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Paleolithic Adaptations and Settlement in Cantabrian Spain

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INTRODUCTION

Since 1965 several key problems in human prehistory have come into sharp focus in Western Europe.

One of these problems is the nature of the replacement of Neanderthal people by anatomically modern *Homo sapiens sapiens*. The classic hypothesis favored a sudden replacement of indigenous European Neanderthals by immigrant, modern humans from the east (Howell 1951; Vallois 1954). Another position argues for an autochthonous transformation within Europe, involving polyphyletic evolution from Neanderthals to modern *Homo sapiens* (Brace 1964; Wolpoff 1981; see also Smith 1982). Common, current interpretations see the evolution of *Homo sapiens sapiens* among "progressive" Neanderthals in the Near East, probably influenced by other, archaic *sapiens* populations in Africa or Asia, with a subsequent, progressive replacement in Europe (Howells 1976; Trinkaus and Howells 1979; Stringer 1982; Stringer *et al.* 1984; Bräuer 1984). The evidence from Central Europe suggests the need for less rigid positions: although the case in favor of Neanderthal-modern *Homo sapiens* continuity is ambiguous, it is becoming increasingly difficult to deny a significant contribution of Neanderthals to the gene pool of modern Europeans; possible the transition was catalyzed by the flow of "progressive" genes into Europe, but without a large-scale population influx (Smith 1984).

The second problem centers around interpretation of the several stone tool assemblages labeled as Mousterian and, at least in Europe, generally attributed

to the Neanderthals: across tens of millennia similar assemblages seem to appear, disappear, and reappear in successive levels of different Western European caves, prompting an "ethnic" interpretation by Bordes (1961, 1973, 1978; Bordes and de Sonneville-Bordes 1970; Laville 1973), a "functional" or tool kit interpretation by Binford (Binford and Binford 1966; see also 1969; Binford 1976; Harrold 1981; Straus 1983b)—the tangible reflection of several, distinctive cultural systems, perhaps "ethnic groups"? Or were at least some of these industries a reflection of adaptive specializations, such as seasonal activities or heterogeneous subsistence modes, within a single cultural system? Was replacement of one industry by another relatively rapid and universal in the region, or was it time transgressive, with more continuity than change? Were such "new" industries more a matter of stylistic change than of fundamental technological shifts, and were they the product of autochthonous cultural transformations or of allochthonous cultural and "ethnic" replacement?

A third problem is posed by the rapid succession of Upper Paleolithic industries that followed upon the Mousterian and the advent of anatomically modern people in Western Europe. Were lithic industries such as the Aurignacian, Perigordian, Solutrean, Magdalenian, and Azilian—and their numerous subdivisions (de Sonneville-Bordes 1960, 1966; Rigaud 1976, 1982; Hodson 1969; Hahn 1973; Bricker 1976; Harrold 1981; Straus 1983b)—the tangible reflection of several, distinctive cultural systems, perhaps "ethnic groups"? Or were at least some of these industries a reflection of adaptive specializations, such as seasonal activities or heterogeneous subsistence modes, within a single cultural system? Was replacement of one industry by another relatively rapid and universal in the region, or was it time transgressive, with more continuity than change? Were such "new" industries more a matter of stylistic change than of fundamental technological shifts, and were they the product of autochthonous cultural transformations or of allochthonous cultural and "ethnic" replacement?

Contemporary research has increasingly sharpened the focus of these problems and it is becoming apparent that human fossils, stone tools, and ^{14}C dates are not, by themselves, adequate to their resolution. Fortunately, some of the most innovative Paleolithic studies have recently been implemented in Cantabrian Spain (Figure 4.1). Zooarchaeology, which provides valuable insights into subsistence patterns (Klein and Cruz-Urbe 1984, n.d.; Klein *et al.* 1981), has also been invoked to understand cultural diversity and change (Clark and Straus 1983; Freeman 1973b; Straus 1977a, 1981, 1982a; Straus *et al.* 1980), as well as to propose a semiquantitative measure of niche width (Clark and Yi 1983). Attention has been given to site exploitation territories (Bailey 1983) as well as to the use of archaeological inventories to test alternative settlement-mobility patterns (Clark and Lerner 1983); by focusing on a region rather than a site, these studies have begun to identify the spatial variability that has traditionally been neglected in most archaeological research.

REGIONAL MATRIX FOR HUMAN SETTLEMENT ca. 20,000 B.P.

The prehistoric Cantabrian habitat can first be examined in spatial and vertical terms, focusing on the elements of the environmental matrix: terrain, glaciation, slope and stream processes, vegetation cover, mammalian fauna, and adjacent

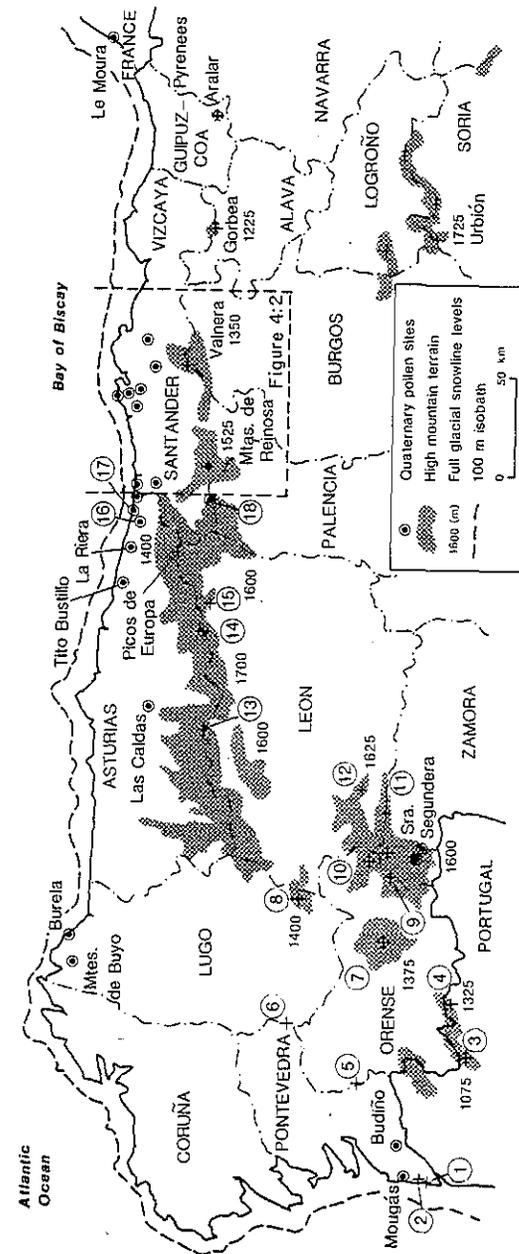


Figure 4.1 Northwestern Spain, showing high mountain terrain, regional climatic snowlines (RCS) elevations of glaciated areas, and pollen or archaeological sites. Location key: 1, La Guardia; 2, Sanjilán; 3, Sierra Cères; 4, Sierra Larouço; 5, Sierra Faro de Avión; 6, Sierra Calva; 7, Sierra Caurel; 8, Peña Rubia; 9, Sierra Cabreira; 10, Sierra Teleno; 11, Mampodre; 12, Mampodre; 13, Mampodre; 14, Mampodre; 15, Mampodre; 16, Mampodre; 17, Mampodre; 18, Mampodre.

oceanic data. The datum for this analysis is the maximum of the last, upper Pleistocene glaciation, conventionally assigned to about 18,000 B.P., although a 20,000 year date would fit the Cantabrian evidence better.

Terrain

Simple contour or elevation maps do not adequately express the roughness and steepness of a landscape. So, the Cantabrian coastal plain is low lying but highly irregular, whereas the interior Duero Basin is high lying but relatively smooth. Hammond (1964) has devised synthetic terrain classes using the local relief and percentage of smooth slopes (estimated from contour spacing to be less than 8% or 5°) for arbitrary 10-km squares, superimposed as a grid on detailed topographic maps. Figure 4.2 shows the application of this method to central Cantabria, based on the 1:50,000 maps (20-m contour interval), with grid characteristics generalized in relation to topographic trends. Six major terrain classes emerge: (1) the coastal plains, with a local relief of less than 100 m and more than 70% smooth slope; (2) the open hills of the coastal piedmont zone, with local relief of 100–300 m and 30–70% smooth slope; (3) the low mountains of the north Cantabrian flank, with local relief of 300–1000 m and less than 30% smooth slope; (4) the high mountains of the Cantabrian spine, with local relief over 1000 m and less than 30% smooth slope; (5) the open mountains of the south Cantabrian flank, with local relief of 300–1000 m and 30–70% smooth slope; and (6) the dissected tableland of the Duero Basin periphery, with 100–500 m local relief and 20–70% smooth slope, and most level land found in the upper elevation range.

These terrain classes directly affect the distribution of large herbivores. The coastal plains and open piedmont hills are ideal for cursorial and gregarious forms such as red deer, horse, and bison, but the adjacent, closed mountain belt would be unsuitable except in the case of larger river floodplains. Animal herds of the coast and piedmont would tend to be nonmigratory, because east-west movements along the coast would eventually cross the territories of other herds. South of the Cantabrian crests, the open mountains and tablelands were also ideal for cursorial herbivores, but the vast Duero Basin would have favored seasonal migration of herds; hunter exploitation could therefore be expected to be both seasonal and mobile, probably favoring short-term occupation of open-air sites that would only occasionally be reutilized. The mountain belt itself was the domain of slope-adapted ibex and chamois, with periodic incursions of groups of deer and horse up the larger valleys. Human exploitation should have focused on such valleys, but the more dispersed and less predictable resources probably favored higher mobility and greater degree of seasonality, compared with settlement in the coastal and piedmont zones.

This basic topographic pattern of central Cantabria applies to the 400-km belt

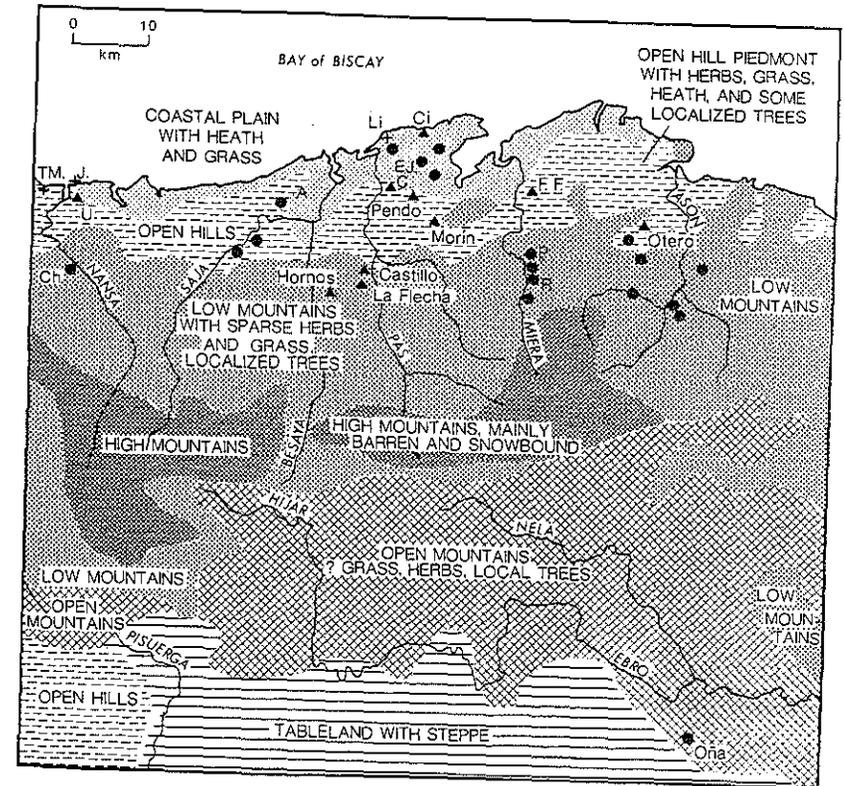


Figure 4.2 Terrain categories and reconstructed full-glacial vegetation patterns of central Cantabria. Key: ▲, Mousterian (and later) sites; ●, Upper Paleolithic sites; A, Altamira; C, Cobalejos; Ch, Chufin; Ci, Ciriago; FF, Fuente del Frances; J, La Jerra; Li, Liencres; P, Pielago; R, Rascaño; TM, Tina Mayor; U, Unquera.

between the Pyrenees and eastern Lugo (Figure 4.1) and will prove fundamental to understanding the settlement patterns of prehistoric hunters and foragers in the region.

Glaciation

Pleistocene mountain glaciers provide proxy paleoclimatic data as well as an understanding of vertical ecozonation. Such information is usefully synthesized in terms of RCS elevations. These can be relatively consistently approximated for a set of cirque or valley glaciers by averaging equilibrium line altitudes (ELAs)

(i.e., the median elevation between the top of the cirque headwall and the base of the terminal moraine; Louis 1968; Porter 1981). Local differences of windward and lee slopes, northerly and southerly exposure, and structural-lithological determinants are commonly equalized by averaging the ELAs for a group of former glaciers to obtain the RCS.

The glacial evidence assembled in Table 4.1 (see Figure 4.1) and presumed to be upper Pleistocene is difficult to date exactly. However, most larger glaciers have left a string of minor recessional moraines that, in terms of vegetation cover, depth of soil development, and degree of erosion are indistinguishable from the much more prominent terminal moraines, recalling the full- and late-glacial stades of the Alps (Jorda 1983; Patzelt 1974; Porter and Orombelli 1982). More specifically, in the Sierra de Segundera, the largest valley glacier had retreated substantially about 16,000 B.P., when a bog began to form at 1030 m (Menéndez Amor and Florschütz 1961). South of the Picos de Europa (Puertos de Riofrio, Santander), a major cirque floor below the Peña Prieta at 1830 m was deglaciated prior to gyttja accumulation that began 10,400 B.P. (Florschütz and Menéndez Amor 1965). These two examples suggest glacial retreat was well underway by 16,000 B.P. and completed by 10,000 B.P.

In overview, the theoretical late Pleistocene RCS of the area rose from below 1100 m elevation near the northwestern coast to over 1700 m in the north-central interior, paralleling the modern climatic gradient from the cool, cloudy maritime sector to the drier, sunnier, continental plateaus. Today minimum annual insolation and maximum winter precipitation are localized in the mountains of Asturias and Santander (Atlas Nacional de España 1965: Plates 39 and 40), although the lowest Pleistocene RCS values are found north of the Portuguese frontier. This suggests that these western mountains experienced greater climatic deviations than did the main Cantabrian ranges.

During the colder and wetter substages of the late Pleistocene, with glacier tongues of the Atlantic catchments extending down as low as 500 m in the west and 900 m in the north, and with RCSs at 1100–1700 m along the Atlantic-Duero watershed, the higher mountains would have been snowbound throughout the year. Even in late summer the passes from Santander and Asturias to the Duero plains would have been largely closed to both animal and human movements. Consequently late Pleistocene settlement in Santander and Asturias would have been isolated, except for the coastal corridor between the Basque country (Vizcaya, Guipuzcoa, Alava) and Galicia (Lugo and beyond). Furthermore, potential montane exploitation by mobile hunters was probably excluded from the nival environment that can be approximated from the "high mountain" terrain of Figures 4.1 and 4.2.

Slope and Stream Processes

The severity of full-glacial climate of Cantabria is further demonstrated by conspicuous mobilization of slope debris, even at modern sea level. The dissected alluvial fills at 5–15 m above modern floodplain in all the larger valleys are found

TABLE 4.1
Late Pleistocene Regional Climatic Snowline (RCS) Elevations in Northwestern Spain and Portugal^a

| Area | Summit elevation (m) | RCS (m) | Comments |
|----------------------------------|----------------------|-----------|--|
| Sierra Gêres (3) | 1642 | 900–1250 | — |
| Sierra Larouço (4) | 1535 | 1250–1400 | — |
| Sierra Faro de Avión (6) | 1151 | (?) | possible glaciation |
| Sierra Faro (6) | 1177 | — | no evidence for glaciation |
| Sierra Queija (7) | 1707 | 1375 | — |
| Sierra Caurei (8) | 1616 | 1400 | — |
| Sierra Calva (9) | 2005 | 1425 | — |
| Sierra Eje (10) | 1925 | 1600 | — |
| Sierra Cabrera (11) | 2124 | 1550–1750 | — |
| Sierra Teleno (12) | 2188 | 1675 | — |
| Astrurias-León watershed (13–15) | 2416 | 1600–1700 | RCSs possibly lower |
| Picos de Europa | 2665 | 1400 | Duje glacier 1400 m, Urdón 1350 m, Deva 1450 m |
| Montañas de Reinoso | 2175 | 1525 | Nansa glacier 1500 m, Saja 1450 m, Hajar 1625 m; RCS of mid-Pleistocene glaciation 150 m lower |
| Valnera Group | 1707 | 1350 | far more extensive mid-Pleistocene glaciation dubious |
| Peña Gorbea | 1475 | 1225 | mainly nivation niches and protalus ramparts |
| Sierra de Aralar | 1427 | 1050(?) | a single, probable cirque |
| Picos de Urbión | 2228 | 1750 | Laguna Negra glacier 1700 m, Laguna Urbión 1700 m, Rio Portilla 1625 m, Rio Frio 1760 m, Laguna Oruga 1800 m |
| Pic Midi d'Ossau (Pyrenees) | 2884 | 1500 | |

^aData listed west to east for mountain ranges; numbers refer to Figure 4.1. Sources (sequential): Schmidt-Thomé 1983; Schmitz 1969; Pérez 1979; Nussbaum and Gyax 1952; Obermaier 1914; Miotke 1968; Clark 1981; Butzer, unpublished data; Lotze 1962; Martínez de Pisón and Arenillas Parra 1979; Schmidt-Thomé 1973; Kopp 1963; Butzer, unpublished data; Nussbaum 1957; Hazera 1983.

to be laterally interbedded with scree mantles, talus aprons, alluvial cones or fans, and debris-slide masses. Such deposits are best developed on and below slopes in excess of 20° in areas of Cretaceous sandstones or Paleozoic slates and quartzites. Remnants of an older generation of detritus, often cemented, are common and these may interfinger laterally with more deeply weathered alluvial terraces at 15–35 m above floodplain. Immediately at the coast the younger screes can be observed to rest on marine abrasional platforms as low as 4–8 m above sea level or on equivalent surfaces of estuarine deposits (Asensio 1974; Butzer

1973; Llopis 1957:43; Mensching 1961; Nonn 1966). Near La Franca (Asturias) and Mougás (Pontevedra) such scree lies directly on organic, low-energy deposits with "infinite" ^{14}C dates and which in turn mantle such wave-cut surfaces (Butzer 1967; Franz 1967; Mary *et al.* 1975). The upper Pleistocene (glacial) age of these younger scree is bracketed by bog clays and peats that began to form above such slope detritus before 3000 B.P. near Buelna (Asturias) and after 10,000 B.P. in the Montes de Buyo (Lugo; Menéndez Amor and Florschütz 1961); there also are intercalated, low-energy organic lenses dated 18,700 B.P. near La Guardia (Pontevedra) and 13,600 B.P. at Burela (Lugo; Butzer 1967; Delibrias *et al.* 1964).

The Cantabrian scree and their older, breccia counterparts consist of angular to subangular rock rubble with a matrix of poorly sorted grit, sand, and soil; thickness on lower slopes may be several meters. Their genesis is elucidated by the range of lateral facies variants: stream beds below and upslope talus (with reduced fine matrix), locally interrupted by steep fans or debris-slide masses derived from coarse, poorly sorted regolith. Such rubbles were produced by effective frost weathering and then transported by a combination of gravity, piprake dislodgement, creep, and overland flow. Only one example of fossil "stone lines" was noted in Santander (on a 5–8° slope in the Besaya valley at 25 m) in an older scree. Frost-generated, stratified scree (*éboulis ordonnées*), consisting of alternating fine lenses and coarse openwork rubble (see Embleton and King 1975:109; Tricart 1967:238), are occasionally seen above 300 m elevation. Cryoturbation and vestiges of slow earthflows that suggest congelifluction can sometimes be seen in clayey alluviations at low elevations, as well as inside caves (Butzer 1981; Clark 1981; Delibrias *et al.* 1964; Hoyos 1981; Llopis 1957:43ff.) Also near sea level there are traces of typical loess, for example, on a footslope at Unquera and in a karst fissure near Cueva Morín (Figure 4.2) (Butzer 1981). These very thin and localized loess deposits were probably a result of deflation from glacier-derived silts in the major river channels (for a recent review on loess, see Pye 1984).

Similar slope debris has also been reported from western Asturias (Asensio 1974) and La Coruña (Nonn 1966). There are frost cracks in some sections, but no true ice wedges. In general the scree of northernmost Spain recall the "heads" of southwestern Britain, but frost played a generally subordinate role to gravity and running water in their transport. They record accelerated denudation in a cold, maritime climate, rather than typical "periglacial" processes. In Pontevedra such scree are absent and replaced by alluvial fans and footslope colluvia that accumulated by running water and creep; this reflects both the weathering properties of granitic bedrock and a less severe Pleistocene climate (Butzer 1967; Nonn 1966). Blockstreams are limited to higher elevations (above 1300 m in Santander, but lower further west), primarily below gelivation cliffs, and sometimes in association with nivation niches.

This picture of mobile slopes with vigorous denudation of all weathering products is complemented by the interdigitated alluvial fills that now form valley-margin terraces. These are coarse to cobble grade, well rounded toward the valley

axes, but subangular near the margins. They imply high-energy, torrential runoff, probably during the spring thaw and summer meltwater season. Such an environment presupposes an essentially open vegetation with an incomplete ground cover. It further implies skeleton soils (Puga *et al.* 1978) and limited plant productivity on all but gentle slopes. Animal biomass in such mountainous topography would have been limited to caprines and smaller mammals, while plant foods for human consumption can be expected to have been scarce.

The Pollen Record

The vegetation inferences made from the geomorphological criteria are substantiated by the palynological data. Six profiles record the most severe, full-glacial climate of ca. 20,000–15,000 B.P. (Table 4.2). This picture of an essentially treeless, full-glacial environment is complemented by five other late Pleistocene profiles that record cold, treeless episodes either younger or older (Table 4.2).

This range of pollen spectra from the Portuguese border to adjacent parts of France gives a consistent picture of an open vegetation, begging the question of the nature of the ground cover. In Pontevedra, Zamora, and on the Cantabrian watershed, grasses are dominant, with abundant *Artemisia* at higher elevations, indicating a steppelike grassland. But true grassland was rare north of the Cantabrian ranges under full-glacial conditions. Instead there was an incomplete ground cover of Ericaceae and Compositae near the coast and of Compositae and Gramineae in the open-hill piedmont and low mountain terrain. The Compositae were primarily of the liguliflorae group, and are mainly identified as Chicoriae. Also common are traces of *Plantago*, Caryophyllaceae, Anthemidae, Umbelliferae, and Chenopodiaceae. These flowering herbaceous plants or small shrubs do not generally provide a complete vegetation mat. The heath plants (Ericaceae) are not identified as to type except at Le Moura, where *Calluna* (ling heather, a maritime form), *Erica* cf. *tetralix* (bog heather), and *Empetrum* (crowberry, a montane form) are indicated (Oldfield 1964). *Ulex* (gorse), prominent in modern heaths of the region, may also have been present on drier, sandy sites. Heath thrives best on acid or neutral soils and appears to have been best developed on open and windswept coastal environments, such as those at La Riera and Tito Bustillo, where Ericaceae are most prominent. Ferns (Filicales) are present in some spectra and mainly appear to be *Polypodium vulgare*, a creeping epiphyte of local significance found directly above several caves today; club moss (*Lycopodium*) is also recorded.

It is noteworthy that the highest arboreal pollen count of the full-glacial spectra (22–35%) comes from Las Caldas, situated in a sheltered west-east valley of interior Asturias. Overall, the persistence of small and presumably scruffy stands of trees in numerous, local refugia is suggested by the rapid increase of arboreal pollen at some sites, but not at others, during minor warming trends ("interstadials"). This can be illustrated by comparing the "mildest" late Pleistocene spectra from 10 available sites in Table 4.2. All of these "interstadial" pollen horizons show

TABLE 4.2
Late Pleistocene Pollen Spectra^a

| Locality | Altitude (m) | Approximate ¹⁴ C age (B.P.) | Arboreal pollen (%) | Comments | Interpretation |
|---|--------------|--|---------------------|--|---|
| FULL-GLACIAL LEVELS | | | | | |
| Sierra Segundera | 1030 | 16,000 | 18 | mainly <i>Pinus montana</i> ; NAP: 45% grasses, also much <i>Artemisia</i> | high mountain grass-steppe with sparse stands of pine |
| Las Caldas | 160 | 19,500 ^a (Coldest Solutrean) | 22 | <i>Pinus silvestris</i> ; NAP: Compositae 53%, Gramineae 9% | Some stands of pine on hillsides; poor ground cover |
| La Riera | 30 | 20,000 | 1 | 55-60% Ericaceae; Compositae dominate Gramineae; ferns | treeless, ericaceous heath |
| El Pendo | 85 | (Terminal Aurignacian) | 6 | Compositae dominate Gramineae; 4% Ericaceae | essentially treeless; poor ground cover |
| Rascaño | 240 | 16,000 ^b | 2 | Compositae dominant; 20-25% Ericaceae | valley floor and slopes treeless; poor ground cover |
| Le Moura | 40 | 14,200 | 2 | Gramineae dominant | treeless grass-steppe |
| Isturitz Cave (Pyrenees) | 210 | (Gravettian) | 1 | Compositae dominant (82%) | treeless slopes; poor ground cover |
| YOUNGER OR OLDER "COLD" LEVELS | | | | | |
| Mougás (Pontevedra) | 5 | 70,000(?) (see Figure 4.4) | 0 | 75-92% Gramineae; 1-6% Ericaceae | treeless, coastal grass-steppe |
| Tito Bustillo | 30 | 10,800 ^d | 0 | almost exclusively Ericaceae and Gramineae | heath-grass coastal steppe |
| Riofrio (18, Figure 4.1) (Cantabrian watershed) | 1830 | 10,400 | 25 | pine, with <i>Artemisia</i> , Gramineae, and Chenopodiaceae | high mountain grass-steppe with some pine stands |
| Morín | 57 | 30,000 | 3 | Compositae dominant; 2-10% Ericaceae | treeless coastal hills; poor ground cover |
| Otero | 60 | (Evolved Aurignacian) | 1 | 45-90% Compositae; no Ericaceae | treeless mountain slopes; poor ground cover |
| "INTERSTADIAL" LEVELS | | | | | |
| Budíño (Pontevedra) | 36 | 26,700 ^e | 59 | <i>Pinus (pinea?)</i> , alder, hazel; Compositae dominant | pine-hardwood parkland; poor ground cover |
| Burela (Lugo) | 45(?) | 13,600 | 24 | <i>Pinus silvestris</i> (and <i>P. montana?</i>); Gramineae dominant | grass-steppe with stands of pine |
| Las Caldas | 160 | 19,250 | 35 | <i>Pinus silvestris</i> , hazel, alder, willow; Gramineae dominant | grass-steppe with stands of pine and hardwoods |
| Tito Bustillo | 30 | 12,600 | 22 | pine, alder, birch, oak; Gramineae, Ericaceae, ferns | grass-heath steppe with some stands of pine and hardwoods |
| La Riera | 50 | 18,000 | 12 | pine, hazel, alder; Gramineae, Ericaceae | heath-grass steppe with rare, open stands of pine |
| Chufín | 156 | 17,400 ^f | 57 | <i>Pinus silvestris</i> , alder, hazel, birch; Compositae, ferns | stands of pine and hardwoods on slopes with poor ground cover |
| El Juyo | 70 | 15,000 | 58 | pine, hazel, alder, oak; Ericaceae, ferns, Gramineae | heath-grass steppe with stands of pine and hardwoods |

(continued)

TABLE 4.2 (continued)
Late Pleistocene Pollen Spectra^a

| Locality | Altitude (m) | Approximate ¹⁴ C age (B.P.) | Arboreal pollen (%) | Comments | Interpretation |
|----------|--------------|--|---------------------|---|--|
| El Pendo | 85 | (Lowest Magdalenian) | 19 | birch, juniper, pine; Gramineae dominant, some Ericaceae | grass-steppe with some hardwood stands |
| Morín | 57 | 28,000 | 65 | pine, some birch, hazel and oak; compositae dominant, ferns | pine groves in open landscape, some hardwoods; poor ground cover |
| Le Moura | 40 | 12,800 (Zone L2) | 26 | willow, pine, birch; Gramineae dominant, many ferns | grass-steppe with stands of hardwoods and pine |

^aSources: Boyer-Klein 1976, 1980, 1982; Delibrias *et al.* 1964; Florschütz and Menéndez Amor 1965; M. M. Paquereau in Hoyos Gómez 1981:50; Leroi-Courhan 1959, 1966, 1971, 1980a, 1980b; Menéndez Amor and Fernández de Vidaurreta 1960; Menéndez Amor and Florschütz 1961; Menéndez Amor and Ortega Sada 1958; Oldfield 1964; M. Van Campo and J. Cohen in Nonn 1966:219-221, 287, Table 17; Straus *et al.* 1981.

^bThe many inconsistent or isochronic dates from Las Caldas (Evin *et al.* 1983) suggest widespread contamination or rodent burrowing.

^cBurleigh *et al.* 1982a.

^dThe Tito Bustillo ¹⁴C dates are inconsistent and the sequence better dated by the paleomagnetic record, with reference to the Lake Windermere "standard," see Creer and Kopper (1974). Using the revised Windermere dating of Thompson and Berglund (1976), the Tito Bustillo pollen column spans ca. 13,000-10,000 B.P., with the parietal art fixed at about 12,500 B.P.

^eThe Budiño pollen comes from the equivalent of the base of the organic, late Pleistocene, occupation level, above kaolinitic sands (see Nonn 1966:221); the available dates are 26,700 and 18,000 B.P. (Butzer 1967).

^fCabrera and Bernaldo de Quiros 1977.

increases in Gramineae, Ericaceae, and ferns, indicating an improved ground cover.

Two informative patterns emerge from the "interstadial" data. One is that forest recovery was most rapid at sites in the piedmont and low mountain country, rather than on the coastal plain. This suggests that the refugia were located inland, in areas of broken topography and elevations of up to perhaps 250 m. The other is that pine, hazel, alder, and oak are most consistently recorded. Although pine is highly overrepresented in pollen rain and transported long distances, small and sparse stands of submontane *Pinus silvestris* must have been found in many sheltered slope locations. Alder, on the other hand, suggests dwarf stands along stream margins or floodplains, probably in wind-sheltered valley segments. Oak and hazel bushes were probably found sporadically in well-drained locales with southerly exposure. The persistence of oak (unfortunately not identified at the specific level) in such a sparsely vegetated environment suggests that wind force and physiological drought during winter posed as much of an impediment to tree growth as did inadequate summer warmth. In general the key criteria for refuge sites appear to have been wind shelter, sun slopes, free drainage, and reduced liability to strong temperature inversions, slope talus movement, or avalanche damage.

Projected to the terrain categories of Cantabria, the pollen data indicate a heath and grass cover on the coastal plain but a mixed vegetative mat of flowering herbs and low shrubs, grasses, heath, and localized ferns in the open hill belt, where some stunted groups of pine, oak, and alder persisted in wind-sheltered locations,

either on south-facing slopes or along streams. The low mountains appear to have had a thin and very incomplete cover of flowering plants and grass, with widely spaced, scruffy stands of pine on south slopes and local stands of alder or oak-hazel in some valley bottoms. The high mountain topography was probably more or less barren and snow covered most of the year, a typical nival zone. The open mountains and tablelands south of the watershed were probably grassy in the main part, although there are insufficient data to gauge the density of the ground cover or the possibility of some pine-oak-hazel parkland in the broken foothill zone.

The central Cantabrian tree line is today demarcated by beech to near 1600 m, although that limit generally is lower due to deforestation (Ern 1966:65). Of the three deciduous oaks, *Quercus sessiliflora* (on limestones) and *Q. pyrenaica* (on siliceous rocks) are found up to 1100 m, with *Q. robur* on the wetter and less continental, northern slopes (Ceballos 1966:Plate 2; Florschütz and Menéndez Amor 1965). However such an implicit, full-glacial ecozone depression of 1350 m would be difficult to argue or interpret because biotic associations and patterns were fundamentally different during late Pleistocene time.

Paleolithic sites (Figure 4.2) are essentially limited to the coastal plain, the hilly piedmont, and the valley margins of the low mountains on the northern periphery of the Cantabrian ranges. The plant cover reconstructed for this area would have supported at least a moderate herbivore biomass. Although detailed study of seeds and phytoliths from El Juyo are underway by W. R. Crowe (personal communication, 1984), presently available evidence suggests there were few plant foods of sufficient quantity suitable for human consumption. Paleolithic people would therefore have been primarily dependent on animal foods.

Mammalian Fauna and Marine Resources

Despite the exquisite anatomical detail with which animals have been rendered in the Upper Paleolithic paintings of Western Europe (Powers and Stringer 1975), there is no significant correspondence between the numbers of individuals of each species so shown and the actual bone counts in related occupation levels (Altuna 1983; Straus 1977b): the cognitive values and motivation underlying the cave art were evidently not identical with the availability of game and the practicalities of procurement in an everyday situation. The archaeofaunal assemblages of the Cantabrian Upper Pleistocene sites have been reasonably well studied (Freeman 1973b; Klein and Cruz-Urbe n.d.; Klein *et al.* 1981; Straus 1977a, 1982a, 1983b). Based on minimum numbers of individuals, the bone counts indicate that red deer (*Cervus elaphus*) consistently was the most common prey animal, and the specimens are relatively large, indicating an abundance of quality forage (Klein *et al.* 1981). The Solutrean faunas for the different environmental zones of Asturias, Santander, and the Basque country have an average of 48% red deer and 22% ibex (*Capra pyrenaica*), with minor components of horse, *Bos* or bison, chamois (*Rupicapra*), roe deer (*Capreolus*), and boar (*Sus scrofa*) (Table 4.3). Reindeer are

TABLE 4.3
Ungulate Faunas from Middle and Upper Paleolithic Assemblages in Cantabrian Spain^a

| Industry | <i>Cervus elaphus</i> | <i>Capreolus capreolus</i> | <i>Capra pyrenaica</i> | <i>Rupicapra rupicapra</i> | <i>Bos</i> or <i>bison</i> | <i>Sus scrofa</i> | <i>Equus caballus</i> |
|-----------------|-----------------------|----------------------------|------------------------|----------------------------|----------------------------|-------------------|-----------------------|
| Magdalenian | 52 | 6 | 24 | 6 | 4 | 2 | 6 |
| Solutrean | 48 | 5 | 22 | 7 | 6 | 1 | 12 |
| Chatelperronian | 31 | 11 | 14 | 16 | 14 | 2 | 12 |
| Aurignacian | | | | | | | |
| Gravettian | | | | | | | |
| Mousterian | 30 | 6 | 9 | 3 | 32 | 2 | 18 |

^aPercentages based on minimum number of individuals (MNI) documented; reindeer, extinct species, and seal excluded. Source: Klein *et al.* 1981; Straus 1977a, 1983a, 1983b.

very rare in Cantabrian sites, except in the Basque country, although reindeer outcompeted red deer in southwestern France (Delpech 1975), where there may have been a thicker, winter snow cover and where "wet meadow" habitats were much more common (see Oldfield 1964 and Paquereau 1975; Cyperaceae and *Typha* are abundant in French profiles, rare in Cantabrian ones). Extinct genera such as giant deer, woolly mammoth, and steppe rhino are insignificant. Study of the micromammalian fauna has barely begun.

Red deer are conventionally regarded as woodland forms, but they also forage successfully in open grass-heath environments (Straus 1981). Much the same can be argued for the wild ox (*Bos primigenius*) and bison (Zeuner 1963:Chapter 8), while mural representations identify the horses as the steppe-adapted Przewalski subspecies (Powers and Stringer 1975). Ibex and chamois are adapted to rough topography. Only the roe deer is generally regarded as a woodland type. The dominant herbivores are, then, generally compatible with other lines of paleoenvironmental evidence. These animals served to convert basic plant productivity into protein and energy accessible for human consumption.

Carnivores are particularly well represented in the Mousterian horizons (61% of the fauna), reflecting the partially carnivore origin of many "Mousterian" bone assemblages; carnivores decline to 21% in the early Upper Paleolithic and 7% in later Upper Paleolithic levels (Straus 1982a). Fox and wolf are most consistently represented throughout these sequences.

Bird and fish bones are present in small numbers at several sites but remain to be studied systematically. The former include eagle, vulture, raven, jackdaw, alpine chough, partridge, and grouse (Straus 1977a). Practically no data on fish remains have been published, although salmon runs are to be expected in the coastal rivers (Jochim 1983) and salmon vertebrae have been recovered in La Riera (Straus *et al.* 1981) and El Juyo (Klein and Cruz-Urbe n.d.). More important are the molluscan remains, rare in Mousterian and early Upper Paleolithic levels but locally abundant in Solutrean, Magdalenian, and Azilian levels (Clark 1983; Clark and Straus 1983; Straus *et al.* 1981; Bruhns 1983): *Ostrea edulis* (common oyster),

TABLE 4.3
 Ungulate Faunas from Middle and Upper Paleolithic Assemblages in Cantabrian Spain^a

| Industry | <i>Cervus elaphus</i> | <i>Capreolus capreolus</i> | <i>Capra pyrenaica</i> | <i>Rupicapra rupicapra</i> | <i>Bos</i> or <i>bison</i> | <i>Sus scrofa</i> | <i>Equus caballus</i> | MNI |
|-----------------|-----------------------|----------------------------|------------------------|----------------------------|----------------------------|-------------------|-----------------------|------|
| Magdalenian | 52 | 6 | 24 | 6 | 4 | 2 | 6 | 1177 |
| Solutrean | 48 | 5 | 22 | 7 | 6 | 1 | 12 | 679 |
| Chatelperronian | 31 | 11 | 14 | 16 | 14 | 2 | 12 | 246 |
| Aurignacian | | | | | | | | |
| Gravettian | | | | | | | | |
| Mousterian | 30 | 6 | 9 | 3 | 32 | 2 | 18 | 211 |

^aPercentages based on minimum number of individuals (MNI) documented; reindeer, extinct species, and seal excluded. Sources: Klein *et al.* 1981; Straus 1977a, 1983a, 1983b.

Patella vulgata and *P. aspera* (limpets), *Littorina littorea* (common periwinkle), and *Mytilus edulis* (blue mussel). Holocene subdominants in archaeological contexts include *Trochoclea crassa* (top shell) and blue mussel, but Mollusca only assume major dietary significance after 9500 B.P. in the Asturian levels.

The Oceanic Evidence

The maximum, full-glacial regression of world sea level (Denton and Hughes 1981:263ff.) would have exposed the narrow Cantabrian continental shelf down to as far as the 100 m isobath, generally found some 10 km offshore, but no direct local evidence is available. In Pontevedra, where such shelf sediments have been mapped, they consist of extensive gravel cordons at about -50 to -80 m, with sandy flats on their shoreward side and marine clays seaward (Nonn 1966:521). Off Cantabria, despite a steeper offshore relief, it is probable that gravelly, wave-built marine platforms are as common as wave-cut platforms and these would have been remodeled by wave action during regressive phases.

It is therefore likely that shellfish were collected from extensive shingle beaches and estuarine zones rather than from the narrow, rocky cliff faces that dominate the present "submerged" coastline. Foraging for seafoods may therefore have been less precarious than today, at least with the quieter seas experienced during the summer months. But whether there once were abundant seasonal sites for marine exploitation on this submerged shelf may never be known. Conspicuous size reduction of *Patella vulgata* ca. 15,000-11,000 B.P. may reflect declining plankton biomass concentrations as Atlantic surface waters warmed up, changes in coastline facies from shingle beaches and estuarine belts to rocky cliffs, increased molluscan "harvesting" (Anderson 1981; Clark 1983), or ecological competition from top shells and blue mussels as surface water salinities increased (Bruhns 1983). Plankton biomass today increases markedly with latitude along the European Atlantic coasts (Coull 1972) and the largest *Patella vulgata* on the Cantabrian coast are found in polluted estuaries (L. G. Straus, personal communication 1984), perhaps because they are not exploited, but these also happen to be very nutrient rich. Systematic oxygen isotopic data on the limpets through time may help in understanding size reduction in relation to temperature change.

Full-glacial, surface-water temperatures have been reconstructed in some detail for the North Atlantic, as based primarily on foraminiferal assemblages from deep-sea cores (McIntyre *et al.* 1976): the 18,000 B.P. paleotemperatures for Cantabrian offshore waters are 1.5°C for February, 3.5°C for May, 9.5°C for August, and 7.0°C for October-November. Today the annual air temperature range of Santander is 10.8°C (British Meteorological Office 1958), compared with 7°C for the offshore waters of the Bay of Biscay.

A reasonable, if rough reconstruction of the full-glacial temperature cycle is reconstructed in Figure 4.3 and can be contrasted with modern, mean monthly

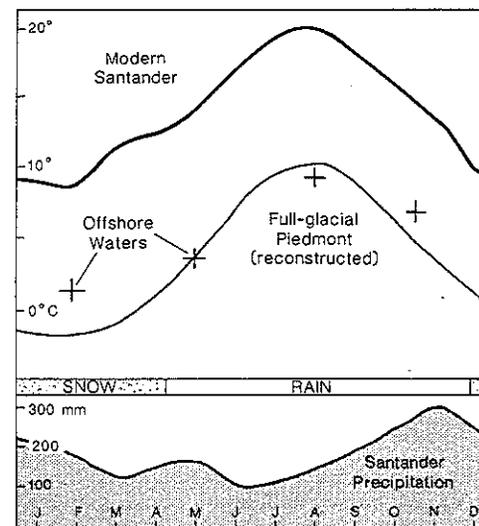


Figure 4.3 The modern annual temperature cycle for Santander, compared with reconstructed full-glacial temperatures. To accommodate the 4°C difference in annual range of air and water temperatures today, February air temperatures for the coast were set 2°C lower than those of the late Pleistocene offshore waters derived from the deep-sea core data, the August counterpart 2°C higher; further, to compensate for the lag of ocean temperatures in the spring and autumn, air temperatures in May should be 1°C higher, in October–November 1°C lower. Finally the median Paleolithic site elevation in the Cantabrian Piedmont is near 100 m today, or 200 m during the glacial-eustatic regression ca. 20,000 B.P.; using a lapse rate of 0.55°C per 100 m, this requires lowering all temperatures by 1.1°C. Modern precipitation is almost exclusively in liquid form, but ca. 20,000 B.P. was probably solid between early December and mid-April.

temperatures for Santander. The February mean of -1.6°C and August mean of 10.4°C indicate a mean annual late Pleistocene temperature of 4.4°C, compared with 14.3°C today. The closest modern thermal analog is Akureyri on the treeless north coast of Iceland at lat. 66° N (January mean -1.1°C, July 11.1°C; British Meteorological Office 1958). This 10°C temperature depression is representative of the Cantabrian coast, but for the Pontevedra coastline, offshore water paleotemperatures (McIntyre *et al.* 1976) would, by similar argumentation, give midwinter and midsummer temperatures of 0.9° and 13.4°C (compared with 9.4° and 19.6°C today (U.S. Hydrographic Office 1963), a depression of only 7.3°C. A thermal analog for Pontevedra is Kristiansund on the Norwegian coast at lat. 63° N (1.4° and 13.3°C). The fact that RCS elevations along the Portuguese border were lower than in Santander implies a higher ratio of solid to liquid precipitation in the far west.

These reconstructions are compatible with (1) the absence of permafrost indicators in lowland Cantabria, although there was effective frost weathering of exposed rock; (2) the minimal development of frost-generated scree in Pontevedra; and (3) my explanation of limited tree growth in both areas as a consequence of a raw and stormy climate, with strong and almost continuous winds. Today, stations around the Norwegian Sea receive only solid precipitation in months averaging less than 2°C. By this approximation, snow would have been the rule in lowland Cantabria from early December to late April, a span of over 4½ months (Figure 4.3). If precipitation amounts and monthly distribution remained the same during late Pleistocene time, this would imply that 44% of the annual 1120 mm were in solid form, that is, about 4.5–5 m snow (converting water to snow at 1:10). Distributed relatively evenly over 18 weeks, and with temperatures oscillating around the freezing point, this argues for a moderately thick snow cover that would only occasionally pose a problem for grazing animals or hunting forays. Under this same proviso, the heaviest precipitation, in November, would have come as rainstorms rather than snow, helping to explain the vigorous slope denudation by running water. Finally, summer radiation would always have been much stronger than at lat. 63–66° N, with 8½ hours of daylight at the time of the winter solstice. This means higher photosynthetic rates during the growing season than around the Norwegian Sea, as well as reasonable time spans for diurnal feeding by herbivores or for the scheduling of hunting rounds, even during midwinter.

In sum, full-glacial climate in lowland Cantabria was decidedly unpleasant, but for both people and animals it did not require the survival skills essential during wintertime in very cold, continental climates. Relatively high insolation, sufficient winter daylight, and moderate snow cover favored vegetative productivity and stable maintenance of a high animal biomass. Seasonal migrations of gregarious herbivores were unnecessary, apart from being constrained by the linear orientation of terrain belts parallel to the coast. From a hunter's perspective this was a very good, not a marginal, environment with reasonably dependable and concentrated resources.

THE TEMPORAL MATRIX OF ENVIRONMENTAL CHANGE

This reconstruction of the full-glacial environment of Cantabria from the perspective of the Paleolithic occupants is essentially static, by focusing on the more important and tangible variables of the regional ecosystem for the most extreme upper Pleistocene cold ca. 20,000 B.P. It provides the framework essential to explore economic models for prehistoric spatial behavior, but it does not elucidate the amplitude and wavelength of environmental change that contribute to understanding intermediate-scale shifts in subsistence behavior or more

fundamental transformations of the cultural systems themselves. It is therefore pertinent now to examine the temporal axis. The longest and most complete records are provided by cave sediment sequences and pollen profiles. In comparison, the external, "open-air" climatostratigraphies are either very coarse or fragmentary and difficult to draw into a coherent pattern.

Cave Sediment Microstratigraphy

The caverns of central Cantabria are generally developed in limestone and include a range of autochthonous cave sediments such as roof spall and grit due to mechanical weathering and dripstones or flowstones due to chemical precipitation (Butzer 1981). There also is a variety of allochthonous sediments washed in from adjacent slopes by colluvial transfer, including suspended silts and clays, quartz sands, and exotic pebbles moved by traction, loess derivatives, and clays related to small-scale mass movements. These sediment types and their interpretation are critical to detailed reconstruction of the regional geomorphic environment and require explication.

Limestone spall and grit are due to mechanical weathering and gradual disintegration of the cave roof and walls. Interpretation largely remains a relative matter, with such debris almost totally absent in Holocene cave strata of the region and no limestone rubbles now forming below bedrock exposures. For this reason, spall and grit in Western European caves are traditionally attributed to frost shattering or frost-related disintegration under colder, Pleistocene conditions, although the process itself remains poorly understood (Farrand 1975). Experimental work has served to identify particularly frost-susceptible lithologies (such as the local chalky limestones) as well as the grain size of the resulting debris, but too many variables (seasonal and total available rock moisture, amplitude and frequency of freeze-thaw cycles) are involved to reconstruct presently a frost regime from debris size and lithology (Latridou and Ozouf 1982; McGreevy 1981). Laville (1975) has devised an elaborate taxonomy of frost spalls based on shape, angularity, and size, but this procedure can only be systematically applied in "dry" caves; in the Cantabrian caverns many horizons of spall were postdepositionally corroded or even largely decomposed, while others are cemented in place. Frost spall and grit can therefore be used to infer "cold" conditions only through semiquantitative assessment of abundance, caliber, and angularity.

Flowstones, mainly banded travertines, are common in the Cantabrian caves, but stalactites, stalagmites, or cave "pearls" less so. Many flowstones, including some interdigitated with hillwash, consist of vertically crystallized laminae of almost pure calcite, with a little silt and clay; these argue for a degree of primary surface accumulation, in contrast to pedogenetic accretion of laminated, postdepositional caliche. Clean calcite accumulation is the antithesis to mechanical

weathering, hillwash accumulation, or erosion and therefore implies a stable soil mantle outside of the cave, supersaturation of water with calcium bicarbonate, and periods of strong evaporation. Such conditions are best met with a dense ground cover, low-intensity rains, and relatively dry and warm summers. Since carbonates were not precipitated during late Holocene time, despite abundant water and vegetation, periodic drought appears to be essential for greater evaporation. Pleistocene flowstones and caliche consequently argue for relatively dry and at least reasonably warm summers, with a closed ground cover. Caliche may however be substantially younger than the beds it cements (Butzer 1981), requiring circumspect field evaluation.

The externally derived sediments are the most difficult to interpret but among the most informative. In each of the key Cantabrian cave sediments, the noncalcareous fraction is almost exclusively derived from residual soils above or around the cave. Consequently, decalcified cave sediments provide a temporal record of changing external ground cover and slope runoff energy, modulated by the mechanics of moving sediment diagonally across the irregular rock outcrops on either side of a cave entrance or directly down the cliff face above the mouth. Two interrelated processes are involved, namely (1) erosion and transport on the external slopes and (2) runoff between the drip line and the cave interior.

140 samples from 6 Cantabrian caves and their environs were grouped into 8 major classes that were then verified as consistent and "real" by an SPSS discriminant-function program (Butzer 1981:149-151). These classes can be summarized in qualitative terms as follows:

1. Coarse, sandy to gravelly sediments, with polymodal sorting, reflecting fluctuating runoff velocities during periods of unusually intensive rains and hydrodynamic energy, at a time when surface soils were stripped of all but their basal horizons.
2. Coarse, sandy and polymodal sediments, with repeated lenticular bedding, reflecting fluctuating runoff velocities, high overall energy, and intensive rains but less than for Class 1.
3. Silt and sand, with moderate sorting, reflecting moderately vigorous slope runoff and repeated, small-scale bursts of cave runoff. The silt content reflects soil and loess eroded outside, during periods of heavy rains.
4. Sorted silts, reflecting vigorous runoff over loessic surficial sediments outside. Since sorting tends to improve upward, penecontemporaneous loess accretion in the area is suggested. Characteristic eolian sand grains are not present and the loess was probably derived from long-distance transport of dust deflated from active, but intermittently dry, alluvial surfaces.
5. Silt and clay, with polymodal sorting, due to erosion of external B horizons and transport of suspended sediment within the cave; exterior runoff was effective, but relatively subdued.
6. Clay and silt, with polymodal sorting, due mainly to low-energy mobilization within the cave and moderately effective runoff outside.

7. Clay derived from B horizons, commonly linked to viscous transfer of water-saturated clayey soil.

These classes of "colluvial" sediment serve to define the external geomorphic environment in terms of "stable" versus "unstable" slopes.

A final environmental criterion is provided by alteration or mixing of both the internal and external sediments that accumulated within a cave. The changes include (1) oxidation mottling (in relation to a higher but fluctuating watertable, mainly perched), (2) partial decalcification or corrosion (due to abundant water in a wet microenvironment), (3) cryoturbation or congelifluction (by frost-heaving or frost-induced plastic flow within the cave), and (4) human occupation and disturbance (Butzer 1982:79). The first three, "pedogenetic" changes carry direct implications for a wet or for a wet and cold cave microenvironment.

Microstratigraphic sequences have been constructed for six Cantabrian caves: Morín, El Pendo, El Castillo, La Flecha, Hornos de la Peña, and Cobalejos (Butzer 1981). None of these paleoenvironmental traces is complete but there is considerable overlap for each distinctive, partial microstratigraphic "set" to allow correlation and, consequently, construction of a composite master curve. To obtain a temporal yardstick, each unit in each cave sequence was adjusted on the basis of median grade, proportions of roof spall, proximity to cave entrance, and prominence of cultural components by a numerical "scoring" formula to derive "adjusted relative thicknesses" for 44 microstratigraphic units. These were then approximately calibrated by means of the available ¹⁴C dates (Burleigh *et al.* 1982a, 1982b; Butzer 1981; Clark and Straus 1983; Clark and Yi 1983). Inclusion of the sedimentary sequence at La Riera (Straus and Clark 1978) was facilitated by comparable processing techniques (R. Slatt, personal communication, 1984). Because of protracted and repeated occupation, La Riera provides unusual detail that requires subdivision and redefinition of Unit 36 of Butzer (1981; see also Laville 1980). It should be noted that such very fine sedimentological resolution, of four or more facies and lenses per millennium, is also prone to introduce cultural or site-specific "noise." The Solutrean levels of Las Caldas, studied by Hoyos Gómez (1981) using the Laville methodology, spans the Units upper 36a-38 in great detail and parallels La Riera reasonably well. The resulting composite microstratigraphy presented in Figures 4.4 and 4.5 spans the entire Mousterian and Upper Paleolithic occupation of central Cantabria in terms of salient variables of the regional geomorphic environment. Units 1-5 antedate the earliest, verifiable Mousterian levels and are not included in Figure 4.4: Unit 1 was cold and unstable, 2 was warm and stable, 3 was warm, stable, and dry, 4 temperate and stable, while 5 was cool, unstable, and moist. Units 2, 3, and 4 are therefore best attributed to the full interglacial conditions of deep-sea isotope Stage 5e (see Shackleton and Opdyke 1973, 1976).

The sedimentological inferences brought to bear in the construction of Figures 4.4 and 4.5 are based on three variables—cold, moisture, and slope processes—derived independently from different criteria. They do not covary in a predictable

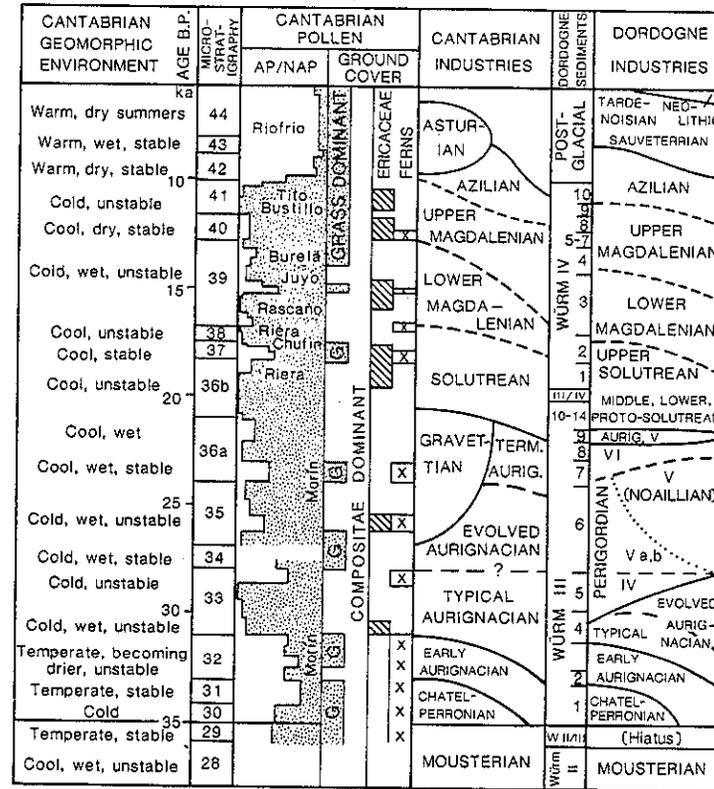
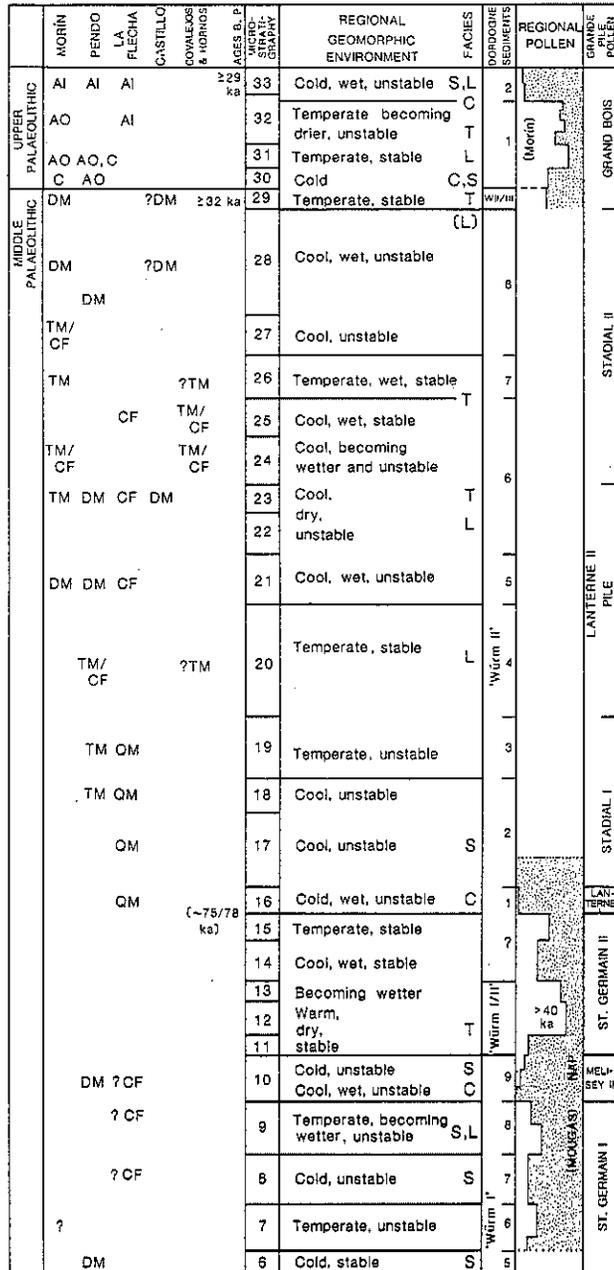


Figure 4.5 The Cantabrian Upper Paleolithic and regional microstratigraphy (see text) compared with the Dordogne model (Laville et al. 1980).

fashion, which is reasonable in light of the complexity of environmental systems. This is in contrast with Laville's (1975) interpretation, based on two variables and essentially a single criterion—the size/quantity and condition of the coarsest debris, which posits a close correspondence between lower temperatures and reduced moisture. That such a covariance is misleading can be further seen from the complexity of the pollen record.

Figure 4.4 The Cantabrian Mousterian and regional microstratigraphy (see text). Geomorphologic inferences and pollen data are compared with the Dordogne (Laville et al. 1980) and Grande Pile (Woillard 1978). Assuming that the Unit 28–29 boundary dates ca. 35,000 B.P., adjusted extrapolation of sedimentation rates places the Unit 15–16 boundary a little beyond 75,000 B.P. Key: TM, Typical Mousterian, sidescraper rich; CF, Typical Mousterian with cleaver flakes; TM/CF, sidescraper rich Typical Mousterian, with cleaver flakes; QM, Quina Charentian; DM, Denticulate Mousterian; CH, Chatelperronian; AO, Early Aurignacian; S, frost spall; L, loess; C, cryoturbation or congelifluction; T, travertine.

Pollen Microstratigraphy

A series of pollen profiles from several key caves span the period ca. 36,000–10,000 B.P. These are from Cueva Morín (Leroi-Gourhan 1971), which covers the stratigraphic Units 29–36a of Figure 4.5 with a fairly wide mesh; the pollen counts are relatively low near the base and there is gap in Unit 34 (at the base of Horizon V). The grain of resolution is much finer in the subsequent units. La Riera (Straus *et al.* 1981) covers Units 36b–38, but since "interstadial" tree recovery near the coast was very slow, Chufín (Boyer-Klein 1980) was selected to represent Unit 37. The profiles of Rascaño (Boyer-Klein 1980) and El Juyo (Boyer-Klein 1982) span most of Unit 39; a gap near the top is probably represented by undated spectra from El Pendo (Leroi-Gourhan 1980b), but the radiometrically fixed external spectrum from Burela (Delibrias *et al.* 1964) seems preferable. Units 40 and 41 are covered by Tito Bustillo (Boyer-Klein 1976), although pollen counts in upper 41 are low. The sharp transition of 41–43 is reflected in El Pendo but is undated, so that the external bog sequence from Riofrio (Florschütz and Menéndez Amor 1965) was used to cover the early and middle Holocene; significantly, this exhibits little gross change through time.

Arboreal versus nonarboreal pollen is plotted in Figure 4.5 as a crude index of regional forest development. The critical ground cover is synthesized separately, by showing those time spans with Gramineae outranking Compositae; periods with grasses dominant probably had a more complete vegetation mat. Prominent Ericaceae zones are also shown. To reduce local edaphic bias, the average Ericaceae count was calculated for each site sequence and above-average horizons were then singled out if greater than 10%; the same procedure was applied to fern spores but only if they were greater than 20% of the total pollen count.

The patterns of Figure 4.5 are no less complex than those of the geomorphic environment. This temporal development of the vegetation cover can now be briefly outlined for the coastal plain, piedmont, and low mountain terrain of Cantabria.

Units 29–32 (ca. 36,000–31,000 B.P.) suggest a mix of open woodland and parkland, except possibly for an open coastal plain. Grass cover was dominant, with good representation of ferns but little development of heath. Unit 33 (ca. 31,000–28,000 B.P.) was marked by a treeless vegetation, with Compositae dominating the incomplete vegetation mat; this phase initially saw temporary heath expansion, suggesting a spell of wet conditions. From the end of Unit 33 through 34, parkland and grass cover returned for about 1500 years, after which conditions fluctuated, in one instance Ericaceae expanding during one episode of partial woodland recovery, in another case grasses briefly assuming dominance. Most of Unit 36b (ca. 21,000–19,000 B.P.) resembled 33, with late expansion of Ericaceae heralding the warm-up and woodland expansion of Unit 37, apparently a wet period also notable for its fern development. Units 38–41 (ca. 16,600–10,200 B.P.) saw several relatively brief periods of quite open vegetation, interrupted by some woodland recovery; Ericaceae or fern peaks suggest the latter intervals were

a little moister. But after 14,000 B.P. the climate was less severe, allowing grasses to dominate the landscape, and Unit 40 and all but the beginning of 41 saw heath expansion, suggesting relatively moist conditions; presumably grazing conditions were optimal, at least on nonacid substrates less prone to heath expansion.

Forest recovery was rapid ca. 10,000 B.P., except for the immediate coast. Early Holocene sediments above the windswept coast at Liencres have 58–83% NAP (Clark and Menéndez Amor 1983), and submerged peats from Tina Mayor and La Jerra indicate forest recolonization as late as 5500 B.P. (Delibrias *et al.* 1982; Mary *et al.* 1975; Figure 4.2). In general, Holocene vegetation trends are difficult to interpret with the available data. Open pine and birch woodland was established at Le Moura after 11,200 B.P., and an oak forest was already in place by 10,000 B.P., with significant expansion of other deciduous trees delayed until 6,000 B.P. Oak and birch dominated the early Holocene at Riofrio, but pine increased rapidly after 8500 B.P. (Florschütz and Menéndez Amor 1965). In the Montes de Buyo, oak was initially dominant but birch increased strongly ca. 8000 B.P. (Menéndez Amor and Florschütz 1961). Overall, there appear to be subtle ecological shifts ca. 8500–8000 and again 6000–5500 B.P.

A unique profile of probably early upper Pleistocene age comes from Mougás (Pontevedra). Dating of the section (Butzer 1967; Franz 1967; Nonn 1966:289) is best undertaken in the context of other local sequences at Sanjián and La Guardia (Figure 2.1; Butzer 1967). There are three organic horizons. One dates ca. 12,000–7000 B.P. and overlies coarse alluvial fans, that in turn rest on a paleosol and a second, organic alluvium, dating ca. 29,000–18,000 B.P. The entire Mougás pollen profile is found in the third and lowest organic colluvium, under more coarse alluvium and resting on estuarine sands; it is substantially older than 40,000 B.P., predating the earliest glacial-age alluvium and postdating an interglacial beach. The profile begins with two peaks of *Pinus cf. montana* (18–34%), followed by a spectrum with 97% NAP; subsequently a peak of alder (72%) and pine (8%) is followed by another increase of NAP (62%) and then another peak of *Pinus cf. montana* (43%) and alder (13%); toward the top NAP ranges from 98 to 100% (Nonn 1966:287, Table 17). Assigning the entire Mougás profile to an early Upper Pleistocene regressive phase is supported by two other sequences.

At Budiño (Pontevedra) an organic colluvium with dates of 26,700 and 18,000 B.P. (Aguirre and Butzer 1967; Butzer 1967) is associated with hearths, workshop debitage, and archaic artifacts (Aguirre 1964; Echaide 1971), in part reworked from underlying, secondary Acheulian levels (Vidal 1981). This mid-upper Pleistocene organic unit is dominated by subtropical *Pinus cf. pinea* (Table 4.2; Nonn 1966:219, 221) and differs substantially from the Mougás profile, and an "interstadial" prior to the full glacial is suggested. At La Franca (Asturias), a cone of slope rubble rests on two distinct beaches at +5.5–6 m and was followed by peat accumulation with two dates of "greater than 35,000" B.P.; 8 pollen spectra have 80–90% tree pollen, dominated by birch and alder (Mary *et al.* 1975). If the two beaches are assigned to the relatively high sea levels of 125,000 and 115,000 B.P. (Butzer 1983), the La Franca pollen profile can be ascribed to deep-sea isotope Stage 5a. The

more complex Mougás profile probably spans isotope Stages 5c–5b–5a, and the patterns of vegetation development are closely comparable with those of the standard west European upper Pleistocene pollen profile of Grande Pile (France; Woillard 1978; Woillard and Mook 1982). The two pine peaks of Mougás are paralleled in the Grande Pile profile by the St. Germain I zone, the first NAP dominance suggests Melisey II, and the alder and the pine peaks parallel the successive birch and pine peaks of St. Germain II, prior to onset of open vegetation at both sites (Figure 4.4).

The Mougás and La Franca profiles are of critical importance for northern Spain because they appear to show that the later phases of isotope Stage 5 were already cool to cold, with no more than open, boreal-type woodlands, paralleling the pollen record from Padul in southern Spain (Florschütz *et al.* 1971). They imply that the long span of deep-sea isotope Stages 4 and 3 coincided with similar oscillations between a treeless and a very open woodland vegetation in the Cantabrian region as did the time span from 35,000–10,000 B.P. By extension, these profiles suggest a basic environmental definition for the period of Mousterian occupation of Cantabria and allow for a broader interpretation of the sedimentary inferences of Figure 4.4.

Climatostratigraphic Interpretation

The cave sediments and pollen, in conjunction, define a coherent environmental trace (Figure 4.5) that encompasses proxy indicators for cold, moisture, slope stability, forest development, and ground cover type. A major interstadial complex, interrupted by a brief cold spell, spans the Cantabrian microstratigraphic Units 29–32, ca. 36,000–31,000 B.P. Climate was cool-temperature, slopes stable and covered with grass swards and open woodland, with rainfall intensity subdued. The colder and mainly treeless Units 33–41, ca. 31,000–10,000 B.P., were interrupted by four minor interstadials, with stable, grassy slopes and partial woodland recovery ca. 28,000 B.P. (Unit 34), ca. 23,500 B.P. (base Unit 36a), ca. 18,000 B.P. (Unit 37), and ca. 15,000 B.P. (mid-Unit 39). There also was a milder interval with stable grassy slopes but no tangible woodland recovery ca. 12,000 B.P. (Unit 40). The remaining intervals of Units 33–39 were cool to cold, virtually treeless, and characterized by unstable slopes, incomplete ground cover, and intensive rains. Unit 41, ca. 11,000 B.P., was anomalous in that ground cover was good but slopes were unstable because of intensive rains.

This part of the Cantabrian sequence can be compared with the "standard" paleoclimatic trace derived from the Dordogne cave sediments by Laville (1975; Laville *et al.* 1980); it spans his "Würm" III and IV stades. The only apparent contradiction is for Laville's "Würm III/IV Interstadial," which falls in the middle of Unit 36b, presumably due to the coarse and sometimes contradictory ¹⁴C chronology in the Dordogne. Further, Laville's criteria measure different variables and cannot be expected to produce identical results; it seems that his methods may underestimate the significance and duration of the "interstadial" episodes. The Cantabrian units, as presently defined, may be a little too coarse to encompass

the full range of fluctuations, while the Dordogne units after about 25,000 B.P. are a little too fine for use beyond the local cave contexts of that area, at least not without exceptionally, perhaps unrealistically fine, radiocarbon controls. The "interstadial" complex of ca. 36,000–31,000 B.P. presumably represents the Arcy-Kesselt, as it is labeled in France (Leroi-Gourhan and Renault-Miskovsky 1977), but attaching names to the still only semicoherent suite of subsequent minor "interstadials" seems to serve no good purpose at the moment.

For the earlier stratigraphic column (see Figure 4.4), the sedimentological criteria single out two zones, namely Units 2–15, characterized by two prominent warm phases and frequent changes of considerable amplitude, and Units 16–28, notable for generally cool climate and unstable slopes, with relatively subdued oscillations. Units 7–17 are tentatively correlated with the Mougás pollen profile and Woillard's (1978) Grand Pile stratigraphy as shown in Figure 4.4. Units 2–15 can be assigned to isotope Stage 5 with a reasonable degree of confidence (Butzer 1981), and Units 2–3, described earlier, probably equate with Laville's (1975; Laville *et al.* 1980) "Riss/Würm Interglacial," Units 11–13 with his "Würm I/II Interstadial." Laville's "Würm" I and II subunits are tentatively correlated in Figure 4.4 on the basis of comparable trends. Two "interstadials" are apparent in this part of the Cantabrian record, namely Units 20 and 26, both of which probably compared with the 36,000–31,000 B.P. "interstadial" in terms of environmental parameters. Units 16–18 appear to represent isotope Stage 4, and Units 19–32 isotope Stage 3.

All in all, Figures 4.4 and 4.5 provide a first, synthetic yardstick for environmental change through time in Cantabria. The archaeological record can now be integrated with this climatostratigraphy as a basis for discussion of possible interrelationships.

INTERPRETING THE MOUSTERIAN FACIES

Temporal definition for the Cantabrian archaeological sequence is given in Figures 4.4 and 4.5. The Mousterian facies, as specifically tied to the microstratigraphy of Figure 4.4 (Butzer 1981), are documented or identified for the following sites (shown by triangles in Figure 4.2): Morín (Freeman 1971, 1973a), El Pendo (Freeman 1980), Castillo (Cabrera 1978), La Flecha (Freeman and Echegaray 1968), Hornos de la Peña (Freeman 1973a), and Cobalejos (L. G. Freeman, personal communication, 1969; Straus 1983c). The dated Upper Paleolithic industries of Cantabria are presented in Figure 4.5, as based on Harrold (1981, 1983), Straus (1983b), Klein *et al.* (1981), Clark and Straus (1983), Clark (1983), Straus (1983a), Echegaray and Barandiarán Maestu (1981), and Echegaray and Freeman (1978). There are, however, few good, dated sequences spanning the early Upper Paleolithic. The parallel, industrial sequence of the Dordogne (Laville *et al.* 1980; Rigaud 1982) is shown for comparison. Questions concerning the significance and validity of such "industrial stratigraphies" are raised and discussed below.

The lithic typology of the Mousterian, as defined by Bordes (1961, 1973, 1978), includes 63 formal tool types that appear to reflect technology, function, and style.

The "facies" consist of repetitive constellations that have a characteristic mix and emphasis, defined by the percentage of certain dominant classes and the presence or absence of certain key types. For example, small, subtriangular or cordiform handaxes are typical of the Mousterian of Acheulian tradition (MAT A), a facies not represented in the Cantabrian caves but possibly associated with open-air sites (Freeman 1973a, 1980). The Levallois technique, involving preparation of cores to predetermine the size of the detached flakes, varies greatly in importance; it was used to make Mousterian points that, with several special (bifacially or unifacially retouched) forms, are prominent in both the MAT A and the Typical Mousterian. Levallois preparation was important in the Ferrassie variant of the Charentian facies, unimportant in the Quina variant. Sidescrapers, probably hand held and generally made on broad flakes (as distinct from narrow blades), include a range of types with one or both edges retouched, presumably to use for scraping or cutting; their frequency is considered particularly diagnostic, averaging 50-80% of the Charentian tool inventories, 25-55% of the Typical Mousterian, and 20-40% of the MAT A. Denticulates, with a rough serrate edge on one side of a flake, dominate the Denticulate Mousterian (35-55%), but notched flakes are also important. Large, thin flakes with unifacial or bifacial retouch along one edge are known as cleaver flakes; these are almost unique to Cantabria and the Basque country and especially important in the local Typical Mousterian (Freeman 1980). Finally, backed knives (i.e., flakes with one sharp edge and the other deliberately dulled) are rare or absent in the Denticulate and Charentian facies.

Even when seen in the context of habitation sites and burials, these stone tools provide a remarkably slim and selective index of Mousterian cultural activities and capacities. Specific microwear polishes can indeed be linked experimentally to categories of tool application (Anderson 1980; Keeley 1980), but the task of identifying use wear for a significant sample of each representative tool type in a Paleolithic assemblage poses problems an order of magnitude greater and has yet to be addressed in a concrete case, such as a Mousterian facies. Without systematic edge-wear studies, the functional interpretation of lithic artifacts remains difficult. Except for the points, which may or may not have been affixed to javelins or spears, these tools intuitively suggest items preferentially suited to cutting, scraping, sawing, engraving, perforating, planing, stropping, or cleaving, in other words, processing tasks involving meat, bone, or wood. Many of them were probably multipurpose, while a substantial percentage are difficult to "type" and suggest a low measure of specialization (R. G. Klein, personal communication, 1984). This raises questions as to just how sensitive particular Mousterian tool assemblages may be as single or multiple tool kits. Functional interpretation of the Mousterian facies is further weakened by the dependence on "indicator" types and by arbitrary statistical divisions along a continuum.

The interpretative dilemma of just what the four major and six minor Mousterian facies mean becomes particularly difficult in this light. The functional hypothesis sees the facies in terms of proportions of specific artifact types believed to have different functional significance (Binford 1973). The alternative viewpoint

recognizes functional differences but also emphasizes stylistic and technological distinctions and admits a measure of temporal change (Bordes 1973, 1978; Mellars 1970, 1973). At this rudimentary level, evidence can be marshaled to support both perspectives to varying degrees. Greater difficulty arises when the second hypothesis is elaborated to argue specific sets of lifeways with different subsistence-settlement patterns, reflecting distinct cultural groupings (e.g., tribes). When applied to several facies juxtaposed in different caves and levels of the Dordogne, and to similar facies encountered through much of Western Europe, the Near East, and North Africa, the ethnic or tribal hypothesis becomes decidedly problematic.

The facies of Cantabrian Spain are Denticulate Mousterian, Quina Charentian, and Typical Mousterian, the last with three variants characterized by unusually high proportions of sidescrapers, the presence of cleaver flakes, or both (Freeman 1973a, 1980). Figure 4.4 serves to highlight several points about these facies in Cantabria:

1. As many as two or three facies may be present in the area during any one microstratigraphic unit, indicating penecontemporaneous occupations reflected by different facies. At La Flecha, Denticulate Mousterian was essentially contemporary with Typical Mousterian in El Castillo, less than 200 m away, suggesting a difference in site function between a minor occupation in a small cave and major occupation in a large one. This intimate spatial interdigitation is difficult to reconcile with culturally distinct groups.

2. The Cantabrian facies each span cold, cool or temperate horizons, wetter and drier episodes, and stable or unstable slope conditions, the degree of catholicity increasing with sample number. There is no demonstrable correlation with environmental trend, arguing that the facies as presently defined cannot be explained as adaptive responses.

3. The Cantabrian Denticulate spans microstratigraphic Units 6-29, representing up to 75,000 years. The different varieties of Typical Mousterian span Units 8-27, perhaps 65,000 years of equally diverse environmental conditions, with no directional trend in terms of either sidescraper or cleaver flake proportions. This represents a remarkable degree of typological and technological stasis, incompatible with more recent cultural systems. On the other hand, the Quina Charentian is limited to Units 16-19, midway in the column, possibly indicating a temporal component (such as the sequence of Ferrassie and Quina Charentian in the Dordogne), also expressed in stylistic terms.

Demonstration of these patterns in Cantabria (Butzer 1981) is important, confirming similar empirical observations in the Dordogne (Bordes 1973, 1978) and reinforcing several deductions. The facies are (1) inextricably interdigitated, spatially and temporally, across 65,000 years, (2) insensitive to environmental parameters, and (3) technologically and functionally "stable" across 75 millennia marked by major environmental changes and oscillations, although there may be some limited stylistic shifts. In confronting a similar problem at Tabun Cave,

Israel, Jelinek (1982) was indeed able to show that the width-thickness ratio of unbroken flakes and the variance of this ratio increased steadily from ca. 125,000-50,000 B.P., indicating a slow shift in flaking technology. But Jelinek's attempt to relate higher incidences of heavy-duty tools such as bifaces in the different facies of the Mugharan tradition (phased out by the Mousterian ca. 115,000-80,000 B.P., see Schwarcz *et al.* 1980) with periods of cooler climate are less convincing.

No historical cultural groups have been known to coexist so closely as the Cantabrian facies interdigitation would require without acculturation within a few centuries, so that the ethnic hypothesis cannot be seriously championed. At first sight, the functional interpretation also appears difficult to uphold. However, Freeman (1973a, 1980; Echegaray and Freeman 1978) has shown that the Cantabrian facies are not mutually exclusive, and that they overlap appreciably in terms of frequencies of different tools; each facies probably includes several tool kits appropriate to different tasks, hence the overlap between facies. It can also be argued that the Mousterian assemblages and tool kits were related more to processing, rather than procurement of food (Butzer 1981). Given a relatively basic interrelationship between people, animals, and plants and quantitative rather than qualitative changes in the type and abundance of resources, ecological shifts would not necessarily demand changes in processing equipment. This argument could potentially be verified or rejected by microwear study of a representative number of characteristic tool types from different levels in several sites.

The Cantabrian evidence, in conjunction with that of the Dordogne, emphasizes the minimal directional change of the Mousterian technocomplex and its facies over many tens of millennia. This can only be explained by a flexible lithic technology, shared by a single cultural system, that maintained an adaptive steady state (Butzer 1980) through a temporal trajectory of repeated environmental change. Since such a condition is inconceivable in modern human experience, it begs new questions.

Lithic technology may well have been one of the more conservative and less representative cultural manifestations of the Mousterian populations. Indeed, the archaeological record emphasizes material culture that provides imperfect and sometimes misleading proxy data for adaptive strategies. It can be argued that tool kits were far less important for human adaptation in a changeable environment than were intangible organizational devices. But this explanation is inadequate to account for the lack of directional change in Mousterian material culture over such phenomenal time spans. One must therefore posit that certain maintenance processes of the cultural system were qualitatively different from those of modern peoples, perhaps reflecting communicative, cognitive, or neural limitations to the behavioral repertoire. Furthermore, Neanderthals were far more robust than later, modern *Homo sapiens* people, suggesting a greater reliance on somatic rather than cultural means of adaptation (Trinkaus and Howells 1979).

The Cantabrian record does not document the full span of Mousterian settlement because caves were occupied only sporadically during the equivalent of oxygen

isotope Stage 5: the first Mousterian inventory is verified in microstratigraphic Unit 6, and earlier cultural traces in Units 1-5 are minimal and undiagnostic. Much of the same applies in the Provence, presumably because early glacial climates were less rigorous than in the Dordogne (de Lumley 1976). Incontrovertible Acheulian levels are not present in Cantabrian caves, if for no other reason than that late mid-Pleistocene erosion reduced older deposits to calcified palimpsests adhering to the walls or ceiling of sites such as El Castillo and Cobalejos (Butzer 1981).

In France, where Mousterian levels are found above Acheulian ones at several sites, definition and delimitation assume importance. The beginning of "Würm I" is set at the base of the Mousterian, and older assemblages tend to be labeled Acheulian (Laville 1975). However Tuffreau (1979) has shown that industries pertaining to (cold) oxygen isotope Stage 6 in northern France are difficult to classify because, apart from possible handaxes, the prominence of Levallois flaking and the bulk of the tool types make them indistinguishable from a generalized Mousterian. In fact there are three classes of industry, one with abundant and typical handaxes ("Upper Acheulian"), the second with rare handaxes ("Epi-Acheulian"), and the third without handaxes (sometimes labeled "Premousterian"). True Upper Acheulian is rare or absent after midisotope Stage 6 in open-air sites of France, Britain, and Germany (Bosinski 1976; Stringer *et al.* 1984; Wymer 1968, 1981), although it is occasionally found in cave strata as late as Stage 5d ("Würm I"; Bordes 1973; Laville 1975). On the other hand, MAT A is not known earlier than the base of Laville's "Würm I" (Laville *et al.* 1980), but Ferrassie-type Mousterian has been identified in late Stage 6 (de Lumley 1976). Evidently the Acheulian and Mousterian interfinger. This transition was completed between 115,000 and 100,000 B.P. in southwestern France (Blackwell *et al.* 1983).

THE MOUSTERIAN-UPPER PALEOLITHIC INTERFACE

In contrast to the Acheulian-Mousterian transition, the end of the Mousterian was abrupt. There are few preserved deposits attributed to Laville's "Würm II/III Interstadial," and the first Upper Paleolithic is in the "cold," basal beds of "Würm III" (Harrold 1981, 1983; Laville *et al.* 1980), with a date of 34,250 B.P. in Abri Pataud (Vogel and Waterbolk 1967). It is possible that a hiatus with little regional settlement separates the Mousterian and Upper Paleolithic in France, with the latter appearing in many sites shortly after 35,000 B.P. However, indisputable Upper Paleolithic is now firmly dated about 43,000 B.P. in Bulgaria (Kozłowski 1982; C. B. Stringer, personal communication, 1984), lending greater credence to dates of 35,200-44,300 B.P. for the Hungarian Upper Paleolithic (Howell 1984; Vogel and Waterbolk 1972). There is then a marked differential of 8000 years between the first appearance of the Upper Paleolithic in Southeastern and Western Europe.

The Cantabrian evidence adds interesting detail to this temporal gradient.

Denticulate Mousterian is documented later than in France, namely a significant occupation in Morín within the "temperate" stratum belonging to regional Unit 29, contemporary with Laville's "Würm II/III Interstadial"; Upper Paleolithic immediately follows in the "cold" Unit 30 (Figure 4.3). Morín therefore provides the youngest, stratigraphically secure Mousterian level anywhere, and there was no hiatus between Mousterian and Upper Paleolithic settlement in Cantabrian Spain. Without prejudging the nature of earliest Upper Paleolithic origins in Southeast and Central Europe, it appears that Aurignacian dispersal across southern France and northern Iberia took place within a few millennia.

Since no significant human fossils have been described from Cantabria, it must be presumed that the Unit 29-30 transition also coincided with replacement of Neanderthals by anatomically modern *Homo sapiens*, analogous to the situation in southwestern France. This interface has become complex with the discovery of a distinctive Neanderthal cranial fragment at St. Césaire, in association with the Upper Paleolithic Chatelperronian industry (Lévêque and Vandermeersch 1980, 1981). The Chatelperronian interdigitates with Early Aurignacian in Phases I and II of Laville's "Würm III" in central and southwestern France (Laville 1975; Laville *et al.* 1980), yet it is stylistically and technologically distinct from Mousterian or Early Aurignacian, despite certain affinities with both (Harrold 1981, 1983; Movius 1969). The Chatelperronian has bone points, awls, and polishers, as well as art objects, never found in the Mousterian; also novel, at least in Western Europe, are habitation structures made with mammoth bones and tusks; the distinctive, crescent-shaped Chatelperronian "points" (knives) are rare in Mousterian assemblages and virtually absent in Aurignacian ones; finally, endscrapers (on blades or flakes), graters or "burins," and retouched blades are far more abundant than in the Mousterian, whereas the Early Aurignacian has an important class of distinctive endscrapers and many more blades. In Cantabria this Chatelperronian industry was coeval with the Early Aurignacian in regional Units 30 and 31 at exactly the same time as in the Dordogne (Figures 4.4 and 4.5). The French dates are 33,860, 33,500, 33,300, and 31,900 B.P. (Vogel and Waterbolk 1963, 1972), reasonably consistent with a placement of ca. 34,000-32,000 B.P.

The Chatelperronian appears to be an autochthonous industry, displaying both Mousterian and Aurignacian influences, that coexisted with the Early Aurignacian for some two millennia before disappearing. Proposed links with the somewhat later Perigordian IV and Gravettian (Figure 4.5) are unconvincing because edge-wear patterns on the superficially similar Chatelperronian and Gravette points are different, arguing for different use patterns (Harrold 1981). Without implying that the Chatelperronian population was exclusively Neanderthal in biological terms, this industry suggests a short-lived alternative adaptation among more archaic resident groups that, ultimately, could not compete with the Aurignacian peoples. The Central and Southeast European evidence presently suggests that, in the French and Iberian context, the Aurignacian represents a cultural and biological immigration—without, however, precluding a measure of gene flow

with indigenous Neanderthals or some technological borrowing from the Mousterian.

UPPER PALEOLITHIC TECHNOCOMPLEXES

The early Upper Paleolithic is represented by two technocomplexes in Cantabria and southwestern France, the Aurignacian and Gravettian (or "Perigordian," an essentially equivalent term reflecting regional preferences and nuances). The differences between the two cover a range of tools that are distinctive in both style and function, for example split base, bone javelin points, steep-sided "carinate" scrapers, and peculiar "nosed" scrapers in the Aurignacian or distinctive knives, bladelets, burins, and tanged points in the Perigordian (Rigaud 1982). There also are substantial statistical differences among the categories of background tool types that were maintained through time. Considerable temporal overlap between the two "traditions" is apparent, particularly in the Cantabrian record (Figure 4.5), although the latter is based on an inadequate number of site sequences with poor radiocarbon control (Bernaldo de Quiros 1978; Echegaray and Freeman 1978). There has been no serious challenge to the Aurignacian and Gravettian/Perigordian as distinct technocomplexes, possibly indicating different cultural systems, although the basic subsistence pursuits appear to have been very similar.

The temporal shifts within each of these technocomplexes are mainly a matter of appearance or disappearance of indicator tools of both functional significance and stylistic flavor. These shifts generally involve a transitional mosaic that results in temporal overlaps of a few centuries to a millennium or two. Such intergrading suggests functional differences, possibly related to seasonality or specific activities, but the possibility of resistance to innovation by some groups cannot be excluded, and some shift in cultural self-definition is implicit from the style trends.

The appearance of the Solutrean marks a major change in French and Cantabrian Paleolithic lifeways. Many sites are occupied for the first time, or reoccupied after long breaks, suggesting a marked increase in group numbers. Unambiguous projectile points were made in stone, and the distinctive small blades (microliths) appear to have been hafted to hunting tools, probably stone-tipped or barbed arrows. This significant technological change and the coincident increase in population density shortly after 20,000 B.P. can also be observed in Asia and Africa (Deacon 1984; Klein 1975; Wendorf and Schild 1976). The key component in this Old World technological change appears to have been an effective bow and arrow.

The conventional view in France holds that the Solutrean and Magdalenian-Azilian (Rigaud 1976, 1982; Laville *et al.* 1980) represent two distinct technocomplexes within the later Upper Paleolithic. Most characteristic of the Solutrean are unifacial or bifacial points, either leaf shaped or shouldered, many of them fine examples of pressure flaking. The Magdalenian was noted for a wide range of tools made in bone, antler, or ivory, including harpoons (unilaterally or

biseriably barbed in the later stages); awls, eyed needles, and javelin tips are present in both the Solutrean and Magdalenian. The Solutrean tool kit commonly included high proportions of endscrapers and perforators, and at times many burins and backed elements, while the latest Magdalenian and Azilian exhibit increasing numbers of microlithic, backed bladelets and crescents ("Azilian points").

Research in Cantabria has instead shown that, apart from the indicator tools, these industries are more similar than they are different (Clark and Straus 1983; Straus 1983d). Some assemblages, when leaf points or bone harpoons are absent or disregarded, cannot be distinguished as Solutrean or Magdalenian. There is about as much spatial variability, related primarily to site function, as there is systematic temporal change. In effect, the Lower Magdalenian of Cantabria is a generalized Magdalenian without bone harpoons, while the Azilian is a Magdalenian with backed bladelets and crescents, also without bone harpoons. Temporal trends are not evident among Solutrean assemblages, but principal component analysis (Straus 1983a) suggests a typological gradient along the Cantabrian coast from Asturias to the Pyrenees, with a much sharper break between the coastal and mountain sites, related to site function and distinct hunting patterns; differences in point styles appear to define social boundaries (Straus 1983a), much in the same way as local styles in Solutrean-Magdalenian cave art (Straus 1982b) or Magdalenian engraved bone (Conkey 1980).

Without questioning either the essential continuity of the later Upper Paleolithic or the importance of functional variability, it is nonetheless possible to see the Solutrean as one cultural system with different adaptive variants and several discrete social groupings. The case for two or more adaptive modes within the Magdalenian-Azilian of Cantabria is reasonably good; whether these qualify as adaptive, let alone cultural, systems is at best ambiguous.

The Asturian of Cantabria deserves mention as a Holocene coastal industry with a distinct technology, emphasizing heavy-duty items and seafood exploitation. Although the Asturian may possibly be a seasonal or special-activity facies of the Azilian (Clark and Straus 1983; Straus 1983d), the points in common other than proximity are minimal and the temporal overlap is only partial, so that a distinct cultural system seems more plausible (Clark 1983).

Overviewing the temporal ensemble of the Cantabrian Upper Paleolithic, the contacts between the different industries or phases are sharp within any one cave (as a function of the nature of the sedimentation and excavation processes) but overlapping when different caves are compared against the climatostratigraphic and radiometric controls. Over the 25,000-year period involved, this lag averages as much as 1300 years for 10 such contacts (see Figure 4.5). Whatever the nature of the intrinsic differences, it is evident that stylistic, technological or adaptive shifts appeared earlier in some locales than others, whether in relation to activity contrasts or social boundaries. Such functional and social mosaics in space will, by implication, also have varied in time, arguing that change, whether adaptive or cognitive, was an intricate amalgam of innovation, diffusion, and social

displacement. One should not therefore expect abrupt replacements coinciding with "events" of the bioclimatic or social environment.

As it turns out, Figure 4.5 shows no suggestive coincidences between archaeological discontinuities (however defined or interpreted) and bioclimatic trends, oscillations, or switches. This would argue that material culture per se is a dependent variable in a very elaborate adaptive or cultural system that responds to short- or long-term crises though organizational flexibility or social modifications—phenomena more likely to be reflected in the spatial record of settlement location, size, and function. This does not diminish the value of artifactual analyses, but it vastly increases the demands on archaeological research if better resolution is to be obtained as to the spatial, economic, and demographic patterning of site complexes.

The mosaic of overlapping or concurrent technological, stylistic, or adaptive aggregates recorded for the Cantabrian Upper Paleolithic in Figure 4.5 is neither unique nor problematic in the later Pleistocene. It is of course shared by the Upper Paleolithic of southwestern France but is even more strikingly paralleled in the Late Paleolithic of the Nile Valley (Butzer 1982:273ff.). The long-term maintenance of social boundaries (of whatever scope) by means of a preeminently cognitive rationale is characteristic of historic cultural systems and evidently was a trait integral to Upper Paleolithic societies. But such boundary maintenance (whether territorial or not) was subordinate to turnover on the diachronic axis. Whatever proxy criteria are chosen—technology, styles, or indicator artifacts—the Upper Paleolithic was notable for its directional change. In real terms there was a progressive increase in niche width as well as in the variability of niche width (Clark and Yi 1983). That is, an increasingly complex repertoire of artifacts and strategies was being directed toward a greater and more efficient exploitation of more numerous resource types.

The Mousterian was spatially characterized by an intraregional and interregional variability defined almost exclusively by ratios of functional tool types, in contrast to the much more complex stylistic, functional, and technological variability of the Upper Paleolithic (Straus 1983b; White 1982). Certain large-scale geographic variants are evident for the Mousterian, for example, the MAT in France and the cleaver-flake facies in Cantabria, but nothing comparable to the regional distinctiveness of the Upper Paleolithic, let alone the intraregional social boundaries that are now becoming tangible within it.

On the temporal axis, the Mousterian maintained a homeostatic steady state over 75,000 years, whereas the Upper Paleolithic suggests a dynamic equilibrium, with progressive, directional change—recorded by 10 temporal components over 25 millennia as well as tangible changes in niche width. These two archaeological manifestations consequently represent adaptive complexes with dynamics that differed in both qualitative and quantitative terms. At least in Western Europe, the Mousterian to Upper Paleolithic interface marks the first appearance of modern cultural systems. Whether this transformation was uniquely linked to the first appearance or emergence of anatomically modern *Homo sapiens* remains to be

demonstrated in other areas of Europe, Asia, and Africa (on long-term, late Pleistocene biological and cultural clines in these areas see Bräuer 1984; Butzer 1977; Farrand 1979; Jelinek 1982; Rightmire 1984; Stringer *et al.* 1984).

SETTLEMENT AND SUBSISTENCE PATTERNING

This diachronic evaluation can now be complemented by examining the spatial coordinates of the Cantabrian archaeological record. The verified sites for different industries are shown in Figure 4.4, according to the following sources: Mousterian (Freeman 1964; Straus 1981, 1983b), Chatelperronian (Harrold 1981, 1983), Aurignacian-Gravettian (Bernaldo de Quiros 1978), Solutrean (Straus 1983a), and Magdalenian (Straus 1983b). Except for Unquera and Ciriego, Mousterian sites were reoccupied, usually many times, by Upper Paleolithic groups. Azilian and Asturian sites are not included. The known sites represent only a very small fraction of the original and include almost no open-air sites, but the state of Paleolithic research in central Cantabria is such that the available inventory is broadly representative. The essential absence of sites in the high mountains or south of the watershed is probably real: much of the uppermost Ebro drainage was systematically surveyed but yielded only a few traces of apparent Upper Paleolithic cave occupation around Oña (Clark 1979).

The verified site distribution indicates that settlement was concentrated on the coastal plain and hilly piedmont, with local extensions of 5–10 km into the larger river valleys of the low mountain country. The plain and piedmont sites are found in broken topography, mainly on the margin of karstic depressions, large or small. Some have a reasonable overview, but the lowest common denominator appears to be availability of shelter and water—in front or inside the back of a cave. The Mousterian palimpsest at Unquera—under 2 m of loessic, hillside colluvium on the margin of an estuarine flat—suggests existence of other, buried, floodplain sites. But none of the many fluvial exposures examined in the region revealed any artifacts, suggesting that reworked floodplain sites were either uncommon or not extensive. Sites in the mountain valleys are distinguished by their location along steep slopes 30–100 m above the floodplain margins, invariably in prime overview locations. These imply more specialized hunting strategies, in contrast to the apparently generalized, multipurpose location of sites along the piedmont or coastal plain.

It has been argued that the Solutrean and Magdalenian saw an expansion of settlement into the low mountain country (Straus 1983a), but 3 of the 9 Mousterian sites verified in central Cantabria already are within this belt, compared with 9 of 27 Upper Paleolithic sites, an equal proportion. The case is qualitatively supported by new clusters of Upper Paleolithic sites in steep hillsides of the Upper Miera and Asón drainage, as well as by montane sites in Asturias and the Basque country (Straus 1983b), although only a very few are located above 400 m elevation.

The expanded exploitation of the low mountain terrain, presumably from seasonal camps, suggests a gradual trend rather than a dramatic shift.

Partially excavated or minimally tested caves do not lend themselves to estimating group size, so that the impression of larger social aggregates for the late Upper Paleolithic must be inferred indirectly. Straus (1983b) estimates the artifact density per volume of sediment of the Mousterian as 25–60% that of the Magdalenian, and he notes that 32 Mousterian tool types are represented by an average of 9.7 specimens per type, compared with 40 and 12.4 for the Magdalenian. Solutrean and Magdalenian occupation levels at many sites are substantially thicker, often several meters, but this can also be explained by more frequent or more protracted occupation. Nonetheless, late Upper Paleolithic open-air sites in southwestern France are indeed substantially larger than Mousterian ones (White 1982, 1983).

Another semiquantitative approach to encapsulating population trends is to compare site numbers per unit of time. For Cantabria, including the Basque country and Asturias, these data are given in Table 4.4. The overall progression is probably valid and of the right order of magnitude, but the site sample is too small. A single survey expanded the number of Asturian sites from 28 to 77 (Gavelas 1980), and the reworked Mousterian palimpsests outside Upper Paleolithic caves have not been included. Late Upper Paleolithic occupations begin on bedrock in many caves, as a result of erosion before ca. 20,000 B.P., and in Rascaño a hiatus of 8000 years is evident below the Magdalenian horizons (Burleigh *et al.* 1982a). Older sediment removal by successive cave occupants is also indicated (Butzer 1981). Bearing these reservations in mind, it nevertheless appears probable that (1) Mousterian groups were very few and widely dispersed, (2) early Upper Paleolithic groups were more numerous but still dispersed, (3) late Upper Paleolithic settlement was relatively common, and (4) Asturian settlement was at least equally common along the coastal strip.

Two conclusions can be drawn from site distribution and number. Firstly, settlement was concentrated on the coastal plain and piedmont, but selective exploitation of larger valleys in the low mountain belt was expanded and probably intensified by late Upper Paleolithic groups. The high mountains and the peripheries of the Duero meseta remained unutilized or sporadically exploited. Secondly, an increase in the intensity of site use and in site numbers per unit time suggest long-term population growth, reflected in more or larger groups or both. This growth may have been substantial, but whether terminal Pleistocene settlement was comparable with the middle or upper ranges of population density for ethnographic hunter-gatherers is entirely a matter of conjecture.

Zooarchaeological faunas tend to reflect a combination of cultural preferences, hunting technology, and local animal availability. The overall pattern is illustrated by Table 4.3. Unfortunately, minimum numbers of individuals are not available for the Solutrean and Magdalenian levels at Las Caldas (Soto and Meléndez 1981), which have some ibex and much red deer, and for the Chatelperronian,

TABLE 4.4
Verified Numbers of Sites per Unit Time Representing Middle and Upper Paleolithic Industries in Cantabrian Spain*

| Industry | Number of sites | Unit of time (years) | Number of sites per millennium |
|-----------------|-----------------|----------------------|--------------------------------|
| Asturian | 77 | 3,000 | 25.7 |
| Azilian | 33 | 2,300 | 14.3 |
| Magdalenian | 62 | 6,500 | 9.5 |
| Solutrean | 35 | 4,000 | 8.8 |
| Chatelperronian | 20 | 14,000 | 1.4 |
| Aurignacian | | | |
| Gravettian | | | |
| Mousterian | 14 | 75,000 | 0.2 |

*Sources: Clark and Yi 1983; Gavelas 1980; Straus 1981, 1983a, 1983b.

Aurignacian, and Gravettian levels at El Pendo, which have 78% red deer and 14% horse bone (Fuentes 1980). Not shown in the table is reindeer, found primarily in the Basque sites; they are also present but very rare in Magdalenian levels further west (Straus 1983c; Straus *et al.* 1981), inferring temporary expansion of its range. With this exception, Table 4.3 provides no obvious argument for basic changes in regional faunas during the course of the late upper Pleistocene.

Table 4.3 documents a progressive increase in red deer and ibex, paralleled by a decrease of *Bos* or bison and horse. A major component in this change appears to be the increasing number of sites situated in the low mountain belt, such as Rascaño and several Basque locations. But ibex and chamois are "alpine" forms only in their preference for steep, rocky terrain, and they were as prominent on the irregular or cliffed topography of the coastal plain near La Riera as they were in submontane Basque sites. Local habitat characteristics were as important as regional terrain.

The age-mortality profile of red deer at El Juyo suggests mass kills (Klein *et al.* 1981), and the increase of red deer between early and late Upper Paleolithic aggregates may reflect acquisition of more effective hunting techniques (e.g., animal drives). However, Table 4.3 leaves no doubt that the nimble-footed alpine forms, ibex and chamois, as well as the ferocious wild boar, were within the hunting competence of both Mousterian and early Upper Paleolithic groups. Although more and larger faunal assemblages may ultimately demonstrate greater efficiency for the early Upper Paleolithic (Straus 1983b), there is as yet no convincing case to question the basic competence of Neanderthals as hunters. Whatever innovations were associated with Solutrean and Magdalenian hunting gear or organization, they represented no more than details in a procurement strategy already successfully developed by Mousterian populations in the region.

The Cantabrian mammalian faunas are not ideal for determining seasonality of site occupation (Klein and Cruz-Urbe n.d.; Klein *et al.* 1981), but initial oxygen

isotopes of Magdalenian Mollusca from La Riera indicate winter exploitation (Bailey *et al.* 1983), while study of the ibex teeth from sites such as Rascaño suggest primarily, but not exclusively, summer occupations (Altuna and Merino 1984). At present, however, for most sites it cannot be determined whether they were used on a seasonal or perennial basis. The only exception is that low mountain sites at 300–600 m elevation were likely to be snowbound during the winter months, favoring a summer, seasonal interpretation, as implied by the ibex data (Altuna and Merino 1984). This limits the hard data base for modeling spatial behavior.

The increase of niche width argued for the Upper Paleolithic (Clark and Yi 1983) is based less on patterns of ungulate hunting than on the increased emphasis given to shellfish foraging. Again the shift was gradual, with a few marine Mollusca found in some Mousterian levels, many more in the Solutrean and Magdalenian, and prominent shell middens associated with the Asturian. In addition to red deer, the Asturians exploited marine, estuarine, and riverine resources, and their grinding stones suggest greater use of plant foods (Clark 1983). Significantly, however, Asturian sites are limited to the coastal perimeter, where forest colonization was delayed until the sixth millennium B.P. It is not surprising that some of these sites include ibex and chamois. It may also not be coincidental that the Asturian disappeared at approximately the time that closed forest finally moved down to the coast and postglacial sea level began to stabilize close to its present level. In any event the Cantabrian region has only a handful of sites that are pre-Neolithic but post-Asturian, providing a strong case that the early to mid-Holocene forests of Cantabria were very sparsely settled.

MODELS FOR SPATIAL ORGANIZATION

The paleoenvironmental evidence presented earlier defined an essentially open environment of moderate to high productivity, with a high ungulate biomass subject to limited—environmental and demographic (predator-prey cycles, see Peterson *et al.* 1984)—stochasticity. At a larger scale, such a coupling of high resource density with predictability would favor geographically stable territorial systems (Butzer 1982:241; Dyson-Hudson and Smith 1978) for both animal herds and people.

The terrain of Cantabria is dominated by a linear coastal plain and hilly piedmont, oriented east-west, intersected at right angles by a succession of floodplains and estuarine zones that extend back into the low mountain belt via a set of subparallel, deep valley systems that trend north-south. The grain of the country consequently represents a rectangular grid, with linear resource concentrations along the coast and the major and minor rivers, accentuated by the piedmont-mountain ecotone. Such a well-defined and predictable resource pattern (Figure 4.6) can be most efficiently used, at the hunger-gatherer level, by a chain of nested, partly overlapping "group operational areas."

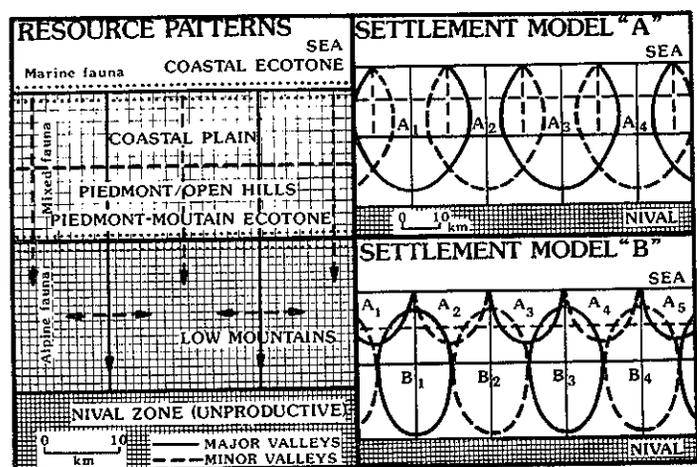


Figure 4.6 Resource patterning in Pleistocene Cantabria in relation to two alternative models for Paleolithic spatial organization (shown at half-scale). Note that the coastal plain was approximately 10 km wider during glacial regressions than it is today.

Two heuristic models can be suggested. For generalized foragers, exploiting some marine resources, the center of operations would be best located in the piedmont belt, near major rivers and the piedmont–mountain ecotone; sporadic or periodic exploitation both of the coast and of the mountain valleys would define an elliptical operational area. For any sector of the Cantabrian coast one would expect a set of more or less equally ranked operational units occupying Zones A_1, A_2, \dots, A_n in Model A of Figure 4.6.

For more diversified or specialized foragers the two ecological options of coast versus mountains would favor adaptive divergence, particularly if the number of competing groups increased. The coastal plain would favor mixed strategies and increasing dependence on r -selected resources such as seafoods, requiring high labor input but providing fairly predictable yields; greater energy expenditure would increase productivity within reduced operational areas. The resulting set of operational areas A_1, A_2, \dots, A_n might well be semicircular, fronting on the sea (Model B, Figure 4.6). More specialized hunting of large game (K -selected resources, providing higher but less predictable returns per unit search cost) would increase the yield of seasonal foraging in the low-mountain belt, so that an expanded, montane operational area would compensate for restricted access to the coastal plain, as shown by B_1, B_2, \dots, B_n in Model B (Figure 4.6). The second model would potentially allow a doubling of group number within the same area.

These models have explanatory value for the Cantabrian Paleolithic record:

1. Mousterian, Chatelperronian, Aurignacian, and Gravettian settlement was thin. At times there also was a mosaic of juxtaposed and distinct industries or technocomplexes. These features suggest nonoverlapping operational areas,

possibly shifting in terms of each year's definition. This would be compatible with a selective set, such as A_1, A_3, \dots, A_n (where n is an odd integer) in Model A.

2. Solutrean settlement was denser and the subsistence record indicates greater use of both marine and montane resources. This would be compatible with a standard version of Model A (i.e., overlapping operational areas).

3. The Magdalenian indicates a shift to both diversification and specialization, with effective integration of marine as well as montane resources into the regional economy as group numbers continued to increase. This transitional mode may have ultimately culminated in the adaptive divergence characteristic of Model B.

4. The Asturian and Azilian appear to represent two distinct systems, operating with limited overlap on the coastal plain and along the piedmont–mountain ecotone, respectively. Contingent on the hypothesis, this archetype of Model B would have been short lived because of concurrent environmental changes and possibly because it put excessive pressure on available resources. Forest recolonization of the operational areas B_1, B_2, \dots, B_n was rapid after 10,000 B.P., dramatically reducing grazing resources and, therefore, ungulate biomass (Butzer 1971:149; Hassan 1981:10). At the same time, the late and postglacial eustatic rise of sea level drowned out a 10-km belt of the coastal plain ca. 13,000–7000 B.P. (Clark and Lingle 1979), progressively truncating the operational areas A_1, A_2, \dots, A_n . This would have placed greater pressure on marine resources and increased competition between the Asturian and Azilian for terrestrial resources. In any event, the Model B solution seems not to have been stable, and it eventually "collapsed."

It appears that the Azilian was squeezed out by 8500 B.P., and the operational areas B_1, B_2, \dots, B_n abandoned. A modified Azilian way of life seems to have survived among small, widely dispersed groups with Tardenosian-like industries in the Cantabrian woodlands (Appellañiz 1975; García Guinea 1975); other Azilian population aggregates may have fused with Asturian groups. The ultimate disintegration of the Asturian by ca. 6000 B.P. may have been related to declining biomass in the increasingly forested coastal zone as well as a changing watermark ecology. Small groups of coastal foragers persisted in the area until the advent of the local Neolithic (Altuna 1980; Clark 1983; González Morales 1982).

Group operational areas theoretically delimit the spatial range of foraging activities during the course of a typical year. This concept of group operational areas differs fundamentally from that of site catchments or exploitation territories, which represent a time–distance circumscription of the area exploited from a particular site at a particular time. Such foraging activities may be expressed by a wide range of potential mobility types in relation to ephemeral, seasonal, or semipermanent sites, whether special purpose or base camps (Butzer 1982:231, 238).

For the Magdalenian and possibly also the Solutrean, Straus posits semipermanent base camps on the coastal plain, linked to exploitation of nonmigratory red deer and increasing use of marine resources; periodic movements into and out of the mountains are indicated by special-activity stations, such as Rascaño, devoted to ibex hunting in the interior valleys (Straus 1983a,

1983b), primarily during the summer months (Straus 1983c). Hunting in the mountains would indeed be easier in summer when the high country was snowfree, but ibex would also move to higher ground in summer for similar reasons. Thus ibex stations at lower elevations could be used in winter, at higher elevations in summer. Today precipitation in the low mountain belt is 50% higher than at the coast during the critical months of December through April (see Atlas Nacional de España 1965; Plates 39 and 40). In view of the lower temperatures, the late Pleistocene snow cover would have been about twice that of the coastal plain, making winter ibex hunts difficult and hazardous above perhaps 300–400 m. Although Straus' mobility model has not yet been demonstrated beyond reasonable doubt, it is compatible with the available but incomplete archaeological evidence, as well as with the model of spatial organization outlined above. North of the Pyrenees, in France and Central Europe, mobility was much greater than in Cantabria, predicated on migratory herds of reindeer (Bahn 1983; Schild 1984).

For the Asturian and, indirectly, the Azilian, Clark and Lerner (1983) have tested three different mobility models against the archaeological inventories and site locations. One of these posits two (seasonal) base camps, one near the marine resources of the coast, the other near or within the mountains with their big game. The second opts for a single, multipurpose (perennial) base camp on the coastal plain. The third assumes a succession of temporary camps defining an annual circuit. The data support the second model, in keeping with the Asturian coastal focus. The test is, however, weakened by parameter definition that assumes forest on the coastal plain during the early Holocene, with open vegetation and alpine faunas at intermediate elevations. Instead, as shown above, the low-mountain country was generally forested by 10,000 B.P. and only the coastal plain had substantial open vegetation; ibex and chamois would have been accessible on the rough, open-coastal terrain as well as in the high mountains but much less common in between.

These examples illustrate current understanding of Paleolithic spatial organization in Cantabria. Formulation and testing of more detailed models for mobility patterns and boundary definition will require a shift of archaeological strategies to extensive surveying, systematic study of open-air sites, and more intensive bioarchaeological study, including seeds and phytoliths.

SYNTHESIS

This synthetic review initially defined the habitat of the Mousterian and Upper Paleolithic peoples of Cantabrian Spain, a narrow coastal belt between a cold sea and a snowbound, mountain spine. Full-glacial climate was raw and windy, to the point that open vegetation prevailed. But due to its extreme maritime character, climate was not excessively cold or snowy and less prone to bouts of severe weather that would decimate animal herds or make human subsistence pursuits particularly hazardous. Grazing was good and supported a high biomass of red

deer and other large ungulates so well that, in conjunction with the linear physical constraints of the region, herds were not migratory. As a result settlement was much denser than in the Spanish interior, as well as better demarcated and more permanent than was the Paleolithic norm for Western Europe.

The repeated climatic oscillations between about 100,000 and 10,000 B.P. did not lead to biome shifts or redefinition. Instead they were limited to quantitative changes in the composition of persisting biotic communities, affecting ecotones and mosaic structures more than biome physiognomy. The total resource base changed in no more than its details.

The archaeological record defines some 75,000 years of Mousterian occupation, noted for a complex interplay of some five facies (i.e., repetitive assemblages of stone tools that each probably represented several tool kits used for various processing tasks). Different facies succeed each other within individual caves, often repetitively, or pose contrasts within contemporary levels of directly adjacent caves. This precludes the hypothesis that the facies represented distinct social, even ethnic, groups. Similarly, the facies show no patterned correlation with environmental modes or shifts, speaking against an adaptive interpretation. The lack of directional change of the Mousterian technocomplex across 75,000 years is remarkable and infers a cultural dynamism different from that of modern peoples. Presumably associated with Neanderthaler populations, the Cantabrian Mousterian suggests different cognitive, communicative, or neural capacities.

The Mousterian terminated ca. 35,000 B.P., about 2 millennia later than in France, and was directly followed by two Upper Paleolithic industries, the Chatelperronian and Aurignacian, contemporary with those in France but 8 millennia later than the earliest Upper Paleolithic in Bulgaria and Hungary. The Chatelperronian is associated with a Neanderthaler skeleton in at least one French site, the Aurignacian with modern *Homo sapiens*. The Chatelperronian disappeared after two millennia, and the Upper Paleolithic was generally characterized by a succession of material innovations and stylistic shifts. However distinct they may have been, and at whatever adaptive, social, or cultural level, some 10 archaeological "components" can be identified over 25 millennia. Distinct temporal lags and overlaps, generally of more than 1000 years, indicate a complex web of innovation, diffusion, adaptation, and change. There appears to have been an incremental increase of experiential information, magnified by an increasing number of permutations and recombinations of exchanged information.

The subsistence and settlement record is less dramatic in regard to Mousterian versus Upper Paleolithic contrasts. The same spectrum of animals was hunted and similar sites were occupied. Only gradually were hunting tools such as projectile points and harpoons added to the artifactual inventory. Site numbers increased steadily and more sites were found along the valleys of the low-mountain terrain. By 15,000 B.P., Magdalenian sites verify mass kills of red deer or ibex, as well as increasing attention to marine Mollusca, suggesting both increasing specialization in traditional subsistence pursuits as well as diversification into previously unimportant econiches.

The archaeological data base is adequate only to propose heuristic models for mobility patterns and, at a larger scale, for the spatial organization of group operational areas. Logistic mobility appears to have been accomplished by long-term base camps coupled with a number of short-term special-activity camps. This flexible organization of periodic movement and group splitting or fusion was, at the macroscale, influenced by Cantabrian geography.

The Cantabrian environment is dominated by parallel, linear elements such as the coastal and piedmont-mountain ecotones, intersected by subparallel floodplains and, in the low-mountain belt, deep valleys. This rectangular grid, superimposed on abundant and predictable resources, subject to little stochastic variation, suggests a logical sequence of settlement patterning. Mousterian, Aurignacian, and Gravettian groups appear to have operated in nonoverlapping areas arranged along the coastal plain and piedmont, each anchored between the coast and a major mountain valley. Solutrean settlement probably involved a chain of partly overlapping operational areas, until increasing Magdalenian group numbers and niche width may have required two tiers of interlocking operational areas, one focused on the coast, the other toward systematic utilization of the low-mountain belt. This adaptive divergence appears to be reflected in the apparent, early Holocene dichotomy of the broad-spectrum, coastal Asturian and the more specialized, interior Azilian.

Forest recolonization of all but the coastal plain ca. 10,000 B.P. may have contributed substantially to disappearance of the Azilian, through reduction of ungulate biomass. The rise of world sea level ca. 13,000-7000 B.P. drowned out a 10-km coastal belt and changed the shore habitat from shingle beaches to rocky cliffs. Changing marine ecology and forest encroachment behind the shore zone also appear to have reduced molluscan resources and big game, possibly explaining disintegration of the Asturian by 6000 B.P. These end-Pleistocene adaptive changes were much more fundamental than anything previous, involving biome alteration or displacement as well as threshold changes within cultural systems. By comparison, earlier environmental trends and shifts during the late Pleistocene left no tangible impact on material culture, hunting residues, or settlement patterning. Social changes, such as the appearance of the Upper Paleolithic or the progression of subsequent archaeological "components," effected only subtle and gradual shifts in tool inventories, prey counts, settlement numbers, and spatial disposition. This argues for a homeostatic steady state during Mousterian times, followed by a dynamic, directional equilibrium that only became metastable at the very end of the Pleistocene. During the interim, social devices and organizational strategies appear to have been adequate to deal with external perturbations or stimuli as well as with demographic and other internal processes, without apparent disjunctions.

The unique coupling of environment and ecumene with their temporal and spatial definition in late Pleistocene Cantabria provides unusual perspectives and

insights on Paleolithic adaptation. The picture developed here lacks much critical detail and leaves many questions unresolved. But it suggests that integration of environmental and cultural data is indeed possible and profitable, if only to pose hypotheses for further data resolution and testing, whether in Cantabria or elsewhere.

ACKNOWLEDGMENTS

An interim draft of this manuscript profited from critical comments by L. G. Straus, W. R. Farrand, R. G. Klein, and G. A. Clark. Useful information was kindly provided by F. H. Smith and C. B. Stringer. The illustrations were drafted by Elizabeth Brooks.

REFERENCES

- Aguirre, E.
1964 Las Gándaras de Budiño (Porrño, Pontevedra). *Excavaciones Arqueológicas en España* 31:1-28.
- Aguirre, E., and K. W. Butzer
1967 Problematical Pleistocene artifact assemblage from northwestern Spain. *Science* 157:430-431.
- Altuna, J.
1980 Historia de la domesticación animal en el País Vasco desde sus orígenes hasta la Romanización. *Munibe* 32:1-163.
1983 On the relationship between archaeofaunas and parietal art in the caves of the Cantabrian sector. In *Animals and archaeology*, edited by J. Clutton-Brock and C. Grigson. *British Archaeological Reports, International Series* 163, Oxford, Pp. 227-238.
- Altuna, J., and J. M. Merino
1984 *El yacimiento prehistórico de la Cueva de Ekañ*. Sociedad de Estudios Vascos, San Sebastian.
- Anderson, A. J.
1981 A model of prehistoric collecting on the rocky shore. *Journal of Archaeological Science* 8:109-120.
- Anderson, P.
1980 A testimony of prehistoric tasks: diagnostic residues on stone tool working edges. *World Archaeology* 12:181-194.
- Appellañiz, J. M.
1975 Neolítico y Bronce en la Cornisa Cantábrica. In *La prehistoria en la Cornisa Cantábrica*, edited by M. A. García Guinea and M. A. Fuente Sanudo. Santander: Instituto de Prehistoria y Arqueología Sautuola. Pp. 199-222.
- Asensio Amor, I.
1974 Contribución al estudio de acciones periglaciares en el límite galaico-asturiano. *Boletín, Instituto de Estudios Asturianos* 83:807-809.
- Atlas Nacional de España
1965 *Atlas Nacional de España*. Madrid: Instituto Geográfico y Catastral.
- Bahn, P. G.
1983 Late Pleistocene economies in the French Pyrenees. In *Hunter-gatherer economy in prehistory*, edited by G. Bailey. Cambridge: Cambridge University Press. Pp. 168-186.

- Bailey, G.
1983 Economic change in Late-Pleistocene Cantabria. In *Hunter-gatherer economy in prehistory*, edited by G. Bailey. Cambridge University Press. Pp.149-165.
- Bailey, G., M. R. Deith, and N. J. Shackleton
1983 Oxygen isotope analysis and seasonality determinations: limits and potential of a new technique. *American Antiquity* 48:390-398.
- Bernaldo de Quiros, F.
1978 *El Paleolítico Superior inicial en la región cantábrica española*. Unpublished doctoral dissertation, Universidad Complutense de Madrid.
- Binford, L. R.
1973 Interassemblage variability: the Mousterian and the 'functional argument.' In *The explanation of culture change*, edited by C. Renfrew. London: Duckworth. Pp. 227-254.
- Binford, L. R., and S. R. Binford
1966 A preliminary analysis of functional variability in Mousterian of Levallois facies. *American Anthropologist* 68(2), Pt. 2:238-295.
1969 Stone tools and human behavior. *Scientific American* 220(4): 70-84.
- Blackwell, B., H. P. Schwarcz, and A. Débénath
1983 Absolute dating of hominids and Palaeolithic artifacts of the Cave of La Chaise-de-Vouthon, France. *Journal of Archaeological Science* 10:493-513.
- Bordes, F.
1961 Mousterian cultures in France. *Science* 134:803-810.
1973 On the chronology and contemporaneity of different Paleolithic cultures in France. In *The explanation of culture change*, edited by C. Renfrew. London: Duckworth. Pp. 217-226.
1978 Typological variability in the Mousterian layers of Pech de l'Azé I, II and IV. *Journal of Anthropological Research* 34:181-193.
- Bordes, F., and D. de Sonneville-Bordes
1970 The significance of variability in Palaeolithic assemblages. *World Archaeology* 2:61-73.
- Bosinski, G.
1976 L'Acheuléen en Europe centrale du Nord. *Colloque X: L'évolution de l'Acheuléen en Europe*, IX. Congrès de l'Union Internationale des Sciences préhistoriques et protohistoriques, Nice. Pp. 52-64.
- Boyer-Klein, A.
1976 Análisis polínico de la Cueva de Tito Bustillo (Asturias). In *Excavaciones en la Cueva de Tito Bustillo* (Asturias), edited by J. A. Moure Romanillo and M. Cano Herrera. Oviedo: Instituto de Estudios Asturianos. Pp. 203-206.
1980 Nouveaux résultats palynologiques de sites solutréens et magdaléniens cantabriques. *Bulletin de la Société préhistorique française* 77:103-107.
1982 Cadre climatique du Magdalénien Cantabrique: Essai de reconstitution par la palynologie. *Cahiers du Centre de Recherches Préhistoriques* (Université de Paris I) 8:91-97.
- Brace, L. D.
1964 The fate of the "classic" Neanderthals: a consideration of hominid catastrophism. *Current Anthropology* 5:3-43.
- Bräuer, F.
1984 A craniological approach to the origin of anatomically modern *Homo sapiens* in Africa and implications for the appearance of modern Europeans. In *Origins of modern humans*, edited by F. H. Smith and F. Spencer. New York: A. R. Liss. Pp. 327-410.
- Bricker, H. M.
1976 Upper Paleolithic archaeology. *Annual Review of Anthropology* 5:133-148.
- British Meteorological Office
1958 *Tables of temperature, relative humidity and precipitation for the world, III, Europe*. London: H. M. Stationery Office.
- Bruhns, N. V. H.
1983 *Patella vulgata*: Contexts and methodologies. Unpublished M. A. thesis, University of Chicago.

- Burleigh, R., J. Ambers, and K. Matthews
1982a British Museum natural radiocarbon measurements XV. *Radiocarbon* 24:262-290.
- Burleigh, R., K. Matthews, and J. Ambers
1982b British Museum natural radiocarbon measurements XIV. *Radiocarbon* 24:229-261.
- Butzer, K. W.
1967 Geomorphology and stratigraphy of the Paleolithic site of Budiño. *Eiszeitler und Gegenwart* 18:82-103.
1971 Environment and archeology: an ecological approach to prehistory. Chicago: Aldine.
1973 Notas sobre la geomorfología regional de la parte occidental de la Provincia de Santander y la estratigrafía de Cueva Morín. In *Cueva Morín: Excavaciones 1969*, edited by J. González Echeagaray and L. G. Freeman. Santander: Patronato de las Cuevas. Pp. 267-276.
1977 Environment, culture, and human evolution. *American Scientist* 65:572-584.
1980 Civilizations: organisms or systems? *American Scientist* 68:517-523.
1981 Cave sediments, upper Pleistocene stratigraphy, and Mousterian facies in Cantabrian Spain. *Journal of Archaeological Science* 9:133-183.
1982 *Archaeology as human ecology*. Cambridge-New York: Cambridge University Press.
1983 Global sea level stratigraphy: an appraisal. *Quaternary Science Reviews* 2:1-15.
- Cabrera Valdes, V.
1978 *La Cueva del Castillo (Puente Viesgo, Santander)*. Unpublished doctoral dissertation, Universidad Complutense de Madrid.
- Cabrera, V., and F. Bernaldo de Quiros
1977 The Solutrean site of Cueva Chufín (Santander, Spain). *Current Anthropology* 18:780-781.
- Ceballos Fernández, L.
1966 *Mapa Forestal de España (1:400,000)*. Madrid: Ministerio de Agricultura.
- Clark, G. A.
1979 The North Burgos archaeological survey (editor). *Anthropological Research Paper* 19, Arizona State University.
1983 The Asturian of Cantabria: early Holocene hunter-gatherers in northern Spain. *Anthropological Research Paper* 41, Arizona State University.
- Clark, G. A., and S. Lerner
1983 Catchment analysis of Asturian sites. In *The Asturian of Cantabria. Anthropological Research Paper* 41, Arizona State University. Pp. 120-139.
- Clark, G. A., and J. Menéndez Amor
1983 Pollen samples from Liencres. In *The Asturian of Cantabria. Anthropological Research Paper* 41, Arizona State University. Pp. 150-151.
- Clark, G. A., and L. G. Straus
1983 Late Pleistocene hunter-gatherer adaptations in Cantabrian Spain. In *Hunter-gatherer economy in prehistory*, edited by G. Bailey. Cambridge: Cambridge University Press. Pp. 131-147, 166-167.
- Clark, G. A., and S. Yi
1983 Niche-width variation in Cantabrian archaeofaunas: a diachronic study. In *Animals and archaeology*, edited by J. Clutton-Brock and C. Grigson, *British Archaeological Reports*, International Series 163, Oxford. Pp. 183-208.
- Clark, J. A., and C. S. Lingle
1979 Predicted relative sea-level changes (18,000 years B.P. to present) caused by the late glacial retreat of Antarctic ice sheet. *Quaternary Research* 11:279-298.
- Clark, R.
1981 Cold climate features of the Cordillera Cantabrica, northern Spain. *Biuletyn Peryglacjalny* 28:5-13.
- Conkey, M. W.
1980 The identification of prehistoric hunter-gatherer aggregation sites: the case of Altamira. *Current Anthropology* 21:609-630.
- Coull, J. R.
1972 *The fisheries of Europe*. London: Bell.

- Creer, K. M., and J. S. Kopper
1974 Paleomagnetic dating of cave paintings in Tito Bustillo cave, Asturias, Spain. *Science* 186:348-350.
- Deacon, J.
1984 Later Stone Age people and their descendants in southern Africa. In *Southern African prehistory and palaeoenvironments*, edited by R. G. Klein. Rotterdam: Balkema. Pp. 221-328.
- Delibrias, G., H. Nonn, and M. Van Campo
1964 Age et flore d'un dépôt periglaciaire reposant sur la rasa cantabrique près de Burela (Galicie). *Comptes rendus, Académie des Sciences de Paris* 259:4092-4094.
- Delibrias, G., M. T. Guillier, and J. Labeyrie
1982 Gif natural radiocarbon measurements IX. *Radiocarbon* 24:291-343.
- Delpech, F.
1975 *Les faunes du Paléolithique supérieur dans le Sud-Ouest de la France*. Thèse, doctorat d'Etat, Sciences naturelles 479, Bordeaux.
- Dennell, R.
1983 *European economic prehistory*. London: Academic Press.
- Denton, G. H., and T. J. Hughes (editors)
1981 *The last great ice sheets*. New York: Wiley.
- Dyson-Hudson, R., and E. A. Smith
1978 Human territoriality: an ecological reassessment. *American Anthropologist* 80:21-41.
- Echaide, M. D.
1971 La industria lítica del yacimiento de Budiño (Pontevedra, España). *Munibe* 23:125-154.
- Echegaray, J. González, and I. Barandiarán Maestu
1981 El Paleolítico Superior de la Cueva del Rascaño (Santander). *Centro de Investigación y Museo de Altamira, Monografía 3*, Madrid.
- Echegaray, J. González, and L. G. Freeman
1971 *Cueva Morín: Excavaciones 1966-1968* (editors). Santander: Patronato de las Cuevas.
1978 *Vida y Muerte en Cueva Morín*. Santander: Institución Cultural de Cantabria.
- Embleton, C., and C. A. M. King
1975 *Periglacial geomorphology*. London: Arnold.
- Ern, H.
1966 Die dreidimensionale Anordnung der Gebirgsvegetation auf der Iberischen Halbinsel. *Bonner Geographische Abhandlungen* 37, Bonn.
- Evin, J., J. Marachal, and G. Marien
1983 Lyon natural radiocarbon measurements IX. *Radiocarbon* 25:59-128.
- Farrand, W. R.
1975 Analysis of the Abri Pataud sediments. In *Excavation of the Abri Pataud, Les Eyzies (Dordogne)*, edited by H. L. Movius. Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge Mass. Pp. 27-68.
1979 Chronology and palaeoenvironment of Levantine prehistoric sites as seen from sediment studies. *Journal of Archaeological Science* 6:369-392.
- Florschütz, F., and J. Menéndez Amor
1965 Beitrag zur Kenntnis der quartären Vegetationsgeschichte Nordspaniens. *Veröffentlichungen des Geobotanischen Instituts Rübél* 37:68-73.
- Florschütz, F., J. Menéndez Amor, and T. A. Wijmstra
1971 Palynology of a thick Quaternary succession in southern Spain. *Palaeogeography, palaeoclimatology, palaeoecology* 10:233-264.
- Franz, H.
1967 Beiträge zur Kenntnis der Bodenentwicklung in NW-Spanien auf Grund fossiler Böden. *Anales de Edafología y Agrobiología* 26:33-51.
- Freeman, L. G.
1964 *Mousterian developments in Cantabrian Spain*. Unpublished doctoral dissertation, Department of Anthropology, University of Chicago.

- 1966 The nature of Mousterian facies in Cantabrian Spain. *American Anthropologist* 68(2), Pt. 2:230-237.
- 1971 Los niveles de ocupación musteriense. In *Cueva Morín: Excavaciones 1966-68*, edited by J. González Echegaray and L. G. Freeman. Santander: Patronato de las Cuevas. Pp. 25-134.
- 1973a El Musteriense. In *Cueva Morín: Excavaciones 1969*, edited by J. González Echegaray and L. G. Freeman. Santander: Patronato de las Cuevas. Pp. 13-140.
- 1973b The significance of mammalian faunas from Paleolithic occupations in Cantabrian Spain. *American Antiquity* 38:3-44.
- 1980 Ocupaciones musterienses. In *El yacimiento de la Cueva de "El Pendo,"* edited by J. González Echegaray. Biblioteca Praehistorica Hispana 17, Madrid. Pp. 29-74.
- Freeman, L. G., and J. González Echegaray
1968 La industria musteriense de la Cueva de la Flecha. *Zephyrus* 18:43-61.
- Fuentes Vidarte, C.
1980 Estudio de la fauna de El Pendo. In *El yacimiento de la Cueva de "El Pendo,"* edited by J. González Echegaray. Biblioteca Praehistorica Hispana 17, Madrid. Pp. 217-237.
- García Guinea, M. A.
1975 El Mesolítico en Cantabria. In *La prehistoria en la Cornisa Cantábrica*, edited by M. A. García Guinea and M. A. Puente Sanudo. Santander: Instituto de Prehistoria y Arqueología Sautuola. Pp. 175-197.
- Gavelas, A. J.
1980 Sobre nuevos concheros asturianos en los concejos de Ribadesella y Llanes (Asturias). *Boletín del Instituto de Estudios Asturianos* 101:675-718.
- González Morales, J.
1982 *El Asturiense y otras culturas locales*. Centro de Investigación Museo de Altamira, Monografía 7, Santander.
- Hahn, J.
1973 Das Aurignacien in Mittel-und Osteuropa. *Acta Praehistorica et Archaeologica* 3:77-107.
- Hammond, E. H.
1964 Analysis of properties in land form geography, an application to broad-scale land form mapping. *Annals, Association of American Geographers* 54:11-19.
- Harrold, F.
1981 New perspectives on the Chatelperronian. *Ampurias* 43:35-85.
1983 The Chatelperronian and the Middle Upper Paleolithic transition. In *The Mousterian legacy*, edited by E. Trinkaus. *British Archaeological Reports, International Series* 164, Oxford, Pp. 123-140.
- Hassan, F. A.
1981 *Demographic archaeology*. New York: Academic Press.
- Hazera, J.
1983 Travaux morphologiques récents sur le glaciaire tardif dans l'Ouest des Pyrénées Centrales autour du Pic du Midi d'Ossau. In *Late- and postglacial oscillations of glaciers*, edited by H. Schroeder-Lanz. Rotterdam: Balkema. Pp. 203-212.
- Hodson, F. R.
1969 Searching for structure within multivariate archaeological data. *World Archaeology* 1:90-105.
- Howell, F. C.
1951 The place of Neanderthal man in human evolution. *American Journal of Physical Anthropology* 9:379-416.
1984 Introduction. In *Origins of modern humans*, edited by F. H. Smith and F. Spencer. New York: A. R. Lis. Pp. xiii-xxii.
- Howells, W. W.
1976 Explaining modern man: evolutionists versus migrationists. *Journal of Human Evolution* 5:577-596.

- Hoyos Gómez, M.
1981 Estudio geológico y sedimentario de la Cueva de Las Caldas. *Excavaciones arqueológicas en España* 115:11-59.
- Jelinek, A. J.
1982 The Tabun Cave and Paleolithic man in the Levant. *Science* 216:1369-1375.
- Jochim, M. A.
1983 Paleolithic cave art in ecological perspective. In *Hunter-gatherer economy in prehistory*, edited by G. Bailey. Cambridge: Cambridge University Press. Pp. 212-219.
- Jorda, M.
1983 L'évolution glaciaire d'altitude dans les Alpes Françaises du Sud au cours des quinze derniers millénaires. In *Late- and postglacial oscillations of glaciers*, edited by H. Schroeder-Lanz. Rotterdam: Balkema. Pp. 35-54.
- Keeley, L. H.
1980 *Experimental determination of stone tool uses*. Chicago: University of Chicago Press.
- Klein, R. G.
1975 The relevance of Old World archaeology to the first entry of man into the New World. *Quaternary Research* 5:391-394.
- Klein, R. G., and K. Cruz Uribe
1984 *The analysis of animal bones from archeological sites*. Chicago: University of Chicago Press.
n.d. The mammalian fauna from the 1978-79 excavations at El Juyo. In *El Juyo: Excavaciones 1978-79*, edited by J. González Echegaray and L. G. Freeman, in preparation.
- Klein, R. G., C. Wolf, L. G. Freeman, and K. Allwarden
1981 The use of dental crown heights for constructing age profiles of red deer and similar species in archaeological samples. *Journal of Archaeological Science* 8:1-31.
- Kopp, K. O.
1963 Schneegrenze und Klima der Würmeiszeit an der baskischen Küste. *Eiszeitalter und Gegenwart* 14:188-207.
- Kozłowski, J. K. (editor)
1982 *Excavation in the Bacho Kiro Cave (Bulgaria): final report*. Warsaw: Państwowe Wydawnictwo Naukowe.
- Latridou, J. P., and J. C. Ozouf
1982 Experimental frost shattering: 15 years of research at the Centre de Géomorphologie du CNRS. *Progress in Physical Geography* 6:215-232.
- Laville, H.
1973 Mousterian industries in the climatic chronology of the early Würm in the Périgord. *World Archaeology* 4:323-329.
1975 Climatologie et chronologie du Paléolithique en Périgord. *Etudes du Quaternaire* 4, Université de Provence (Marseille).
1980 Les dépôts solutréens de la grotte de La Riera (Asturies). *Bulletin de la Société préhistorique française* 77:234-236.
- Laville, H., J. P. Rigaud, and J. Sackett
1980 *Rockshelters of the Perigord*. New York: Academic Press.
- Leroi-Gourhan, A.
1959 Résultats de l'analyse pollinique de la grotte d'Isturitz. *Bulletin de la Société préhistorique française* 56:619-624.
1966 Análisis polínico de la Cueva del Otero. *Excavaciones Arqueológicas en España* 53:81-85.
1971 Análisis polínico de Cueva Morín. In *Cueva Morín: Excavaciones 1966-1969*, edited by J. González Echegaray and L. G. Freeman. Santander: Patronato de las Cuevas. Pp. 357-365.
1980a Análisis polínico de El Pendo. In *El yacimiento de la Cueva de "El Pendo,"* edited by J. González Echegaray. *Biblioteca Praehistorica Hispanica* 17, Madrid. Pp. 263-266.
1980b Interstades würmiens: Laugerie et Lascaux. *Bulletin, Association française pour l'Etude du Quaternaire* 1980(3):95-100.
- Leroi-Gourhan, A., and J. Renault-Miskovsky
1977 La palynologie appliquée à l'archéologie. In *Approche écologique de l'Homme fossile*, edited

- by H. Laville and J. Renault-Miskovsky. Paris: Université Pierre et Marie Curie. Pp. 35-49.
- Leroyer, C., and A. Leroi-Gourhan
1983 Problèmes de chronologie: Le castelperronien et l'aurignacien. *Bulletin de la Société préhistorique française* 80:41-44.
- Lévêque, F., and B. Vandermeersch
1980 Découverte des restes humains dans un niveau castelperronien à Sainte-Césaire. *Comptes rendus, Académie des Sciences de Paris* D291:187-189.
1981 Le néandertalien de Sainte-Césaire. *La Recherche* 12:242-244.
- Llopis Lladó, N. (editor)
1957 *Livret-guide de l'excursion N2 (INQUA): Le Quaternaire de la Région Cantabrique*. Oviedo: Diputación provincial de Asturias.
- Lotze, F.
1962 Pleistozäne Vergletscherungen im Ostteil des Kantabrischen Gebirges. *Abhandlungen, Akademie der Wissenschaften und der Literatur (Mainz), Math.-Naturw. Klasse* 1962(2):1-21.
- Louis, H.
1968 *Allgemeine Geomorphologie* (second ed.). Berlin: De Gruyter.
- Lumley, H. de
1976 Les civilisations du Paléolithique moyen en Provence. In *La préhistoire française*, edited by H. de Lumley. Paris: CNRS, Vol. 1, Pt. 2: 989-1004.
- McGreevy, J. P.
1981 Some perspectives on frost shattering. *Progress in Physical Geography* 5:56-75.
- McIntyre, A., et al.
1976 Glacial North Atlantic 18,000 years ago: a CLIMAP reconstruction. *Memoirs, Geological Society of America* 145:43-76.
- Martínez de Pisón, E., and M. Arenillas Parra
1979 Algunos problemas de morfología glaciaria en la España atlántica. *Acta Geologica Hispanica* 14:445-450.
- Mary, G., J. Medus, and G. Delibrias
1975 Le quaternaire de la côte asturienne (Espagne). *Bulletin, Association française pour l'Etude du Quaternaire* 11(42):13-24.
- Mellars, P.
1970 Some comments on the notion of 'functional variability' in stone tool assemblages. *World Archaeology* 2:74-89.
1973 The character of the Middle/Upper Paleolithic transition in southwest France. In *The explanation of culture change*, edited by C. Renfrew. London: Duckworth. Pp. 225-276.
- Menéndez Amor, J., and F. Florschütz
1961 Contribución al conocimiento de la historia de la vegetación en España durante el Cuaternario. *Estudios Geológicos* 17:83-99.
- Menéndez Amor, J., and M. L. Ortega Sada
1958 Determinación de las especies de *Pinus* que vivieron en los alrededores de Puebla de Sanabria (Zamora) a lo largo del Tardiglaciario y el Holoceno. *Las Ciencias* 23:606-626.
- Menéndez Amor, J., and E. Fernández de Vidaurreta
1960 Resultado del estudio de los macrofósiles vegetales encontrados en los sedimentos de la Laguna de las Sanguijuelas. *Las Ciencias* 25:831-845.
- Mensching, H.
1961 Die Rias der galicisch-asturischen Küste Spaniens. *Erdkunde* 15:210-224.
- Miotke, F. D.
1968 Karstmorphologische Studien in der glazialüberformten Höhenstufe der Picos de Europa, Nordspanien. *Jahrbuch der Geographischen Gesellschaft Hannover, Sonderheft* 4.
- Moure Romanillo, J. A.
1968 La Cueva de Cobalejos en Puente Arce, Santander, y su industria paleolítica. *Ampurias* 30:181-193.
- Movius, H. L.
1969 The Chatelperronian in French archaeology: the evidence of Arcy-sur-Cure. *Antiquity* 43:111-123.

- Nonn, H.
1966 *Les régions cotières de la Galicie (Espagne): Étude géomorphologique*. Publication 3, Fondation Baulig, Faculté des Lettres, Université de Strasbourg.
- Nussbaum, F.
1957 Ueber Berg- und Talformen in den westlichen Pyrenäen. *Tijdschrift, koninkrijk Nederlandsch Aardrijkskundig Genootschap* 74:342-355.
- Nussbaum, F., and E. Gygas
1952 Glazial-morphologische Untersuchungen im Kantabrischen Gebirge (Nordspanien). *Jahresbericht der Geographischen Gesellschaft Bern* 1952:54-79.
- Obermaier, H.
1914 Estudio de los glaciares de los Picos de Europa. *Trabajos Seria Geologica* 9, Museo Nacional de Ciencias Naturales (Madrid).
- Oldfield, F.
1964 Late Quaternary deposits at Le Moura, Biarritz, Southwest France. *New Phytologist* 63:374-409.
- Paquereau, M. M.
1975 Le Würm ancien en Périgord: Etude palynologique. *Quaternaria* 18:67-159.
- Patzelt, G.
1974 Holocene variations of glaciers in the Alps. In *Lés Methodes quantitatives d'étude des variations du climat au cours du Pléistocène*. *Colloques Internationaux CNRS* 219, Paris. Pp. 51-59.
- Pérez, Alberti, A.
1979 Nuevas observaciones sobre glaciario y periglaciario en el NW de la Península ibérica. *Acta Geologica Hispanica* 14:441-444.
- Peterson, R. O., R. E. Page, and K. M. Dodge
1984 Wolves, moose, and the allometry of population cycles. *Science* 224:1350-1352.
- Porter, S. C.
1981 Glaciological evidence of Holocene climatic change. In *Climate and history*, edited by T. M. L. Wigley, M. J. Ingram, and G. Farmer. Cambridge: Cambridge University Press. Pp. 82-110.
- Porter, S. C., and G. Orombelli
1982 Late-glacial ice advances in the western Italian Alps. *Boreas* 11:125-140.
- Powers, R., and C. B. Stringer
1975 Palaeolithic cave art fauna. *Studies in Speleology* 2:266-298.
- Puga Pereira, M., F. Macias Vazquez, and F. Guitian Ojea
1978 Pedological and geomorphological cycles in a catena of Galicia (NW Spain). *Catena* 5:375-388.
- Pye, K.
1984 Loess. *Progress in Physical Geography* 8:176-217.
- Rigaud, J. P.
1976 Les civilisations du Paléolithique supérieur en Périgord. In *La Préhistoire française*, edited by H. de Lumley. Paris: CNRS, 1(2):1257-1270.
1982 *Le Paléolithique en Périgord*. Thèse, Doctorat de l'Etat, Université de Bordeaux I.
- Rightmire, G. P.
1984 *Homo sapiens* in sub-Saharan Africa. In *Origins of modern humans*, edited by F. H. Smith and F. Spencer. New York: A. R. Liss. Pp. 295-325.
- Schild, R.
1984 Terminal Paleolithic of the North European Plain: a review of lost chances, potential, and hope. *Advances in World Archaeology* 3:193-274.
- Schmidt-Thomé, P.
1973 Neue, niedrig gelegene Zeugen einer würmeiszeitlichen Vergletscherung im Nordteil der Iberischen Halbinsel (Prov. Vizcaya und Orense in Nordspanien; Minho-Distrikt in Nordportugal). *Eiszeitalter und Gegenwart* 23/24:384-389.
1983 Besonders niedrig gelegene Zeugen einer würmeiszeitlichen Vereisung in Nordwestspanien und Nord-Portugal. In *Late- and postglacial oscillations of glaciers*, edited

- by H. Schroeder-Lanz. Rotterdam: Balkema. Pp. 203-230.
- Schmitz, H.
1969 Glazialmorphologische Untersuchungen im Bergland Nordwest-spaniens (Galizien-Leon). *Kölnner Geographische Arbeiten* 23, Cologne.
- Schwartz, H. P., P. D. Goldberg, and B. Blackwell
1980 Uranium series dating of archaeological sites in Israel. *Israel Journal of Earth Sciences* 29:157-165.
- Shackleton, N. J., and N. Opdyke
1973 Oxygen isotope and palaeomagnetic stratigraphy of Equatorial Pacific core V28-238. *Quaternary Research* 3:39-55.
1976 Oxygen-isotope and paleomagnetic stratigraphy of Pacific core V-28-239, late Pliocene to latest Pleistocene. *Memoirs, Geological Society of America* 145:449-464.
- Smith, F. H.
1982 Upper Pleistocene hominid evolution in south-central Europe. *Current Anthropology* 23:667-703.
1984 Fossil hominids from the upper Pleistocene of Central Europe and the origin of modern Europeans. In *Origins of modern humans*, edited by F. H. Smith and F. Spencer. New York: A. R. Liss. Pp. 137-209.
- Sonneville-Bordes, D. de
1960 *Le Paléolithique supérieur en Périgord* (2 vols.). Bordeaux: Delmas.
1966 L'évolution du Paléolithique supérieur en Europe occidentale et sa signification. *Bulletin, Société préhistorique française* 63:3-33.
- Soto, E., and G. Meléndez
1981 Fauna de la Cueva de las Caldas. *Excavaciones Arqueológicas en España* 115:259-268.
- Straus, L. G.
1977a Of deerslayers and mountain men: Paleolithic faunal exploitation in Cantabrian Spain. In *For theory building in archaeology*, edited by L. R. Binford. New York: Academic Press. Pp. 41-76.
1977b The Upper Paleolithic cave site of Altamira (Santander, Spain). *Quaternaria* 19:135-148.
1980 Mesolithic adaptations along the coast of northern Spain. *Quaternaria* 21:305-328.
1981 On the habitat and diet of *Cervus elaphus*. *Munibe* 33:175-182.
1982a Carnivores and cave sites in Cantabrian Spain. *Journal of Anthropological Research* 38:75-96.
1982b Observations on Upper Paleolithic art: old problems and new directions. *Zephyrus* 34-35:71-77.
1983a El Solutrense Vasco-Cantabro: Una nueva perspectiva. *Centro de Investigación y Museo de Altamira, Monografía* 10, Madrid.
1983b From Mousterian to Magdalenian: cultural evolution viewed from Vasco-Cantabrian Spain and Pyrenean France. In *The Mousterian legacy*, edited by E. Trinkaus. *British Archaeological Reports, International Series* 164, Oxford. Pp. 73-111.
1983c Paleolithic adaptations in Cantabria and Gascony: a preliminary comparison. In *Homenaje al M. Almagro Basch*. Madrid: Ministerio de Cultura. Pp. 187-201.
1983d Terminal Pleistocene faunal exploitation in Cantabria and Gascony. In *Animals and archaeology*, edited by J. Clutton-Brock and C. Grigson. *British Archaeological Reports, International Series* 163, Oxford. Pp. 209-225.
- Straus, L. G., and G. A. Clark
1978 Prehistoric investigations in Cantabrian Spain. *Journal of Field Archaeology* 5:289-317.
- Straus, L. G., et al.
1981 Paleoecology at La Riera (Asturias, Spain). *Current Anthropology* 22:655-682.
- Straus, L. G., G. A. Clark, J. Altuna, and J. Ortea
1980 Ice Age subsistence in northern Spain. *Scientific American* 242(6):142-152.
- Stringer, C. B.
1982 Towards a solution of the Neanderthal problem. *Journal of Human Evolution* 11:431-438.
- Stringer, C. B., J. J. Hublin, and B. Vandermeersch
1984 The origin of anatomically modern humans in Western Europe. In *Origins of modern humans*, edited by F. H. Smith and F. Spencer. New York: A. R. Liss. Pp. 51-135.

- Thompson, R., and B. Berglund
1976 Late Weichselian geomagnetic reversal as a possible example of the reinforcement syndrome. *Nature* 263:490-491.
- Tricart, J.
1967 *Le modèle des régions périglaciaires*. Paris: SEDES.
- Trinkaus, E., and W. W. Howells
1979 The Neanderthals. *Scientific American* 241(6):118-133.
- Tuffreau, A.
1979 Les débuts du Paléolithique Moyen dans la France septentrionale. *Bulletin, Société préhistorique française* 76:140-142.
- U. S. Hydrographic Office
1963 Sailing directions for the west coasts of Spain, Portugal and Northwest Africa. *U. S. Naval Oceanographic Publication* 51, Washington, D.C.
- Vallois, H.
1954 Neanderthals and presapiens. *Journal of the Royal Anthropological Institute* 84:111-130.
- Vidal, J. M.
1981 Nuevas excavaciones arqueológicas en las Gandaras de Budiño (Pontevedra, Galicia). *Actas y Guías de Excursiones, 5. Reunion del Grupo español de Trabajo del Cuaternario, Universidad de Sevilla, Sevilla*. Pp. 210-220.
- Vogel, J. C., and H. T. Waterbolk
1963 Groningen radiocarbon dates IV. *Radiocarbon* 5:163-202.
1967 Groningen radiocarbon dates VI. *Radiocarbon* 9:63-106.
1972 Groningen radiocarbon dates X. *Radiocarbon* 14:6-10.
- Wendorf, F., and R. Schild
1976 *Prehistory of the Nile Valley*. New York: Academic Press.
- White, R. D.
1982 Re-thinking the Middle/Upper Paleolithic transition. *Current Anthropology* 23:169-192.
1983 Changing land use patterns across the Middle/Upper Paleolithic transition: the complex case of the Périgord. In *The Mousterian legacy*, edited by E. Trinkaus. *British Archaeological Reports, International Series* 164, Oxford. Pp. 113-121.
- Woillard, G. M.
1978 Grande Pile peat bog: a continuous pollen record for the last 140,000 years. *Quaternary Research* 9:1-21.
- Woillard, G. M., and W. G. Mook
1982 Carbon-14 dates at Grande Pile: correlation of land and sea chronologies. *Science* 215:159-161.
- Wolpoff, M.
1981 Allez Neanderthal. *Nature* 289:823.
- Wymer, J. J.
1968 *Lower Palaeolithic archaeology in Britain*. London: John Baker.
1981 The Palaeolithic. In *The environment in British prehistory*, edited by J. Simmons and M. Tooley. Ithaca: Cornell University Press. Pp. 49-81.
- Zeuner, F. E.
1963 *A history of domesticated animals*. London: Hutchinson.