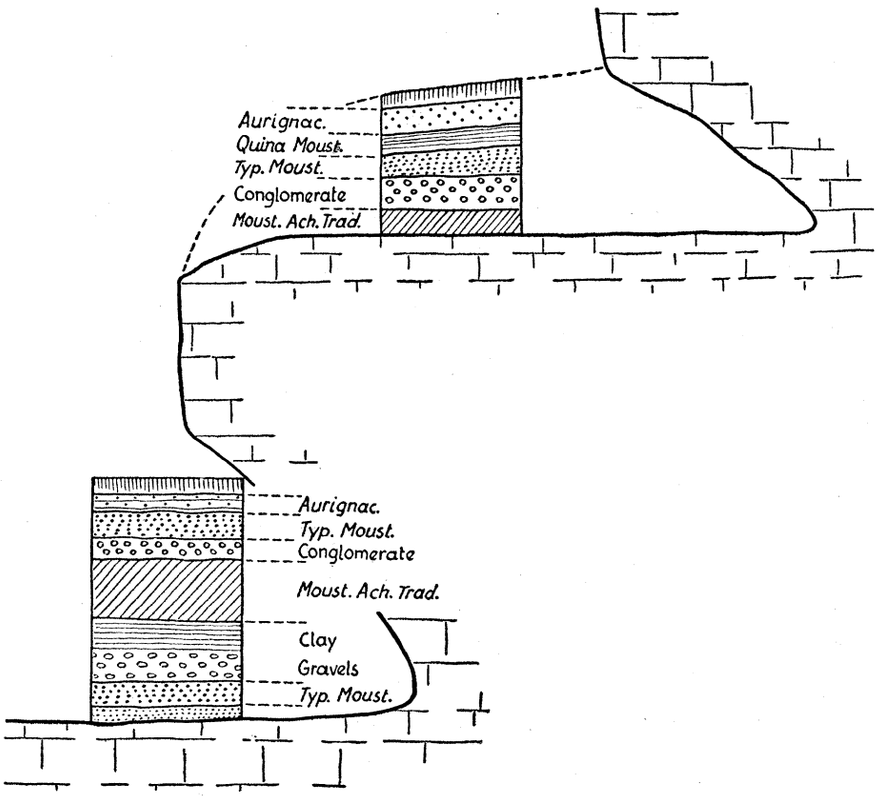

Fig. 5. Schematic section at Le Moustier (Dordogne), upper and lower shelters, showing the interstratification of several types of Mousterian.

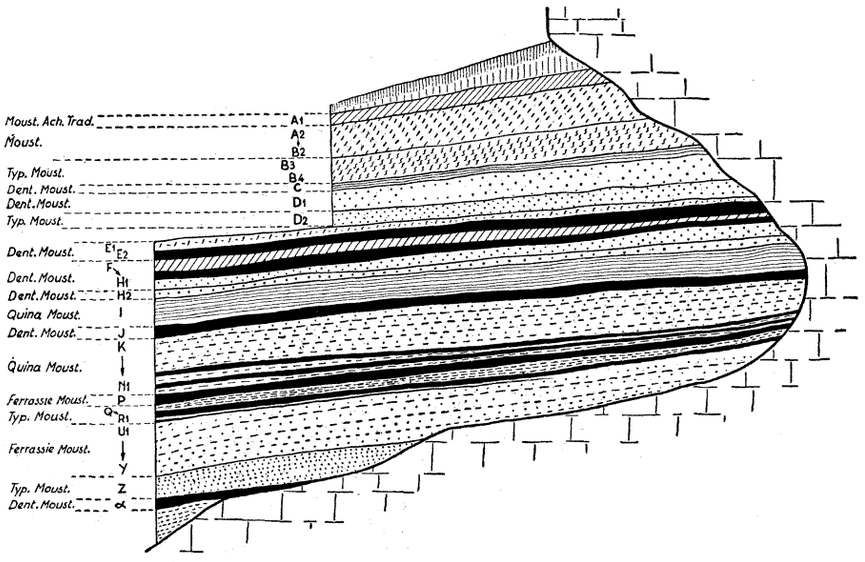

Fig. 6. Schematic section at Combe-Grenal (Dordogne), showing the interstratification of several types of Mousterian.

It was pointed out long ago that there are resemblances between the Quina-type Mousterian and another stage of the early Upper Paleolithic, the Aurignacian. In fact most of the tool types characteristic of the Aurignacian are in a way foreshadowed in the Quina-type Mousterian, just as the Périgordian I tools are foreshadowed in the Mousterian of Acheulean tradition. Carinate and nosed scrapers (Fig. 3, Nos. 2 and 7) exist in the Quina-type Mousterian; actually such tools are present as early as the "Tayacian" in the layers at La Micoque. The special Quina retouch (see Fig. 3) is very close to the kind of retouch used by the Aurignacians on the side of their blades, and some double side scrapers on blade-like flakes might be regarded as forerunners of the more elongate "Aurignacian blade" (Fig. 3, No. 9).

But these affinities are less marked than those between the Mousterian of Acheulean tradition and the Lower Périgordian. Distribution for the Aurignacian is much wider than for the Lower Périgordian. The evidence suggests that the peoples of the Aurignacian invaded the West, bringing with them a well-developed culture. If there is a bridge between the Quina and Ferrassie types of Mousterian and the Aurignacian, it is to be found outside of France.

There is some slight evidence that Ferrassie-type Mousterian survived for a short time into Würm III in Provence. No trace has been found in Upper Paleolithic cultures of derivatives from either Typical Mousterian or Denticulate Mousterian.

Ways of Life

What do we know about possible differences in the ways of life of these several groups within the Mousterian? As yet, very little. Until recently, little attention has been given, in excavating, to such matters as the horizontal distribution of tool types in a shelter. Modern excavations, in France and elsewhere, are not yet numerous enough to give any clear answers. In any case, to obtain such information is no easy task. Mousterian layers are usually very rich and contain a great mixture of broken bones, tools, chips, and flakes, together with congelifracts, pebbles, ashes, and sometimes charcoal. Even the most careful excavation will not always reveal, for instance, whether some beautiful scrapers in a given grid square *A*3 are exactly contemporary with a hand axe in grid square *E*5. In fact, we can seldom achieve this degree of certainty.

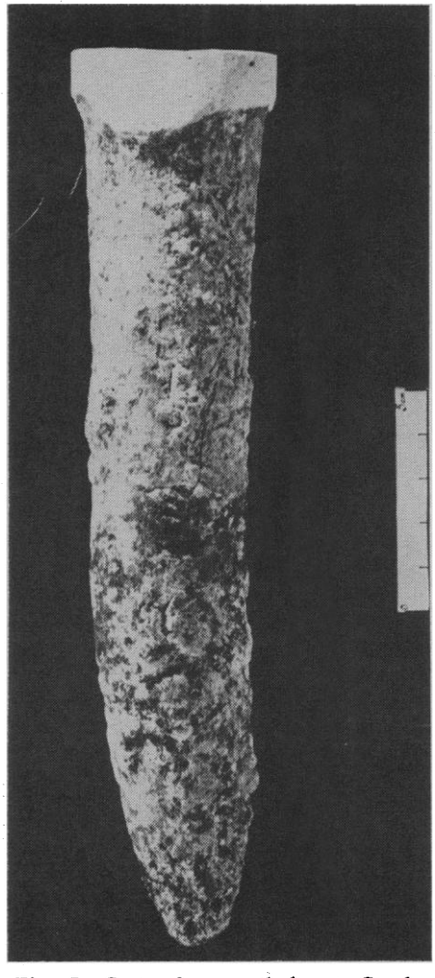

Fig. 7. Cast of a posthole at Combe-Grenal, layer *G* (length of the cast, 21 centimeters).

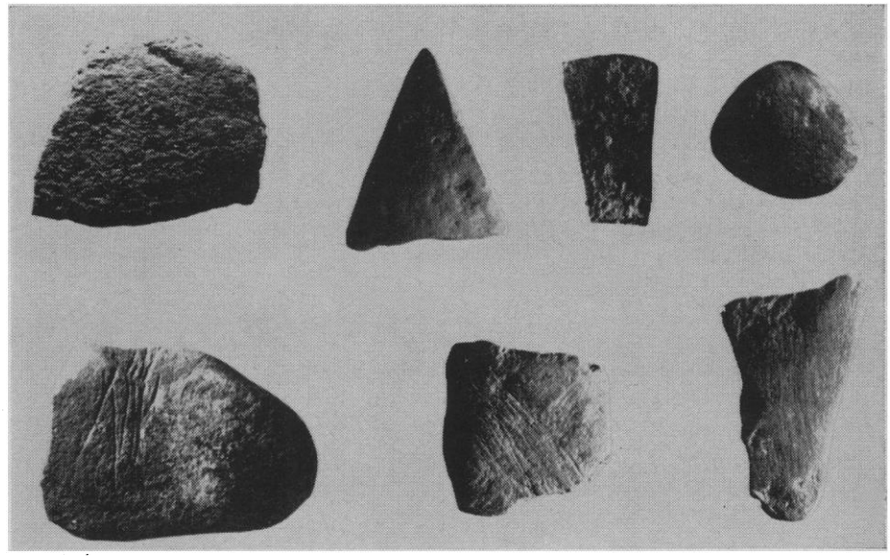

Fig. 8. Fragments of manganese dioxide from the Mousterian-of-Acheulean-tradition level of Pech de l'Azé (Dordogne). (Top row, from left) unworked lump, triangular pencil, trapezoidal pencil, rounded pencil; (bottom row) scratched lumps.

And to make distribution graphs for layers more than 1 or 2 centimeters thick would lead us exactly nowhere. In a thick layer, the only appropriate parts for such studies are the bottom and the top; the bottom is better if the layer overlies another layer that is compact and sterile.

However, fireplaces can often be found, and rough distribution maps for some tools can be worked out. In Pech de l'Azé (cave I), for instance, we found that the hand axes and scrapers were more numerous right around the fireplaces. There seems to have been a special place outside for the making of hand axes, for most of the finds there are of flakes such as would be struck off in that process. In the same site, the lower (and richest) layer ended against a low stone wall, just a little outside the cave and the adjacent shelter.

At Combe-Grenal we found a posthole in layer *G*, extending down to layer *K*. A cast made of this hole shows quite clearly that the post must have been a pointed wooden shaft driven into the ground, and that the tip mushroomed against a stone in layer *K* (Fig. 7). This shaft was perhaps one of a row of shafts used to support skins or woven branches to close the cave.

For half a century it has been known that the Mousterian peoples buried at least some of their dead. Most of these burials seem to be associated with the Quina-type and Ferrassie-type Mousterian cultures; however, some are from the Typical Mousterian. We also know that in every Mousterian context mineral color (manganese dioxide, red ocher) was used. Some bits have been scratched to make colored powder; others are pointed, like pencils (Fig. 8). However, there is no cave painting that can be traced back to the Mousterian. These colors presumably served for body painting.

Some hunting habits can also be deduced from the animal remains in the layers. Thus, it seems that peoples of the Denticulate Mousterian favored horses as game. Layers from this culture are everywhere rich in horse bones. At Pech de l'Azé (cave II), in the same geological layer and very close together, there are two cultural levels; one is Denticulate Mousterian and the other is Typical Mousterian. There is no indication of a long lapse of time or of any significant climatic change between the two. However, the animal remains from the former are mainly horse, while those from the latter are red deer and wild oxen.

Conclusions

All this gives a picture of life in Mousterian times that is rather different from the picture, too often given, of brutish half-men, crouching in caves, terrified and not very clever. It seems that Mousterian tribes may, at times, have numbered some 30 to 50 individuals. These people had weapons to combat cave lions and cave bears, whose

remains are sometimes found in the occupation layers. They used paints, were clever flint workers, and buried their dead. It is obvious that they did not lack inventive powers.

Most of the stone tools which were developed in Upper Paleolithic times by *Homo sapiens* were invented by Mousterian or even by Acheulean peoples. The blade (that is, a blade made through a special technique of *débitage* and not the result of a flaking accident) goes back at least to the end of the Acheulean, and in some Mousterian assemblages blades comprise up to 40 percent of the *débitage*. End scrapers and burins were known in the Middle Acheulean. The backed knife is an Acheulean invention also. But if all these tools already existed in the Acheulean, they were further developed and diversified in the Mousterian. Even the multiple tool is found in the Mousterian (Fig. 1, No. 8); some complex tools—for instance, a burin combined with an end scraper—are also found, but rarely.

The peoples of the Mousterian also experimented with bone tools, but there they fall very short of the achievements of men in the Upper Paleolithic. They never did more than make some bone spear points, and in the main they used only bone splinters, shaping them crudely. But in this respect the first people of the Upper Paleolithic (Périgordian I) appear not to have done much better.

To conclude, it does not seem that, culturally at least, there is any great gap between the Mousterian cultures and the early Upper Paleolithic cultures that followed. One of the latter, at least, has its roots quite clearly in the Mousterian of Acheulean tradition. And even if some anthropologists deny to Neanderthal man (*sensu stricto*) the right to be counted among our direct ancestors, one thing is sure: these ancestors of ours were at a cultural level very like that of the Mousterian peoples. So we come uncomfortably close to the old joke: It was not William Shakespeare who wrote *Hamlet* but another man who lived at the same time and whose name was also William Shakespeare!

CURRENT PROBLEMS IN RESEARCH

Stellar Content of Galaxies

Two parameters which describe the stars that make up any galaxy are age and chemical composition.

Halton Arp

In order to understand how a galaxy is formed, how it evolves, and how different kinds of galaxies are related to each other, it is necessary to understand the kind of stars a galaxy contains. An important impetus to the understanding of the relation of the galaxy to the stars which it contains came in 1944 when Baade originated the concept of population types. According to his original definition, a type II population consists of stars which have the same Hertzsprung-Russell diagram as globular cluster stars, and population-I stars have a color-magnitude diagram like stars in spiral arms, in galactic clusters, and in the neighborhood of the sun. It was quickly realized that population I contains the highly luminous, and therefore young, stars, while population II is an old population.

In the following years galaxies were widely analyzed in terms of the relative number of old and young stars they contained, and the designation of population type became common in astronomical literature. Inevitably this terminology has been modified and extended. The new results, which are just now becoming available, introduce new concepts, reflect our increased knowledge of the kinds of stars galaxies contain, and begin to offer us further insight into the relationships between different kinds of galaxies as well.

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Our Own Galaxy

Advent of the parameter of chemical composition. It became possible to derive an age for a cluster of stars by observing in the color-magnitude diagram the absolute magnitude at which the main sequence broke away to evolve more rapidly (*1*). Systematic observations of clusters of stars led finally to the discovery of a globular cluster, M 3 (*2*), and a galactic cluster, M 67 (*3*), in which the observed main sequences both terminated at the same absolute magnitude. Presumably they were of the same age, but, by definition, they belonged to different populations. The contradiction would only be resolved by attributing the conspicuous differences between their color-magnitude diagrams to differences in the chemical composition of the stars in the two clusters. That such differences exist was borne out by an examination of the spectra (*4*). From this point forward astronomers began to talk less about populations I and II and more about the twin parameters of age and chemical composition. It also became apparent that subdwarfs were associated with the halo regions in which the globular clusters resided (*5*). It was shown that the subdwarfs, like the globular-cluster giants, were extremely metal-poor (*6*). It was obvious now that not only were the globular-cluster stars metal-poor throughout but that the main sequence to which they should be fitted was the subdwarf main sequence.