Postglacial Adaptations

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I. INTRODUCTION

There is no doubt that the environmental changes of the late Pleistocene and early Holocene had tremendous impact on hunting-gathering populations in both northeastern North America and western Europe. The exact nature of these changes and the human responses, however, are seriously debated on both sides of the Atlantic. These debates involve a large number of cultural and environmental variables, all of which underwent change, perhaps at different rates, both absolutely and in relation to one another. Yet descriptions of regionally homogeneous environments and stereotypic human economies have come to characterize a number of different stages of this period, despite the paucity of evidence and frequent, but vague, cautions about regional variability and complexity. The purpose of this paper will be to examine this period in portions of western Europe in an attempt to understand the processes of late- and postglacial adaptation. Although specific features of the European situation are quite different from those of northeastern North America, it is likely that many of the general patterns of environmental change and the resulting problems requiring solution are similar for the two areas.

II. THE WEST EUROPEAN LATE- AND POSTGLACIAL

The standard interpretation of the west European archaeological record of late- and postglacial times is generally as follows:
1. Temperatures rose.

2. Vegetation changed, with increasing forestation, first with pine and birch, then with hazel, oak, elm, and maple.

3. Cold-loving Pleistocene animal species, including gregarious herd species, became extinct or migrated northward to be replaced by more solitary forest resources.

4. Economies became marked by greater internal diversity, greater regional variation, and a greater emphasis on plants and fish at the expense of large mammals.

5. The archaeological record underwent changes and became impoverished, reflecting lower population densities, smaller, more dispersed groups, and technological adjustments to the new resources.

The beginning of this chain of events is usually taken to be the Allerød period of about 10,000 to 9,000 BC, a time of pronounced warming and reforestation. During this period the Magdalenian reindeer hunters were transformed into more eclectic foragers whose major big game were the more solitary deer and moose, and whose material culture was the Azilian, Late Paleolithic, or Federmesser, represented by small, scattered assemblages with smaller and fewer artifact types than occurred previously. Although in the succeeding period of the Younger Dryas, about 9,000 to 8,300 BC, temperatures dropped and tundra vegetation and a reindeer-based economy returned, at least to northern Europe, this represented only a brief and relatively localized interruption to the sequence, which then continued into the Holocene, beginning about 8,300 BC, with the appearance of Mesolithic industries and economies based largely on deer, boar, fish, shellfish, and at least hazelnuts among possible wild plant foods.

Although this scheme is quite satisfying and simple, recent work in France, Germany, and Switzerland is suggesting a much greater complexity. Most notable among the emerging research results are the tremendous variability in time and space and the lack of neat correlations among lithics, time period, vegetation, and fauna.

A. Climate and Vegetation

Recent sedimentological studies in southwestern France have provided a much greater understanding of the complexity of climatic changes in the Late Glacial (Laville 1977). Since the glacial maximum of about 16,000 BC, eight different climatic oscillations in this period can be documented. The average duration of each phase is roughly 1000 years, with a wide range of from 100 to 2400 years. Noteworthy is the apparently increasing variability through time: the regional sequence of oscillations can be rather reliably estimated for the period of about 16,000 to 11,100 BC, but the subsequent phases, from 11,100 to 8,300 BC,
are more difficult to establish and to correlate among locales (Ibid: 529). Moreover, while the average duration of each oscillation in the first part of the sequence is approximately 1600 years, this decreases to about 600 years in the latter phases. Even allowing for the probability that the amount and sensitivity of sedimentological climatic indicators which are preserved increases through time, thereby creating a somewhat finer-grained and more complex climatic picture, it appears that the pace of climatic fluctuation increased during this Late Glacial period. The largest absolute changes in temperature and humidity, marking the end of glacial climates, may have occurred quite rapidly, perhaps within a few centuries (Bryson 1974; Hare 1976), but these dramatic changes seem to have been preceded by, and to have culminated, a period of tremendous variability and instability in the Late Glacial climate.

Although studies from other areas are less detailed, this climatic sequence of variability characterized much of north and west Europe. The magnitude and significance of these changes, however, would have differed greatly. Even at the glacial maximum, southwestern France was characterized by a lack of permafrost and a mixture of tundra and steppe vegetation together with significant amounts of coniferous and deciduous trees, implying considerable local variation or patchiness (Paquereau 1976). Regions to the north and east of southwestern France were increasingly subject to the influences of latitude and the relative positions of landmass and ice sheets. During full glacial times, northern France and especially Germany differed from the southwest by their marked development of permafrost, their lower average yearly temperatures, and their more continental climate characterized by greater seasonality (Flint 1971:618; West 1968: 292). The climate of central and southern Germany, positioned between the Scandinavian and Alpine ice sheets, seems to have been particularly harsh. Such extreme climatic conditions may have depressed any effects of local microenvironmental variation, so that a relatively uniform steppe-tundra developed.

With the Late Glacial oscillations of climate, the discrepancies between the vegetation of southwestern France and southern Germany only partially diminished. Throughout much of the Late Glacial, southwestern France contained vegetation characteristic of tundra, steppe, and prairie, as well as pine, birch, willow, hazel, and trees of the mixed-oak forest, their relative proportions fluctuating with the changes in temperature and humidity. The Older Dryas period showed an open tundra-grassland with scattered conifers and deciduous trees. The Allerød period which followed was quite complex, demonstrating multiple stages, each strongly affected by local conditions (Paquereau 1977: 44). In general, however, this period was characterized by an open mixed forest with a well developed shrub understory. The cooling of the subsequent Younger Dryas resulted only in slight deforestation to form an open mixed parkland. With the onset of the Preboreal phase of the Holocene, the forest again became increasingly varied and closed.

Germany was quite distant from this glacial vegetational refuge, and, as a result, the only significant trees throughout the Late Glacial were pine and birch. In southern Germany, the Older Dryas showed a virtually treeless steppe tundra, but this was succeeded, during the
Allerød, first by a birch woodland, followed by a quite dense pine forest. The Younger Dryas then witnessed only slight deforestation to form an open pine woodland. Again, reforestation characterized the Preboreal, but hazel and trees of the mixed oak forest became significant only at the end of this phase. Northern Germany showed more extreme conditions, in that both Dryas periods showed quite open tundras or park-tundras, while the Allerød witnessed an open birch-pine forest (Bertsch 1961; Firbas 1949: 1950).

These areas, consequently, showed significant differences in Late Glacial vegetational patterns. Southwestern France consistently had considerable vegetational diversity and oscillations in temperature and tree cover of relatively low amplitude. Southern Germany, by contrast, contained relatively lower vegetational diversity throughout, but quite dramatic fluctuations in temperature and tree cover; while northern Germany had a similarly low diversity, but less extreme changes in tree cover.

To summarize, the Late Glacial was a period of significant climatic variability, with oscillations of temperature and humidity becoming increasingly frequent and brief toward the end of the Pleistocene. The Allerød warm period especially seems to have been characterized by complex fluctuations. Corresponding to, but slightly later than, these climatic phases were changes in vegetation with significant differences evident between regions. Throughout the Late Glacial, southwestern France showed substantially greater spatial variability but less extreme temporal variability than did German environments.

B. Fauna

The low-latitude tundras and park-tundras of glacial Europe are often said to have been richer than any modern northern counterparts. This richness, especially in the relatively patchy environments of southwestern France, probably took the form of an unparalleled faunal diversity in glacial times. Simply in terms of large herbivores, the variety of species that appear in French Upper Paleolithic sites is astounding, and includes mammoth, woolly rhinoceros, reindeer, horse, bison, red deer, roe deer, aurochs, ibex, chamois, saiga antelope, muskox, giant deer, wild ass, moose, and wild boar. These species differed, of course, in their relative abundance, and fluctuated with spatial and temporal variation. Reindeer, horse, and bison seem to have been consistently the most numerous. In the harsh and more homogeneous conditions in glacial Germany, by contrast, it is likely that overall faunal abundance and diversity were considerably lower.

The climatic and vegetational changes of the Late Glacial had tremendous impact on these animal communities. Some species disappeared during the Late Glacial; others persisted but decreased in abundance and spatial distribution; while still others, already present, became more numerous and wide spread. In much of southwestern France, for example, mammoth, giant deer, wild ass, ibex, muskox, saiga antelope, and wooly rhinoceros disappeared by the end of the Older Dryas. These latter three
species had virtually disappeared as well in this area (Beden 1976; Delpech 1977; Delpech and Heintz 1976; Prat 1976). Thus, during the course of the Late Glacial, two-thirds of the large herbivorous species disappeared.

As this species depletion occurred, it would seem that species equitability increased, at least temporarily, as red deer, roe deer, aurochs, and boar increased at the expense of the most abundant glacial herbivore, bison.

In Germany there occurred a similar impoverishment of faunal species, but most significant about the Late Glacial in this area would probably have been the net increase in animal biomass, at least during the earlier phases of the Late Glacial, compared to the harsh full glacial times. Southern Germany probably showed more drastic fluctuations of this biomass toward the end of the period, especially with the change from tundra to the relatively closed and homogeneous forest of Allerød times—an development not seen in southwestern France at all, and not attained in north Germany until postglacial times.

The Late Glacial, consequently, was a period of tremendous changes in climate, vegetation, and animal communities, changes that would have had profound effects on human populations. Perhaps the most important problem posed by these changes would have been a heightened economic instability and insecurity. Old staple resources were disappearing or changing their distribution. New, less familiar resources were becoming more abundant. Fluctuations in the vegetation and climate were disrupting familiar resource behaviour patterns. Former strategies and locations of resource selection and procurement would have become somewhat less successful. Adjustments would have been necessary. Before discussing the archaeological evidence for these readjustments, it might be useful to examine the ethnographic record for patterns in hunter-gatherer responses to such instability.

III. HUNTER-GATHERER RESPONSES TO INSTABILITY

Since all environments contain some degree of instability, hunter-gatherers tend to incorporate a number of strategies for overcoming this instability into their economic and social systems. Among the most common of such strategies are: 1) the reliance on a variety of alternative resources, the importance of which can vary with environmental conditions; 2) selection of settlement locations to provide simultaneous access to multiple resources; 3) institutionalized systems of division of labor, sharing, exchange, and feasting, allowing spatial redistribution of resources; 4) development of storage techniques and delayed reciprocal relationships, both of which allow temporal redistribution of resources; and 5) development of wide-ranging social relationships and residential flexibility, permitting spatial redistribution of people and information. All of these strategies serve to maintain a necessary level of economic security in conditions of rather constant environmental fluctuation.
Along with this concern for security is an equally important goal of efficiency in economic behavior of many hunter-gatherers, which also finds expression in patterns of resource selection and procurement, settlement location, and population distribution (Jochim 1976). When resources decline, however, many common responses emphasize security, often at the expense of efficiency, at least temporarily. Such responses include the following:

1. increasing the dependence on less mobile, but perhaps less aggregated, resources like plants, fish, or small game (Lee 1972:344; Nelson 1973: 142; Rogers and Black 1976: 13);

2. broadening the resource base, in accordance with a more generalized opportunistic feeding strategy (Dunning 1959: 31; Lee 1968: 35; Schoener 1970: 385);

3. utilizing a greater variety of tools and techniques for exploiting the declining resources (Nelson 1973: 85);

4. traveling further from camps for food-getting (Rogers and Black 1976:22; Silberbauer 1972:298);

5. moving camps more frequently to compensate for more rapid local resource depletion (Rogers and Black 1976:22);

6. dispersing into smaller groups within the exploitation territory (Gould 1968: 119; Nelson 1973:304; Rogers and Black 1976:22);

7. leaving the exploitation territory, either to join other groups or to search for more abundant resources (Burch 1972:358; Smith 1978: 85).

All of these responses would have the effect of increasing the costs of food procurement, of travel, and of maintaining social ties, thereby reducing energetic efficiency.

IV. PROBLEMS AND RESPONSES IN LATE GLACIAL WESTERN EUROPE

The Late Glacial European environment presented a number of new problems which threatened the economic stability of human populations. A number of these problematic changes, together with some possible responses, may be summarized as follows.

A. Average temperatures increased through the series of climatic oscillations.

One implication of this trend was an increase in the variety and amount of potential plant foods, with an increased utilization of plants a logical consequence. A second possible implication of this temperature increase would be a decrease in magnitude of population oscillations, especially of small animals and fish as the terrestrial and lacustrine
vegetation became more complex; furthermore, there may have been a decrease in the frequency of such oscillations with increasing forestation (Rickleff 1973: 482-5). Although such oscillations, characteristic of modern arctic and subarctic environments, were probably already much less dramatic in the lower latitude and more diverse environments of glacial Europe, the Late Glacial climatic changes would have further decreased their significance. One result would be the increased stability of small game and fish populations and their increased reliability and use as food sources.

B. Yearly and perhaps seasonal variability in temperature increased during this transitional period as well.

Such variability may have magnified the importance of local factors such as topography, exposure, and drainage in determining microenvironmental characteristics, leading to greater regional environmental diversity or increased patchiness. Such diversity may have encouraged a greater economic diversity within and between regions. The consequences for human distribution and mobility cannot be predicted without a knowledge of the size, distribution, and richness of the various habitat patches. A second implication of this increased variability would be an erratic but greater frequency of relatively extreme temperatures. Depending on the tolerance of the various plant and animal species, it is likely that significant upper or lower limiting temperatures would occur relatively often, producing densities of these species below that predictable from more stable conditions with similar average temperatures. The exploitation of such species would consequently also be less than that expected on the basis of groups in analogous but more stable environments.

C. Furthermore, the increased temperature variability would lead to a decreased predictability of animal behavior and distribution as well as of the timing of seasonal changes.

The planning of economic activities, especially hunting, would therefore involve greater uncertainty. In response to this uncertainty, the economy might be broadened by including new resources which were previously not present or not exploited. The economy might also be shifted to emphasize the more stable resources, such as plants, fish, and small game. Both responses would have spatial and organizational implications.

D. At the same time, both the variety of animal foods and the abundance of formerly important large animals were decreasing.

This situation would encourage both an increased utilization of the remaining animal species and an increased use of plant resources. Simultaneously, an attempt to continue to hunt the declining populations of large mammals might encourage increasing human dispersal to locate them, and the use of a greater variety of techniques to capture them.
Their decreasing abundance, in addition, would have led to an even greater unpredictability of behavior of these large mammals (Burch 1972: 357).

E. The faunal changes involved an overall decrease in the abundance of herd species in favor of more solitary animals.

In this situation, any communal hunting techniques would become less rewarding, and hunting by individuals or small groups would be encouraged. In addition, because the animal resources would be more dispersed, and because of the decreasing benefits of economic cooperation, increasing human dispersal would be expected. It should be added at this point that the degree of human aggregation for cooperating in the interception of large migratory herds of caribou seen among Chipewyan and Eskimo groups of North America was probably not characteristic of the Upper Paleolithic of southwestern France, even in full glacial times (see Spiess 1978, but also Bahn 1977). It seems likely that the complex, low-latitude environments, with their greater species diversity, contained more competitors of the reindeer, resulting in lower relative densities, smaller aggregations, and less extreme and regular migrations. Perhaps in the harsher and simpler environments of Germany the reindeer behavior would have been more analogous to that of North American caribou. Nevertheless, the Late Glacial changes would have caused a significant reduction in animal resource clumping.

F. A final problem would have been the decreasing visibility over long distances due to increasing forestation.

One implication of this process may have been the decreasing use of game drives in favor of stalking and ambushing techniques. Furthermore, both search and pursuit times involved in hunting may have increased, amounting to an increased cost of animal foods. Unless offset by a simultaneous and sufficient increase in the use of lower cost plants and fish, this lower income would probably result in lower human population densities. Complicating this population tendency would be the effects both of deglaciation opening new lands formerly unhospitable or under ice, and of sea level rising and drowning coastal areas, thereby altering the man-land ratios without changes in number of people.

It is clear that these problems and responses were not separate, but complexly interrelated. In addition, they were neither simultaneous nor equally important in different regions. Interesting dichotomies have been drawn between generalized, rich, stable, uniform environments and those which are specialized, poor, unstable, and heterogeneous, with each of these extreme types encouraging quite different adaptive strategies by hunter-gatherers (Gamble 1978). Yet these various environmental characteristics may vary somewhat independently, especially in times of climatic change. In the Late Glacial, southwestern France was unstable and heterogeneous, but relatively rich, while southern Germany was unstable, poor, but relatively homogeneous. Neither environments nor strategies may lend themselves to such general categorization.
<table>
<thead>
<tr>
<th>YEARS B.C.</th>
<th>POLLEN ZONE</th>
<th>SOUTH</th>
<th>FRANCE</th>
<th>LATE GLACIAL VEGETATION AND INDUSTRIES</th>
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<tbody>
<tr>
<td>12000</td>
<td>YOUNGER DRYAS</td>
<td>SOUTHWEST</td>
<td>FRANCE</td>
<td>mixed PINE - MAZE</td>
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<td>11000</td>
<td>OLDEST DRYAS</td>
<td>SOUTHWEST</td>
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<td>closed PINE - MAZE</td>
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**Table 1**
V. LATE GLACIAL ARCHAEOLOGY IN WESTERN EUROPE

A. Artifact Assemblages

According to the traditional chronology, the bulk of the Late Glacial, from roughly 16,000 to 10,000 BC, is occupied by the Magdalenian. Around 10,000 BC, the Magdalenian is transformed into Azilian and other Late Paleolithic industries which persist through Allerød and Younger Dryas periods until about 8300 BC. It is becoming clear, however, that a single, simultaneous technological evolution signifying adaptive changes did not occur; rather, there is apparently a significant degree of overlap for the dates of Magdalenian and Azilian in France (Table 1). A number of Magdalenian occupations, for example, have been placed well into the Allerød (Arambourou 1976; 1977; Debrosse 1976a; Delpech 1977; Leroi-Gourhan, Brezillon, and Schmider 1976; Leroi-Gourhan and Girard 1977; Le Tensorer 1976), and even well into the Younger Dryas (Debrosse 1976b; Laville 1977). Azilian occupations are well dated in the Allerød and Younger Dryas phases, but also the Older Dryas and Preboreal (Bintz 1976; Celerier 1976; Laville 1977; Leroi-Gourhan and Girard 1977; Lorblanchet 1976; Simmonet 1976). No clear spatial patterning is yet apparent which might suggest the significance of specific local environmental factors in this temporal distribution.

Furthermore, contrary to the rather homogeneous and stable lithic inventories of the earlier Magdalenian (Sonneville-Bordes 1974), there is also growing evidence for a remarkable diversity of assemblages late within this tradition, reflected in the presence or absence of certain artifact forms, relative proportions of artifact categories, and artifact size (Arambourou 1977; Bordes and Fitte 1964; Bordes and Sonneville-Bordes 1977; Hahn 1977; Lenoir 1977; Lorblanchet 1976). The determinants of this temporal and spatial variability are as yet unknown, but this diversity of assemblages is precisely what one might expect in a situation of changing and varied technological adaptations in the Late Glacial. This interpretation is supported by the appearance in the Late Glacial of an impressive variety of new forms of stone implements as well as the development of bone harpoons, microlithic tool forms, and the bow and arrow (Mellars 1973; Sonneville-Bordes 1974).

B. Economy

Somewhat more satisfactory is the evidence for Late Glacial economies. A large majority of Magdalenian sites in France, Germany, and Switzerland do, in fact, show a dominance of reindeer among the fauna, but other economic characteristics and trends, especially of the Upper Magdalenian, deserve mention.

1. There is a significant number of occupations with faunas dominated by other large herbivores, including horse, bison, ibex, chamois, saiga antelope, roe deer, and red deer (Delpech and Heintz 1976; 1977; Hahn 1977; Lenoir 1977; Sacchi 1976; Sieveking 1976; Sturdy 1975).
2. Along side these dominant herbivores there is characteristically a wide range of other mammals represented in the archaeological faunas (Hahn 1977; Mellars 1973).

3. An appreciable number of sites in Germany, Switzerland, and southwestern France suggest an increasing importance of birds (especially ptarmigan) and fish (especially salmon in southwestern France) in the Upper Magdalenian (Bandi 1947; Hahn 1977; Mellars 1973; Sieveking 1976). The elaboration of harpoons at this time seems to be related to the growing importance of fish (Arambourou 1977).

4. There is scattered evidence for a considerable importance of small mammals, especially hare, occasionally to the point of dominating the faunal collection (Debrosse 1976b; Mauser 1970; Schweizer 1959).

5. Evidence for the use of plant resources is virtually nonexistent, although recent finds in the Late Magdalenian occupation of Duruthy in southwestern France included a mortar, pestles, and backed bladelets showing traces of adhesive and polish, perhaps suggesting harvesting and processing of wild grasses (Arambourou 1977).

In the following Azilian or Late Paleolithic there are many sites in which red deer is the dominant resource, but in addition, a number of the trends observed earlier continue and increase in importance.

1. Other large herbivores, including ibex, horse, and moose, are occasionally the most important faunal resource (Blintz 1976; Hahn, Müller-Beck, and Taute 1973; Klindt-Jensen 1957; von Koenigswald 1972).

2. Reindeer persist as a resource in a number of sites (Arambourou 1977; Hahn, Müller-Beck, and Taute 1973; Riek 1957).

3. There is a decrease in the variety of large animal resources exploited as a result of the Late Pleistocene extinctions (Table 2).

4. There is a continuing importance of fish and hare, with these occasionally dominating the fauna (Blintz 1976; Celerier 1976; Perpere 1976; von Koenigswald 1972).

Throughout the Late Glacial, consequently, there is a significant concentration of hunting upon first reindeer and then red deer, but, in addition, a simultaneous exploitation of a broad range of other large herbivores and a growing emphasis of fish and small game. Red deer occasionally form the focus of Magdalenian economies, and reindeer continue to be a component of some Azilian and Late Paleolithic economies. Variety within local economies and diversity among regional economies appear to have been underestimated for this time period.
<table>
<thead>
<tr>
<th>SPECIES</th>
<th>LATE MAGDALENIAN</th>
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C. Settlement

During the height of the last glacial period the areas of western Europe that were occupied were relatively limited. England was apparently uninhabited between about 23,000 and 12,000 BC. (Evans 1975), and there is a similar gap in occupation of Belgium (Sonneville-Bordes 1961). Germany shows very scant evidence of occupation for the period of 21,000 to 18,000 BC and a complete lack thereafter until about 14,000 BC (Hahn and von Koenigswald 1976). Switzerland is similarly largely unoccupied until the end of the Late Glacial (Bandi 1968). In France, the Early Magdalenian, dating from about 16,000 to 13,000 BC, is confined largely to the southwest, with scattered finds in sharp contrast to earlier times, and is no doubt related to the harsh full glacial conditions in northern and central Europe. Southwestern France apparently served as a glacial refuge not only for plants and animals, but for humans as well, with important demographic and social implications (Jochim 1978).

The Late Glacial climatic oscillations opened new lands suitable for occupation, and the Middle and Upper Magdalenian do, in fact, demonstrate a tremendous expansion (Sonneville-Bordes 1974). Britain, Belgium, north and south Germany, Switzerland, and northern France are reoccupied, and the Pyrenees highlands are penetrated for the first time in thousands of years (Clottes 1976). This expansion finds its strongest expression, at least in France, during the Magdalenian IV stage dating to the relatively warm Bölling phase of roughly 12,000 to 11,000 BC. In the Pyrenees, the succeeding Magdalenian V and VI of the colder Older Dryas phase are represented by considerably fewer sites (Sieveking 1976). Whether the same is true of other regions of France is difficult to determine since the identification of the principal diagnostic criteria of these different Magdalenian stages requires organic preservation. In south Germany and Switzerland, on the other hand, the latest Magdalenian (Magdalenian VI) seems to be most abundant, dating to the Older Dryas.

This expanded distribution, together with an absolute increase in the number of sites of the Upper Magdalenian, has been interpreted as evidence of a population explosion (Sacchi 1976; Sonneville-Bordes 1974), but other factors may have contributed as well. Greater mobility or separation of activities into more frequent, special, short-term camps would cause an increase in the number of sites within an exploitation territory. Fragmentation and dispersal of populations could also increase regional site density, as well as providing an impetus for expanding into unoccupied areas. Such increased mobility and dispersal are, in fact, suggested for the latest Magdalenian, at least in the lower Dordogne Valley, the Pyrenees, south Germany, and Switzerland, by the relatively small, thin, and poor deposits of most Magdalenian V and VI occupations (Hahn 1977; Lenoir 1977; Sieveking 1976).

Azilian and Late Paleolithic sites are far less abundant and are characteristically small and thin (Arambourou 1977; Hahn 1977; Lorbanchet 1976; Sonneville-Bordes 1974). It would appear that the processes of fragmentation and dispersal reached an extreme state in this period. Whether the decrease in site abundance represents a population
decline or other factors such as greater transience and loss of site visibility, or shift of settlement locations cannot be determined as yet.

The possible magnitude of a shift in settlement is suggested by an examination of the distribution of Magdalenian and Late Paleolithic sites in Switzerland and south Germany (Figure 1). In both areas the Magdalenian is relatively restricted to the deep valleys of the limestone regions of the Jura and Swabian Alb. In the succeeding Late Paleolithic, by contrast, settlements shift to lower valley locations at the edges of these limestone plateaus and especially to the lower, more rolling morainic areas recently deglaciated, and characterized by abundant small lakes (Hahn 1977; Hahn, Müller-Beck, and Taute 1973; Taute n.d.; Wyss 1973). This change in settlement seems to represent a shift to the areas richest in fish and small game, which would be the most secure animal resources. A rarity of sites with both Magdalenian and Late Paleolithic levels also suggests a major shift.

VI. CONCLUSION AND IMPLICATIONS

"Postglacial" climatic changes began during the Late Glacial, and "postglacial" adaptations began in this period as well. The Late Glacial was marked by increasing environmental instability and diversity. These environmental changes posed a number of problems to human populations, to whom a number of solutions are available. The time scale of the environmental changes in the Late Glacial is so large that the fluctuations would not have been evident to individuals. Even with a history provided by the cultural transmission of past experiences, at most it might have been realized that some resources were not quite so abundant, nor so often in certain spots.

Given this gradual rate of change, it is to be expected that cultural adjustments would similarly have been gradual, and in minimal stages, each altering past patterns of behavior as little as possible. Thus, the sequence of changes should begin with those of the lowest costs, causing the least dramatic alterations. Furthermore, since the nature and direction of environmental changes were not clear, the necessary adjustments would also have been unclear, leading, perhaps, to a variety of different coping mechanisms simultaneously by different individuals and groups.

The archaeological record of portions of western Europe suggests that a variety of solutions were, indeed, adopted. In general, it would seem that the initial responses to the instability were to try to maintain resource variety alongside a strong focus on reindeer, despite gradual faunal impoverishment, and to increase harvesting effectiveness through a technological experimentation and diversification. Increasingly, another response became significant, that of shifting economic goals to stress more secure resources at the expense of economic efficiency. Simultaneously, processes of population fragmentation and dispersal grew in importance, even while large herd animals were still available, presumably, however, in reduced amounts. A final response, evident in south Germany and Switzerland, at least,
FIG. 1
SWISS AND SOUTH GERMAN
LATE GLACIAL SETTLEMENT

- LIMESTONE PLATEAUS
- MORAINIC LOWLANDS
- ALPINE HIGHLANDS
- OTHER REGIONS
- LAKES

- MAGDALENIAN SITES
- LATE PALEOLITHIC SITES

20 km
was a shift in the focus of settlement, perhaps reflecting a greater commitment to more stable resources.

Additional types of responses, including socio-cultural means of solving problems of resource instability, have not been considered. Such solutions, however, might include mechanisms both of wider geographic affiliation and of claiming stable local concentrations of particularly secure resources. Much of the portable and cave art of this time probably functioned, in part, in these contexts (Jochim 1978). The changing nature and general decline of such artwork in the Late Magdalenian suggest an inadequacy of such mechanisms in the stress of accelerated environmental fluctuations, and this failure may have directly led to the simultaneous adoption of alternative responses, especially of group fragmentation and increased dispersal.

Given the variability even within Western Europe, it would be foolish to try to draw parallels between Late Glacial Europe and North America. By focusing on general problems and responses, however, it seems possible to suggest some implications for the patterns of Late- and Postglacial adaptation in the Northeast.

1. The PaleoIndian period corresponds to a time of great environmental instability, so that a number of coping mechanisms may characterize this period, producing economies necessarily deviating from an extreme focus on big game herds. An economic diversity would have been encouraged not only by the environmental fluctuations, but also by the greater resource diversity of low-latitude glacial environments.

2. The processes of increased population fragmentation, dispersal, and mobility might be expected to occur before the disappearance of large herd animals. Such processes could be seen as solutions to the problems of declining abundance of these resources, perhaps, rather than as anticipatory adaptations to new, local, non-aggregated resources.

3. A dramatic shift in the focus of settlement may occur relatively late, after the appearance of other responses. If, as in southern Germany, such a shift emphasized areas of presently poor archaeological visibility, then an apparently large population decrease would be suggested. The hypothesis of an Early Archaic population decline must be examined in this light, especially since the diversity and productivity of the low-latitude, mixed pine-oak forests of Pollen Zone B may be underestimated.
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