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THE ORIGINAL ARMS RACE: IBERIAN PERSPECTIVES ON THE SOLUTREAN PHENOMENON

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Introduction

It should be no surprise that most of the traditional "fossil director" artifacts for the various Upper Palaeolithic industries of Western Europe are considered to be weapon tips – either lithic or osseous. These include: the Chatelperron and Font-Yves points, the Aurignacian split-base and lozenge-shaped bone points, the Les Cottés, Vachons, La Gravette, Micrograve tte, Font-Robert and shouldered Perigordian points, unifacial, laurel leaf, willow leaf, Solutrean (invasively retouched) and Mediterranean (backed) shouldered, concave base, rhomboidal, Parpallo tanged, and Montaut asymmetrical points, a plethora of antler points (of a variety of cross-sections, tip and base shapes, single-, double- or non-bevelled, named (e.g., sagaies d'Isturitz) and unnamed, Teyjat, Laugerie-Basse, Hamburg, Ahrensburg, shouldered and other Magdalenian points, Azilian and Malaurie points, proto-harpoons, round- and flat-section harpoons (both uni-and bi-laterally barbed). Within the different lithic raw material provinces of Europe the basic, "substrate" Upper Palaeolithic tools (endscrapers, burins, perforators, backed and retouched blades, etc.) – with the possible exception of a few truly unusual types such as strangled blades or Noailles burins – remain fairly similar in morphology across long periods of time, varying in their relative frequency within assemblages largely because of functional and sampling factors. Despite cases of technological convergence, however, many of the point types do seem to be confined to relatively limited time periods and geographical areas. The aim of this paper is to explore the role of certain "Solutrean" points as temporal and spatial diagnostics and as weapons tips in the context of a discussion of human adaptations to the conditions of the Last Glacial Maximum in the Iberian Peninsula.

Some Points on Points

Of course the label "point" is subject to verification through experiment and studies of *microwear* traces and breakage patterns. Some of the larger, blunter stone "point" types (e.g., Chatelperron, laurel leaf),may have actually been used most or all of the time as knives, and some of the bone and antler types (e.g., split-base and bipolar-bevelled) may have in reality been handles of foreshafts. Nonetheless, simple common sense suggests that most of the kinds of artifacts listed above (as well as some unretouched flakes and bladelets) were indeed used as tips and/or barbs for composite weapons. Such weapons minimally consisted of a tip and a shaft, but also include a foreshaft and barbs, as well as a propulsion mechanism (itself multicomponent), namely an atl-atl (or, conceivably, a bow). Besides the stone, antler, bone and/or wood elements, these weapons would employ plant resins and sinews as

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fixative agents and sometimes possibly feathers to fletch arrows or darts. Often we may lose sight of these facts when we become concerned with the typology and typometrics of the durable elements, the stone and, to a lesser extent the bone and antler object. See Geneste and Plisson (1986) for an example of how shouldered points may have been attached to shafts; see Leroi-Gourhan (1983) for an example of how microlithic elements were actually set into a sagaie in the Magdalenian of Pincevent; see Nuzhnyj (1989) for many examples of microlith function as weapon tips, barbs and edges; see Allain & Descouts (1957: 100) and Allain & Rigaud (1989) for further examples and for discussion of microlith hafting by means of natural glues and resins; recent excavations in the Final Magdalenian of the Abri Dufaure (Straus n.d.b.) have yielded a magnificent bilaterally grooved sagaie in association with an assemblage of stone tools, half of which are backed bladelets).

It should be obvious why weapon tips were so important to Upper Palaeolithic people and why there seems to have been so much temporal and regional variability among "points". While classified as "hunter-gatherers", people living at the middle latitudes in Last Glacial Europe could get the majority of their nutrition only from animal sources. Plant products edible by humans would have been relatively scarce, particularly under full stadial climatic conditions. Pollen diagrams for glacial maxima in Europe show a dearth of trees and shrubs with edible fruits, nuts and berries. Some seeds and roots may have been eaten, but they would have made only very small contributions to overall diet. Shellfish were utilized in significant quantities from Solutrean times on in some coastal regions (e.g., Cantabrian Spain (Straus *et al.* 1980), but never constituted more than a supplementary or "tiding-over" resource. Upper Palaeolithic people, especially those who lived during the Wurm Upper Pleniglacial and Tardiglacial from about 25,000 to about 12,000 BP, lived by hunting. Their game were mostly medium-large ungulates (cervids, equids, caprines, bovines). Besides the food provided by the meat, fat, grease, marrow and brains of these animals, Upper Palaeolithic hunters obtaine a variety of secondary products from them. These included hides, senews, intestines, bones, antlers, teeth which were used for clothing housing, cordage, containers, weapons and other tools, ornaments, works of art and even fuel. Specialized hunting of fur-bearing carnivores may have been done mainly with traps, while the lagomorphs so common in Mediterranean Europe may have been snared, netted or clubbed in drives. However, the large-scale, efficient killing of the ungulates would have required the use of pointed weapons. Even the kinds fish commonly killed in late Upper Palaeolithic Western Europe (notably large salmon and pike) would have been speared. While sharpened hardwood sticks can be and certainly were used as weapons, stone, bone and antler tips no doubt increased the potential for penetration and mortal damage of thrusting spears and relatively low-velocity missles used against large game.

Pre-metallurgical societies have wood, bone, shell, antler, stone and ivory as options for tipping spears and missles. When and where available, antler is a good material since it can be easily shaped into a variety of forms (including self-barbed harpoons), is resilient and resistent to breakage, and can be readily reworked when it does break (as witnessed by the many known reworked, short harpoons). Bone is less easily worked, more brittle and probably shatters into unrecyclable fragments more frequently than antler, but it was used, though far less frequently than antler, in the European Upper Palaeolithic. (Of course, cervids – notably reindeer and/or red deer – were abundant in Ice Age Europe). Antler, however, may have had the disadvantage of providing fairly dull/easily blunted points. But it is a "cheap", simple technology, particularly if plain sagaies are being manufactured by the groove-and-splinter technique followed by planing (using a burin facet edge, for example) and then smoothing on sandstone. The durability of antler is attested to by the fact that many utilitarian objects of that material (e.g., atl-atl hooks, perforated batons, harpoons and even some sagaies) were carved and engraved, an artistic investment suggestive of artifact curation, *in sensu* L.R. Binford.

Hard stones have the advantage of sharpness when flaked, but they have the disadvantage of relative brittleness when compared to antler. Nonetheless, the kinds of stones commonly used for points in the European Upper Palaeolithic (notably varieties of flint, quartzite and quartz) are fairly tough and resilient (especially vis a vis easily

shattered lithic materials such as obsidian). Tip sharpness is clearly advantageous in facilitating weapon penetration, while point edge sharpness increases wounding and bleeding potential.

Weapon tips made of stone can be of two fundamentally different kinds: large, "expensive" points (e.g., foliate points characteristic of the Solutrean, Clovis, Folsom and other culture-stratigraphic units worldwide) or small, "cheap" elements that are either themselves the points or elements of compound points. The former are invasively retouched unifacially or bifacially by percussion or pressure flaking (or both) – a process which requires large blanks (usually blades, themselves elaborate to produce) of flawless, tractable raw material, a high degree of technical skill, time and acceptance of the fact that the objects may break during the course of manufacture. After such an elaborate investment, foliate lithic projectile points, particularly the thinner ones, were likely to have short use-lives due to breakage on impact (either on or off target), as well as loss. The larger points could be – and indeed manifestly were – reworked after breakage into shorter points or recycled into other kinds of tools such as endscrapers.

The other kind of lithic weapon element include a variety of microliths ("armatures"): retouched or backed bladelets, backed micropoints, geometrics and even unretouched bladelets or small flakes. These were probably (though not exclusively) used as tips of gracile missles (darts or arrows) or as barbs (mounted obliquely) or cutting edges (mounted parallel) on antler or wood tips. The common existence of impact traces and fractures on these kinds of lithic elements (Keeley 1981; Moss 1983; Dumont 1986) and of laterally grooved sagaies (including the Pincevent one with two lithic elements still in place (Leroi-Gourhan 1983)) is evidence of these uses. Such unelaborate elements are easy to make, require only small pieces of stone, can be readily replaced when broken, dulled or lost with replacements that can be simply and easily transported in large quantities (in a skin pouch, for example) or made on the spot of many locally available materials. In the terminology of Oswalt (1976), technologies incorporating many microliths in this fashion are ones exhibiting a high degree of complexity in terms of "technounit quantity". The same three options for sophisticated weapon tips (large stone bi- or uni-facial points, simple antler points, and antler tips with stone insets) existed in the late Upper Palaeolithic of Siberia, sometimes coexisting within the same archaeological cultures. This suggests that the different kinds of projectiles may have been used at different seasons, for different game or in different hunting tactics (Morlan 1987). Different sizes, sharpnesses and configurations of lithic weapon elements (i.e., tips, barbs or edges) would have had differing characteristics in terms of penetration, shock, bloodletting and "sticking power" in target bodies. In addition, different mobility strategies may have governed the relative popularity of large versus small weapon point types, particularly if large bifaces served as multipurpose tools for highly mobile people often far from good known lithic sources.

All these Upper Palaeolithic weaponries were complex, required much manufacturing and maintenance time, and are evidence of significant "gearing-up" (*in sensu* L.R. Binford) in preparation for hunting activities that were not casual affairs. Success or failure, sometimes perhaps life or death, depended on the effectiveness of the arms as well as on the skill and knowledge of the hunters.

A Short, Biased History of Stone Age Weaponry

Following the long agony and eventual demise of Raymond Dart's (1957) "osteodontokeratic culture of Australopithecus" (see, for example, Brain 1981; Binford 1981), our earliest ancestors seem to have been armed with sticks and stones much after the fashion of Jane Goodall's and Bill McGrew's chimpanzees. There is no evidence for weapons among the artifacts of the Oldowan Techno-complex per se. Similarly (pace Scott 1986, and others), the rethinking and reanalyses of Olorgesailie (e.g., Binford 1977), Zhoukoudian (Binford & Stone 1986) and especially of Torralba and Ambrona (e.g., Klein 1987; Binford 1987), have left substantial doubt about the role of big game hunting in the subsistence of *Homo erectus*. Despite occasional claims that spheroids were bola stones or that bifaces

could be hurled like deadly discuses, few serious researchers seem to now argue for weapons functions among the flake and core artifacts of the Oldowan or Acheulean. Among the multiple purposes to which many Acheulean tools seem to have been put, butchering and plant processing seem to have been dominant (see Keeley 1980). Among surviving late Middle and early Upper Pleistocene artifacts, only the Clacton and Lehringen wooden "spears" (Oakley *et al.* 1977; Adam 1951) might be candidates for weapon status (but see Gamble 1987, for a novel alternative explanation).

Most debate currently swirls around the possible extent and nature of hunting in the Middle Palaeolithic (both in the Middle Stone Age of Subsahran Africa and in the Mousterian of the Mediterranean Basin). Scavenging, opportunistic hunting and systematic specialized hunting are the differing visions of various authors who have recently studied or interpreted the Middle Palaeolithic faunal assemblages from such sites as Klasies River Mouth, Combe Grenal, Lezetxiki and Cueva Morin (e.g., Freeman 1973; Klein 1976; Binford 1984; Chase 1986; Straus 1976b, 1982, 1983a; Altuna 1972, 1989). If archaic *Homo sapiens* hunted, what were their weapons, beyond throwing stones and possibly sharpened sticks? The late François Bordes (1961) argued in his typology of flake tools for functional Mousterian and Levallois points, on the criteria of triangular outline with convergent, retouched or unretouched edges coming to a sharp point, sometimes with base thinned by removal of the bulb of percussion. To test Bordes' idea that such objects were used to hunt and that they were not simply convergent sidescrapers, various researches have been studying traces of supposed hafting, wear and breakage among "points" and other Mousterian tools. The microwear studies of Beyries (1987) and Anderson-Gerfaud (n.d.) do not lend support to the "hunting" function, while a limited number of such objets from Israeli sites are said by Shea (n.d.) to have been used as projectile tips on the basis of edge damage observed under low magnification. However, with the exception of the Aterian, an epi-Mousterian mostly found in the Maghreb, there are few Middle Palaeolithic pieces that look to me like undoubted hafted projectile points, though further research may modify my present opinion. If archaic *Homo sapiens* had tipped weapons, they were probably rather crude, inefficient affairs; hunting success of whatever extent, may have largely depended on Neanderthals' enormous physical strength and endurance (see Trinkaus 1987).

The Upper Palaeolithic of Western Europe began under the relatively benign climatic conditions of the Wurm Interstadial/Interpleniglacial. Osseous and blade-based lithic points certainly characterize the Aurignacian and suggest a new degree of efficiency and effectiveness in the hunting conducted by Cro-Magnon. However we lack breakage and wear analyses needed to prove the actual weapons function of all the types labelled "points" in standard typologies. A notable characteristic of the Aurignacian in the classic region of Southwest France is the richness of osseous "points" and relative scarcity of retouched lithic implemets which could have been used as weapon tips. The situation seems to have reversed in the Gravettian, with fewer osseous and many more lithic "points". However, despite good faunal preservation, osseous points are not particularly frequent in most Aurignacian levels in Cantabrian Spain, and there are some in most of the Gravettian levels (Straus & Heller 1988: 118–19). There is no apparent difference in faunal assemblages between the Mousterian and Aurignacian in Cantabrian Spain that would suggest a major increase in the amount or effectiveness of hominid hunting or widening of the spectrum of exploited game (Straus 1977a; Straus & Heller 1988), although there is a decrease in the carnivore component in the caves also inhabited by *Homo sapiens* beginning in the Aurignacian (Straus 1982).

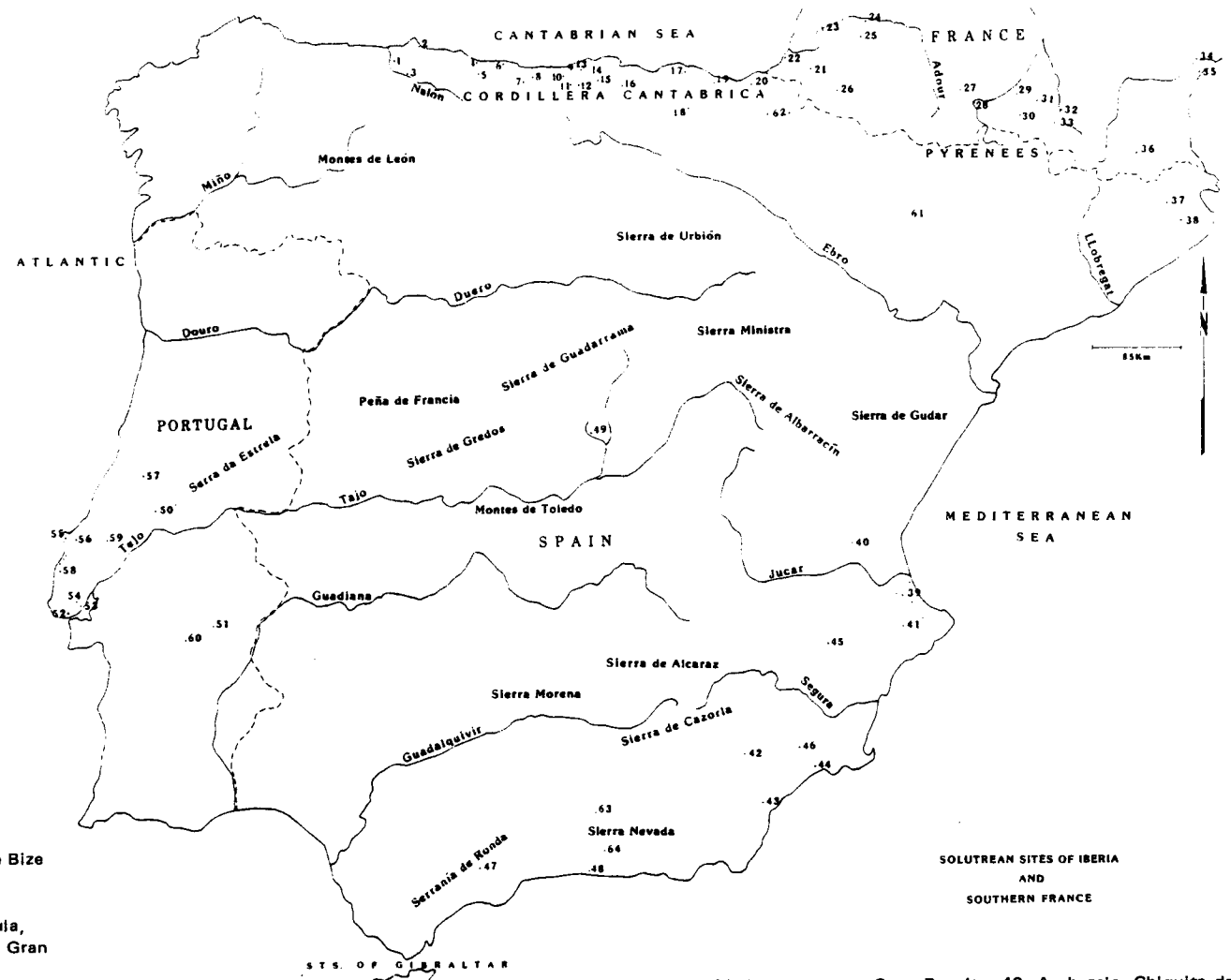
The significant development of convincing lithic points in the Gravettian coincided in time with the onset of the Upper Pleniglacial, perhaps necessitating changes in both technological and tactical means for insuring hunting success under more precarious environmental conditions. Indeed, in Cantabrian Spain the first inklings of true specialized, mass hunting of swift, elusive game appear in the Gravettian (notably at Bolinkoba in Vizcaya, where the hunting of ibex may have been facilitated by the use of tipped projectile weapons). The sharp, slender Gravette and Microgravette points undoubtedly provided penetration and could have been used on propelled spears or darts. However, for ease of hafting, wounding potential and stricking power, Solutrean points (especially rhomboidal/tanged,

concave base and shouldered types) may have represented significant technological improvements (as did the microlithic elements which were became increasingly frequent at some sites late in the Solutrean time range). The Solutrean, whose "substrate" tools are banal, represents a change in weapon technology in Southwest Europe at the beginning of the Last Glacial Maximum.

The Solutrean World

The coldest part of the Upper Pleniglacial, the Last Glacial Maximum (LGM), came around 18,000 (Climap 1976), although there is some debate about the exact timing and time lags among various cold climate indicators (e.g., the Brandenburg glacial advance, pollen spectra, oxygen isotope ratios from deep sea cores, etc.) in different regions (see for example Laville *et al.* 1980; Butzer 1981, 1986). By about 21,000 years ago the environments of Northwest Europe, fairly heavily settled in the early Upper Palaeolithic, were becoming increasingly difficult and finally untenable for human population. Great Britain, the Lowlands, Germany, and northern France were gradually abandoned, as the northern limits of human settlement and exploitation territories moved southward (Bosinski 1988; Campbell 1977; Fagnart 1988; Jochim 1983, 1987; Otte 1984; see also Desbrosse & Kozlowski 1988). Even if human use of the lands north of the Loire during the LGM was not totally nil, it seems to have been sporadic, perhaps consisting of summer hunting expeditions. Southwest Europe was more tightly circumscribed at this time than at any other in the Upper Pleistocene; besides the Atlantic and the Mediterranean, it was bounded to the north by polar desert and the expanded Scandinavian Glacier and to the east by the Alpine Glacier which nearly reached the Riviera shore at the time.

The distribution of archaeological sites in Western Europe corresponding to the LGM shows dense settlement in southern France and in the Iberian Peninsula. Particular foci of settlement were 1.) Poitou-Charentes/Limousin/Guyenne, 2.) the Saone-Rhone valley/Provence, 3.) the northern flanks of the Pyrenees (Adour and upper Garonne basins), 4.) Vasco-Cantabria, 5.) Catalonia, 6.) Levante, 7.) southern Andalusia, and 8.) Portuguese Estremadura/northern Alentejo. There are a few Solutrean outliers just north of the Loire around Le Mans and in the Seine basin mostly south of Paris, but their exact dating is unknown (Smith 1966, whose Maps I–III still give fairly complete distribution of Solutrean sites in France). The distribution of Solutrean sites and site clusters in southernmost France and in Spain and Portugal is shown in Fig. 1. One of the striking aspects of the overall Solutrean site distribution is its localized nature. The dense west-central French group is separated from the Rhone-Provence group by the then-glaciated Massif Central, and the Pyrenean sites are rather isolated from both, though there are tenuous links in the settlement pattern via the Aude and upper Garonne basins. The dense Vasco-Cantabrian group, while connected to the sites of the lower Adour/Pays Basque to the east, is cut off by the then glaciated Cantabrian Cordillera/Picos de Europa from the rest of Iberia. At the other end of the Pyrenees, there is a site in French Catalonia (Embulla) at least geographically associated with the dense cluster of Solutrean sites in Gerona. Recent discoveries at Abauntz (Navarra) and Chaves (Huesca) (Utrilla 1982; Baldellou & Utrilla 1985), as well as some foliate points from mixed quarry collections from Coscobilo (Navarra), raise the intriguing possibility of some Solutrean-era use of the southern Pyrenean flanks/Ebro basin. The dense, but untill recently little-known cluster of Solutrean sites in Portuguese Estremadura (the region between the lower Tagus and the Atlantic) is isolated on the one hand from Cantabria (separated by the Cantabrian Cordillera, Peña de Francia, Montes de Leoñ and Serra da Estrela, which was also glaciated) and on the other hand from the sites of Andalusia and Valencia. However the presence of possible Solutrean points (including one stemmed point resembling the Parpalló type found both in eastern Spain and in Portugal) in a number of old sand pits in Madrid (e.g., Pericot & Fullola 1981; Martinez 1984) and the existence of two Solutrean sites in the northern interior of Alentejo (the art cave of Escoural and the open-air locality of Monte de Fainha) suggest the existence of avenues of communication across central Iberia via the Tagus and Guadiana basins. (Survey and cave testing in summer of 1988 failed to reveal any evidence of Solutrean or other Upper Palaeolithic occupation in the Al-



1. Peña de Candamo
2. Cueva Oscura de Peràn
3. La Lluera, Las Caldas, La Viña
4. El Cierro, Cova Rosa
5. El Buxú, Aviao
6. Coberizas, Cueto de la Mina, La Riera, Tres Calabres, Balmori
7. Sel
8. Cueva Chufin
9. Altamira
10. Peña de Carranseja
11. Hornos de la Peña
12. La Pasiega, El Castillo
13. El Pendo, Cobalejos, Camargo El Ruso
14. Cueva Morín
15. La Bona, El Salitre, Fuente del Francés
16. El Mirón, La Haza
17. Atxeta, Santimaniñe
18. Bolinkoba, Axturi
19. Ermittia, Ekain, Amalda
20. Aitzbitarte III &IV, Torre
21. Isturitz, Azkonzilo
22. Chabiague
23. Rivière, Saussaye (Tercis)
24. Montaut
25. Grotte du Pape (Brassempouy)
26. Haréguy
27. Les Harpons (Lespugue)
28. Gourdan
29. Roquecourbère
30. Montfort
31. Le Mas d'Azil
32. Massat
33. La Carane
34. Les Grande et Petite Grottes de Bize
35. La Crouzade
36. Les Embullas
37. Reclau Viver, L'Arbreda, Embula, El Encantats, Davant Pau, Bora Gran
38. Cau de Les Goges
39. Parpalló, Les Mallaetes, Cova del Llop, Barranc Blanc, Rates Penaes, Cap Gros, Les Maravelles; 40. Covalta; 41. Les Calaveres Cova Beneito; 42. Ambrosio, Chiquita de las Treinta, 43. El Serron, Los Murciélagos; 44. Los Tollos, Vermeja, Palomarico; 45. Cantos de la Visera, Horadada; 46. Los Mortolitos, Cejo del Pantano, La Moneda, Hernandez Ros; 47. Tajo de Jorox; 48. Ana de Quadra Salcedo, Nerja; 49. Valdivia, La Parra, La Huerta de Bon Andrés, El Sotillo, Los Vascos, El Cojo, Martinez, Nicasio Poyato, Camorro, Vidal; 50. Caldeirão, Almonda; 51. Monte de Fainha; 52. Ponte de Lage, Cascais; 53. Vila Pouca; 54. Salemas, Correio-Mor; 55. Furninha; 56. Casa da Moura; 57. Ourão; 58. Vale de Almoinha, Baio, Santa Cruz, Porto Dinheiro, Lapa da Rainha; 59. Olival do Arneiro; Passal, Vale Comprido; Quintal da Fonte; 60. Escoural; 61. Chaves; 62. Abauntz Coscobilo, 63. Pantano de Cubillas; 64. Los Ojos

Fig. 1. Solutrean sites of Iberia & southern France

garve (Straus 1988). Future work should concentrate on deeply buried cave and open air sites, by following up on fortuitous Solutrean discoveries, as Otte is doing in the case of the well at Monte de Fainha in Alentejo. (Roche 1972)).

The Solutrean of Iberia

In the present state of our knowledge, the distribution of Solutrean sites on the Iberian Peninsula is fundamentally peripheral – along the coasts. The low coastal areas, usually flanked by interior hills or mountains were probably far more hospitable and richer in wide varieties of food resources than the high, cold, desolate mesetas of much of the Peninsula. The coastal margins of the Peninsula afforded the diversity of resources typical of ecotones. Both in Cantabria and Levante there is substantial evidence for the exploitation of marine molluscs (and at La Riera, anadromous fish) beginning in the Solutrean (Straus & Clark 1986; Davidson 1983). That the interior was occasionally used at some times during the Upper Palaeolithic (though not necessarily during the LGM, when it would have had a particularly continental climate and few, scattered food resources, plus expanded areas of glaciation) is attested to by the existence of rupestral art sites in Burgos, Segovia, Guadalajara, Caceres, Jaen, Albacete and Tras-os-Montes. The few possible Solutrean find-spots in central Spain suggest at least some inland expeditions during the LGM.

The Solutrean of Spain, first synthesized entirely on the basis of old collections by Jorda in 1955, has recently been the subject of regional summaries anchored by one or more major new excavations per region (Straus 1975, 1983b; Straus & Clark 1986; Corchon 1971, 1981; Fullola Pericot 1979; Soler & Maroto 1987; Ripoll Lopez 1986, 1988). The Solutrean of Portugal, first reviewed by Ripoll Perello in 1965 and Roche in 1974, has recently been enriched by new discoveries (at Caldeirão and Almonda), the first radiocarbon dates and syntheses all by Zilhão (1984, 1987, 1988).

As observed earlier by Smith (1973), Straus (1977b, 1977c, 1978, 1983b), Fullola Pericot (1985) and others, the various Solutrean regions are often distinguished by the presence of distinctive point types: the lower Adour by asymmetrical Montaut leaf points, Asturias and Santander by concave base points, Levante by stemmed Parpallo points. Some point types tend to be more frequent in certain areas than others (e.g., true willow leaves in SW France; slightly tanged rhomboidal points in Cantabrian Spain and especially in Euzkadi; backed shouldered points in Mediteranean Spain and invasively retouched ones in Cantabrian Spain, although the two types are not mutually exclusive). Other regions are distinctive for their lack of common generic Solutrean point types (shouldered points absent north of the Loire and in the Saone valley according to Smith (1966)). Part of this variability could be due to temporal or raw material considerations, but much of it is probably the result of actual social and territorial separation. It is interesting to note cases of "out-of-place" geographic diagnostic types: Parpalló points in Madrid and in Portugal, concave base points in the Spanish and French Basque Country, Montaut points in Cantabrian Spain, Cantabrian-type shouldered points in Portuguese Estremadura. Such specimens are suggestive of actual contacts (direct or indirect) among different Last Glacial Maximum populations (regional bands) or of movements of people. We presently lack the petrographic analyses which might help answer the obvious question as to whether these "exotic" pieces represent actual imports or local "imitations" of foreign styles of projectile tips.

Solutrean Chronology

The chronology of the Solutrean is now quite well established. Table 1 contains the list of all known radiocarbon dates associated with Solutrean points, as well as those dates from Southwest Europe which fall within the LGM time frame even if Solutrean points were not found in the dated deposits. The dates clearly show that, overall, Solu-

Table 1

RADIOCARBON DATES FOR THE SOLUTREAN & LAST GLACIAL MAXIMUM IN SOUTHWEST EUROPE

Site	Level	Lab. No.	Date BP (Libby half–life)	Solutrean "Stage"	
		SOUTHWESTERN FRANCE			
Abri Fritsch	8d	GrN–5499	19,280 ± 230	..Upper..	
Roc de Sers	--	Gif–3609	19,230 ± 300	"Upper"	
Laugerie – Haute	2	GrN–4605	19,870 ± 190	"Final"	
"	2	GrN–4441	20,000 ± 240	"Final"	
"	5	GrN–4442	19,600 ± 140	"Upper"	
"	5	GrN–4495	19,740 ± 140	"Upper"	
"	12a	GrN–4469	20,160 ± 100	"Lower"	
"	12a	GrN–4446	20,810 ± 230	"Lower"	
"	12d	GrN–4573	20,750 ± 150	"Lower"	
"	H1 (12)	GrN–1888	20,890 ± 300	"Lower"	
La Tannerie	--	Ly–2228	18,020 ± 270	"Upper"	
Combe Saunière	IV (1)	OxA–485	16,300 ± 220	"Upper"	(top)
"	IVa (1)	OxA–488	17,700 ± 290	"Upper"	
"	IVb	Ly–3329	17,470 ± 240	"Upper"	
"	IV (1)	OxA–489	19,450 ± 330	"Upper"	
"	IV (2)	OxA–751	15,190 ± 200***	"Upper"	
"	IV (8)	OxA–752	19,490 ± 350	"Upper"	
"	IV (9)	OxA–753	19,630 ± 320	"Upper"	
"	IV (10)	OxA–754	15,200 ± 200 ***	"Upper"	
"	IV (11)	OxA–755	14,890 ± 200***	"Upper"	
"	IV (12)	OxA–756	15,120 ± 200***	"Upper"	
"	IV (14)	OxA–757	18,860 ± 320	"Upper"	(base)
Cuzoul (Vers)	30	Gif–6699	19,400 ± 210	"Upper"	
Grotte du Phare	L *	Gif–6777	19,900 ± 350	?	
		EASTERN FRANCE			
Solutré	240–250 cm	Ly–1533	19,590 ± 280	"Middle"	
"	210–250 cm	Ly–1534	17,310 ± 470	"Middle"	
"	9b	Ly–316	17,150 ± 300	"Middle"	
"	8b	Ly–314	16,740 ± 300	"Middle"	
		SOUTHEASTERN FRANCE			
Oullins	d2	MC–2358	20,920 ± 350	"Upper"	
"	d2	Ly–1984	20,100 ± 500	"Upper"	
"	d2	Ly–1985	20,060 ± 450	"Upper"	
"	7	Ly–799	19,710 ± 400	"Lower"	
"	6	Ly–798	19,360 ± 420	"Lower"	
Tête de Lion	E -F *	Ly–847	20,650 ± 800	"Lower/Middle" (?)	
La Salpêtrière	i 3	MC–2085	20,500 ± 300	"Middle"	
"	i 1 = 8 – 9	MC–1372	18,700 ± 500	"Middle"	
"	i 1	MC–1370	19,100 ± 500	"Middle"	

La Salpêtrière	"	i = 8	MC–2449	21,600 ± 700	"Lower/Middle"
"		i	Ly–2050	18,290 ± 250	"Middle"
"		i	Gif–6018	18,600 ± 350	"Middle"
La Salpêtrière		8	Ly–2051	18,680 ± 680	"Middle"
"		24	Ly–941	20,200 ± 660	"Middle"
"		v2	Ly–940	17,900 ± 690	"Middle"
Chabot		2	Ly–699	17,700 ± 400	"Lower"
"		2a	Ly–698	18,200 ± 400	"Lower"
Embulla		1	?	16,560 ± 250	"Upper"
			NORTHERN SPAIN		
Amalda		IV	I–11435	16,090 ± 240	"Upper"
"		IV	I-11428	16,200 ± 380	"Upper"
"		IV	I–11355	17,580 ± 440	"Upper"
"		V *	I–11372	17,880 ± 390	?
"		V/VI *	I–11663	19,000 ± 340	?
Urtiaga		F	GrN–5817	17,050 ± 140	?
Lezetxiki		IIIa *	I–6144	19,340 ± 7.0	?
Aitzbitarte IV		VIII	GrN–5993	17,950 ± 100	"Upper"
Ekain		VIII *	I–13005	20,900 ± 450	?
Chufin		1	CSIC–258	17,420 ± 200	"Upper"
La Riera		17	GaK 6445	16,900 ± 200	"Upper"
"		17	GaK–6444	17,070 ± 230	"Upper"
"		16	GaK–6983	18,200 ± 610	"Upper"
"		15	UCR–1272A		
"		15	UCR–1272A	17,225 ± 350	"Upper"
"		14	UCR–1271A	15,690 ± 310	"Upper"
"		12	GaK–6446	17,210 ± 350	"Upper"
"		10	GaK–6447	19,820 ± 390	'Upper"
"		8	GaK–6450	15,860 ± 330**	"Upper"
"		8	GaK–6981	20,690 ± 810	"Upper"
"		4	GaK–6984	20,970 ± 620	"Upper"
"		1 *	UCR–1270A	19,620 ± 390	?
"		1*	Ly–1783	20,360 ± 450	?
"		1 *	BM–1789	20,860 ± 410	?
Las Caldas		3	Ly–2421	18,250 ± 300	"Upper"
"		4	Ly–2422	1.,050 ± 290	"Upper"
"		7	Ly–2423	18,310 ± 260	"Upper"
"		9	Ly–2424	19,390 ± 260	"Upper"
"		12 top	Ly–2425	19,030 ± 320	"Middle"
"		12 base	Ly–2426	19,480 ± 260	"Middle"
"		16	Ly–2428	19,510 ± 330	"Middle"
		18 *	Ly–2429	19,000 ± 280	"Middle" (?)
Hornos de la Peña		?	BM–1881	18,230 ± 510	?
Hornos de la Peña		?	BM–1882	19,950 ± 300	?
Hornos de la Peña		?	BM–1883	20,700 ± 350	?

		EASTERN SPAIN			
Chaves	C1	GrN–12681	19,700 ± 310	"Upper"	
Reclau Viver	2-3. 2 m	M–1019	13,200 ± 600 ***	"Upper"	
L'Arbreda	1	Gif–6418	17,320 ± 290		
"	2	Gif–6419	17,720 ± 290	"Upper"	
Parpalló	4.0-4.25 m	Birm–521	17,900 ± 340		
"	4.75-5.0 m	BM–861	18,080 $^{+850}_{-770}$	"Upper"	
"	6.25-7.75 m	Birm–520	20,170 ± 380	"Lower"	(?)
Parpalló	6.5-7.0 m	BM–859	20,490 $^{+900}_{-800}$	"Lower"	
Les Mallaetes	III	KN–I/918	16,300 ± 1500	..Upper..	
..	Va	KN-I/919	20,140 ± 460	"Middle"	
"	VI	KN-I/920	21,710 ± 650	"Lower"	(?)
Les Calaveres	I	?	20,665 ± 1066	"Upper"	(?)
		SOUTHEASTERN SPAIN			
Ambrosio	II	Gif–7276	16,500 ± 280	"Upper"	
"	IV	Gif–7275	16,620 ± 280	"Upper"	
"	VI	Gif–7277	16,590 ± 1400	"Middle"	
Cova Beneito	--	Ly–3593	16,560 ± 480	"Upper"	
		PORTUGAL			
Vale Almoinha	--	ICEN–71	20,380 ± 150	"Upper"	
Caldeirão	Eb	ICEN–70	14,450 ± 890 **	"Upper"	
"	Fa	ICEN–69	15,170 ± 740 **	"Upper"	
"	Fa	?	20,400 ± 270	"Upper"	
"	H	?	19,900 ± 260	"Middle"	
"	I	?	22,900 ± 380	"Lower"	
Cabeço do Porto Marinho I	Lower *	SMU –	16,990 ± 446	?	

*: No Solutrean points found.

**: Date probably too young, but plausible at +1 or +2 sigma:

***: Date too young; probably contaminated.

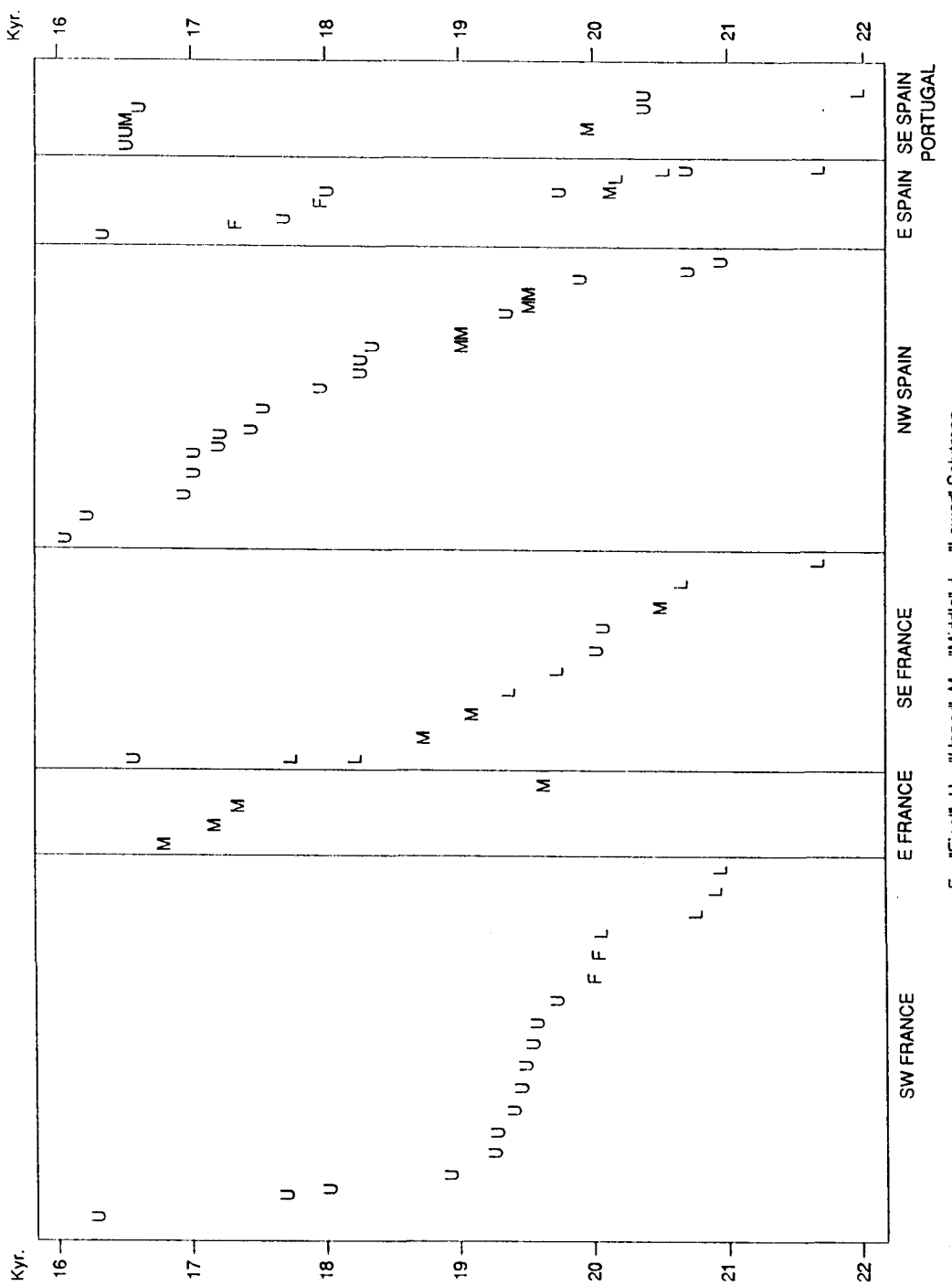


Fig. 2. Solutrean ^{14}C dates

trean points were made during the period between about 21,000 and about 17,000 or maybe even 16,000 years ago. All the long series of radiocarbon dates (Laugerie-Haute, Combe Saunière, Las Caldas and La Riera) and several of the short series have reversals in the stratigraphic ordering of the mean dates, although usually at one or two standard deviations the series are coherent. There are, however, some very serious inversions that are likely cases of contamination, stratigraphic mixing, downwardly migrated samples or laboratory error. At this time, dates of at least less than 16,000 BP would seem to be suspect.

If one discounts the young dates from Combe Saunière (which are more likely to have been contaminated with younger materials moved or percolated from higher strata than are the "old" dates susceptible to contamination from below and which occur throughout the entire stratigraphic sequence in association with other dates 3–4000 years older), it would appear that the Solutrean point technology survived longer in Spain (until perhaps as recently as 16,000 BP) than in France. It could be hypothesized that a less forgiving environment further north made the development of even more effective, efficient weapons advantageous to human groups sooner than in the somewhat more benign south. Noteworthy is that fact that the entire sequence of so-called Solutrean stages is contained within the space of only 1000 years at Laugerie-Haute, still the only site where all those stages are represented. At that classic site, the "Upper" Solutrean dates to around 20,000 BP, whereas most Iberian "Upper" Solutrean levels date to 1000– 3000 years more recently (Fig. 2). There are substantial temporal overlaps both within and among regions among assemblages attributed by archaeologists to the different Solutrean "stages" on the bases of the presence or absence of supposedly diagnostic foliate point types. Perhaps the only significant temporal trend that stands out in several long Solutrean stratigraphic sequences is the replacement of the foliate points by a weapons technology consisting of osseous points and backed bladelets. With the new date from Embulla, it is possible that part of the disparity in ages between north and south is a result of sampling, but that site is almost in Spain. (The "end" of the Solutrean in Portugal is still an open question, since the dates from Caldeirão are on samples that included rabbit bones that could be intrusive from higher levels; the new dates for the "Upper", "Middle' and "Lower" Solutrean are much older (Zilhão 1988 and this volume). Certainly the "beginning" seems very early there.) The many late Solutrean radiocarbon dates from Vasco-Cantabria, Levante and Andalusia do fully overlap with the early "Magdalenian" time range in Guyenne, however it has been argued on sedimentological grounds that the Solutrean of Le Malpas in Dordogne cntinued well into a time period when there were already "Magdalenian" materials at Laugerie-Haute (Laville *et al.* 1980: 307–311). The substantial overlap of "Middle" and "Upper" Solutrean dates at several sites with early Magdalenian and "Badegoulian" dates at sites also in classic regions of France is graphically demonstrated by Trotignon *et al.* (1984: Table 17), and has been recently confirmed by dates as early as 18,400 and 18,300 B.P. for the Magdalenian 0 of Le Cuzoul, where, as at the Abri Fritsch, it overlies an "Upper" Solutrean dating to 19,400 B.P. (Clottes & Giraud 1989).

Point, Counterpoint

One fact that seems apparent from the now abundant corpus of Solutrean dates is that the traditional "stages', developed in Dordogne and refined by Smith (1966), do not have universal value. I have made this argument several times before and thus will not belabor it here, referring the reader instead to earlier publications (Straus 1983b, 1986, for example). Suffice it to say that even within France, assemblages attributed to the "Middle" or even "Lower" Solutrean (because of the presence of laurel leaves or unifacial points and the absence of shouldered points and (always rare) willow leaves) date to ages contemporary with or even younger than the "Upper" Solutrean at Laugerie–Haute. Among such sites are Solutré, Oullins, La Salpêtrière and Chabot.

For reasons of sampling error and functional differences among and functional changes within sites as loci of activities on landscapes, specific types of points may or may not be found. Even at Laugerie-Haute, the supposed diag-

nostics of the "Upper Solutrean" are very rare in most of the relevant collections analyzed by Smith (1966). By contrast other sites, notably le Fourneau-du-Diable, have yielded huge quantities of shouldered points. Many "Solutrean" sites are so defined on the basis of the discovery of only one or two points; this is strikingly typical of the situation in Euzkadi for reasons that are as yet unclear (Straus n.d.a., 1990). Since, in the traditional scheme, the point types do not replace one another but are rather added on to the existing types in the Solutrean repertoire (e.g., Smith 1964), the presence of a laurel leaf does not necessarily a "Middle Solutrean" make, whereas the presence of a shouldered point by definition does signify an "Upper" Solutrean. The potential importance of sampling error or variability in site role in this kind of scheme is obvious. For example, at the recently and carefully excavated sites of Las Caldas (Corchón 1981) and La Riera (Straus & Clark 1986) there are levels bracketted by Solutrean levels but that themselves lack any points. In some of the levels with no "Upper" Solutrean diagnostic artifacts (shouldered and concave base points in Asturias), Solutrean points in general are so few and so fragmentary as to be poor indicators of stage attribution, even by normative criteria. (Some of the pieces could be unfinished blanks, others could be tip fragments of diagnostics, themselves undiagnostic since it is the bases of the "Upper" Solutrean points that are indicative of their typological affiliation.)

In all of Cantabrian Spain, there are only two long Solutrean sequences from published, modern-quality excavations: Las Caldas and La Riera. (Other recent excavations have either uncovered only single Solutrean levels or are unpublished.) At Las Caldas the "Upper" Solutrean fossil directors happen to have been found in some of the uppermost levels, radiocarbon dated between about 19,400 and 17,000 BP. At La Riera the shouldered and concave base points happen to have been found in some of the lower levels (radiocarbon dated quite securely between about 21,000 or 20,500 and about 19,800 BP – dates that, incidentally, are not out of line with other "Upper" Solutrean dates from such sites as le Cuzoul, Fritsch, Roc de Sers, Combe Saunière, and especially Laugerie-Haute, Oullins, Chaves and Vale Almoinha). With the exception of a mesial willow leaf fragment found in Level 17 (17,000 BP), Levels 11–17, the stratigraphically uppermost Solutrean levels at La Riera, yielded only 4 fragments of laurel leaves (one a convex base, the rest banal). Of the 19 definite concave base points (all basal fragments – no whole points), 18 came from levels 4–7. The remaining point fell from the stratigraphic section during cleaning and was labelled as coming from Level 10 "or lower", so it too could belong to the basal levels. The mesial point fragment from Level 2 (Straus & Clark 1986, Fig. 8.9, No. 1) classified as a "laurel leaf", could probably better be called a willow leaf – another " Upper" Solutrean diagnostic in a very early level. Thirty-two of the 34 definite shouldered points (i.e, fragments including the shoulder, plus 3 nearly whole points) from our excavations in La Riera were found in Levels 4–7 and one each was found in Levels 3 and 8. There is an isolated possible shouldered point stem fragment in Level 10. However, almost all the shouldered point stem and tip fragments and almost all the likely distal and mesial fragments of concave base points were found in Levels 4–7. Thus the vast majority of the "Upper" Solutrean fossil directors occur in the lower levels dated to around 20,000 BP, while there are a few others (two willow leaves and a possible shouldered point) associated with a few "Middle" Solutrean types in the higher levels, dated around 18,000–17,000 BP at La Riera. The interesting thing about the La Riera situation is that the lower levels with the vast majority of shouldered and concave base points yielded other data which suggest that they may represent residues of specialized hunting camps. Ibex seems to have been the main game, little stone knapping seems to have taken place in the cave (at least not primary reduction), and some of the flints used seem to be non-local (see Straus & Clark 1986 for a full discussion). The fact that all the points are broken (with many snaps and several pseudo-burinations that are probably impact fractures) indicates that the bases may have been returned to the site still attached to their shafts and the tips may have come back imbedded in carcasses. Other sites with numerous whole Solutrean points (e.g. Cueto de la Mina, Fourneau-du-Diable) may have been places where such weapon tips were manufactured and "stockpiled".

The association of both large concave base points and smaller shouldered points with ibex remains in the early Solutrean levels at La Riera brings up the question of point function. At this stage we simply cannot correlate speci-

fic point types with specific game or even sizes of game. The specialized ibex hunting at Bolinkoba in Vizcaya went on from Gravettian through Magdalenian times with a variety of probable osseous and lithic weapon tips; the associated Solutrean ones are large rhomboidal laurel leaves (and possible fragments thereof). At faunistically more generalized (but red deer-dominated) sites such as Altamira, one finds the whole gamut of point types, but at others one point type dominates heavily, as at Las Caldas, where there are many concave base points and few other types including shouldered ones. It is more likely that point types were associated with different types of hafts and weapons and with different hunting tactics, than with specific game.

Point Metrics

Statistics on the two most measurable point types (shouldered and concave base) were provided in Straus (1983b: 125–126). These data included the samples from our 1976–79 excavations in La Riera. Since then, further points have been published from the new excavations in Las Caldas (Corchon 1981), slightly modyfying the statistics on concave base points. For all concave base points from Las Caldas, maximum width data are:
n = 45; x = 2:29 cm.; SD = 0.42; COV = 18.34.
Concavity width data are: n = 35; x = 1.79 cm.; SD = 0.39; COV = 21.79.
Unbroken point length data are: n = 13; x = 6.71 cm.; SD = 1.59; COV = 23.70.
(Due to typographical errors in Straus (1983b: 125), coefficients of variation for maximum width of concave base points at the other sites should be corrected. The correct "COV's" are 13.37 for Cueto de la Mina, 20.09 for La Riera 12.68 for Altamira and 14.09 for La Pasiega.)

Because it seemed conceivable that the frequently cooccurring shouldered and concave base points of Cantabrian Spain had different hafting and utilization modes, I have calculated statistics for all the available points in the two groups.

LENGTHS OF WHOLE POINTS (ALL SITES)

	Shouldered Pts.	Concave Base Pts.
n:	99	44
x:	4.94 cm.	6.34 cm.
SD:	3.98	1.33
COV:	80.57	20.98

TIP ANGLES (ALL SITES)

n:	100	25
x:	41.56 deg.	45.84 deg.
SD:	12.59	19.43
COV:	30.29	42.39

MAXIMUM WIDTHS*

n:	100	45
x:	1.37 cm.	2.29 cm.
SD:	0.30	0.42
COV:	21.90	18.34

*Sample for shouldered points: Cueto de la Mina, La Riera, Tres Calabres + El Buxu; sample for concave base points: Las Caldas.

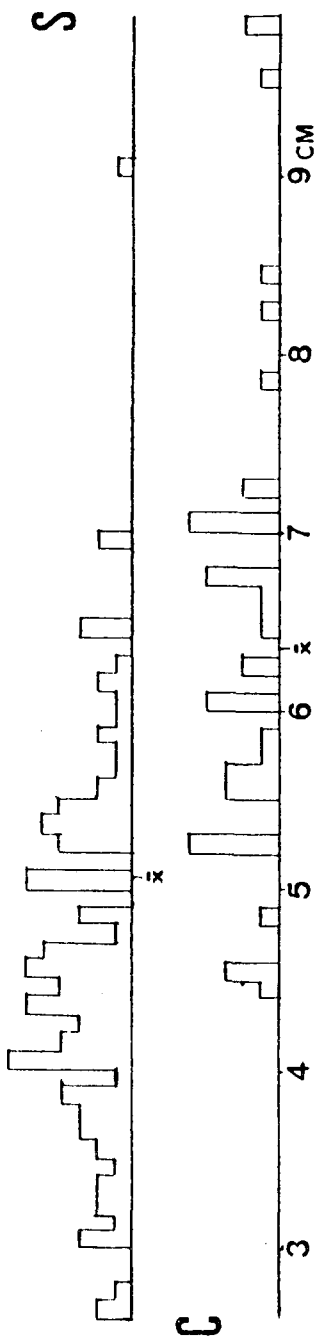


Fig. 3. Shouldered and concave base point lengths. Cantabrian Solutrean.

The differences between the mean lengths, widths and tip angles of shouldered and concave base points are all statistically highly significant ($p = 0.01$, $z = 2{,}58$). Although the distributions of point lengths and tip angles overlap considerably, these results strongly suggest that the two point types were not strictly isofunctional. A reasonable hypothesis, based on the difference in size between the two types, would be that the small (and lighter, ca. 3 gm) shouldered points were used as tips for missles (darts or arrows), while the larger (and heavier, ca. 9 gm.) concave base points were used as tips for spears. The former would have been hafted onto very slender shafts or foreshafts. Not surprisingly, if this hypothesis of difference in the mode of utilization is correct, the most dramatic metric dichotomy has been observed in the point widths: the concave base points are on average nearly twice as wide as the shouldered points (Fig. 3).

An alternate form of possible spear point used in Vasco-Cantabrian Spain was the slightly tanged rhomboidal points one or more recognizable ones of which have been found at Las Caldas (n =3), La Riera (1), Cueto de la Mina (3), Chufin (1), Altamira (1), Hornos de la Peña (3), El Pendo (1), Morin (1), El Castillo (1), Atxurri (1), Bolinkoba (4). Summary statistics are these:

RHOMBOIDAL POINTS (ALL SITES)

	Pt. Length	Pt. Width	Thickness	Max. Tang Width	Tang Length	Tip Angle
n:	6	20	17	20	19	9
x:	5.19 cm.	2.16 cm.	0.53 cm.	1.60 cm.	1.53 cm.	52.89 deg.
SD:	0.88	0.32	0.13	0.25	0.46	10.88
CV:	16.96	14.81	24.53	15.63	30.07	20.57

It is worth noting that the width of the rhomboidal points is essentially the same as that of the concave base points. Width dimensions, as with the shouldered and concave base points, seem to be the ones that Solutrean artisans most closely standardized. This is undoubtedly due to considerations of hafting and penetration. Standardized widths on such disposable elements of multicomponent weapons systems would have been important to the efficient functioning of such systems (i.e., the ease of rearming after loss or breakage of a point). The lithic element was the more expendable part of the system, whereas the wooden shaft and possible antler foreshaft were the more "curated" components. What I am suggesting here is that concave base points and rhomboidal points (as well as other rarer large point types, such as convex and straight base ones) may have been at least roughly isofunctional in the sense that they were probably tips for spears. Whether these spears were thrust or hurled cannot be ascertained at this time. The shouldered points (and perhaps some of the rarer small willow and laurel leaves) were probably tips of missles which were projected ("shot"), although we do not now know how. The atl-atl had been invented by Solutrean times in Dordogne (there is an example at Combe Saunière (Stodiek n.d.), but no Solutrean atl-atl and only one certain Magdalenian one are known from Cantabrian Spain (Barandiaran 1972). The fact that birds do not seem to have been regularly acquired in northern Spain until Magdalenian times, perhaps for feathers to fletch arrows, does not mean that arrows (and bows) were necessarily not yet invented, since unfletched arrows can be shot accurately if relatively heavy (see Christenson 1986). Darts propelled by atl-atl can be either fletched or unfletched.

Although evidence of breakage was not studied specifically, my drawings of Cantabrian Solutrean points show that:

1. very few points survived whole (indeed some of the few whole ones, notably the well-known quartz rhomboidal point with a natural hole from El Pendo (Carballo 1960), may not have been intended for use);

2. step and hinge fractures are common;
3. pseudo-burin blows are fairly frequent.

These observations suggest that the points were indeed used and used as projectile tips, in line with the experimental results published by Odell & Cowan (1986) and other studies cited by Christenson (1986). However, large Cantabrian Solutrean laurel leaves may well have been used as knives – not points – as suggested by the North American type examples provided by the authors. Microwear analyses would be required to test this hypothesis.

Foliate Points versus Backed Bladelets versus Sagaies

Geneste and Plisson (1986) recently published a fascinating functional analysis of shouldered points and backed bladelets from the Solutrean levels of Combe Saunière. They conclude on the bases of striations and breakage patterns that both were used as weapon tips (although some of the bladelets were used as knives for cutting). As early as 1974, I (Straus 1974) was pointing out that backed bladelets were common artifacts in certain assemblages that were Solutrean by definition (due to the presence of at least one or a few "points"). This fact was confirmed by the results of our excavations in La Riera (Straus & Clark 1986), as well as by those of de la Rasilla & Hoyos (1988) in nearby Cueto de la Mina and of Altuna *et al.* (1988) in Amalda (Guipuzcoa). (Backed bladelets are present in most Solutrean levels at Las Caldas, but in small numbers (Corchón 1981); the unique Solutrean levels from recent, water-screened excavations at Cueva Morin and Cueva Chufin (Santander) both yielded about 11% backed bladelets in association with shouldered and foliate points (Straus 1983).

At La Riera there seem to be three kinds of Solutrean assemblages insofar as concern probable or possible weapon tips. Levels 4–7, as noted above, have large numbers (18.8–31.8%) of classic points (mostly shouldered and concave base), but they also have moderate numbers of backed bladelets (5.4–14.2%). Levels 2/3, 8–14 have few potential lithic weapon tips of either kind (0–7.0% and 0–3.1%, respectively). Levels 15–17 have virtually no Solutrean points (0–1.3%), but a wealth of backed bladelets that grows through time (11.8–70.9%). The situation in the latter three levels could be interpreted as the functional replacement of large foliate points by multicomponent points in which the backed bladelets served as barb and/or tip elements set in antler or wooden points. With many backed bladelets per point and their frequent replacement, it is not hard to explain the large numbers of these microlithic elements that come to dominate the uppermost Solutrean level at La Riera. This trend continued, of course, in the Magdalenian of La Riera and other Cantabrian sites. However, if this general interpretation (i.e., that Solutrean points and backed bladelets were at least in part isofunctional) is correct, then the near-absence of both in the basal and middle parts of the Solutrean sequence at La Riera would imply either that little hunting took place near the site or that, for some reason, points were infrequently brought back to the cave, either on shafts or in carcasses. This problem (not solved) brings up the final issue of osseous (mostly antler) points (sagaies).

The analysis by González Morales (1986) of the worked bone from La Riera permits us to examine the importance of sagaies in the putative armaments of the site through time. Basal Solutrean levels 2–3 have none; Levels 4–7 have 12 sagaies plus 12 fragments (mostly in Level 7); Levels 8–10 have 16 plus 11 fragments; Levels 11–14 have only 4 plus 11 fragments; uppermost Solutrean levels 15–17 have 6 plus 22 fragments. By contrast, early Magdalenian Levels 18–20 have 13 sagaies plus 37 fragments. While these data are hard to quantify in a standarized form, it seems clear that antler points increased in importance toward the end of the sequence of Solutrean-point-bearing levels and – together with the backed bladelets – seems to have replaced them functionally. By comparison, in the whole sequence of 17 Solutrean levels at Las Caldas (Corchon 1981), there are one legitimate and two problematical sagaies, whereas the unique Middle Magdalenian deposit yielded 13 magnificent sagaies. In my tally of sagaies with Solutrean provenience (done before the results of the new La Riera, Las Caldas or Amalda excavations were known),

I came up with a total of about 378 for the entire Vasco-Cantabrian region. This number is quite small in comparison with the numbers of sagaies attributed to the Magdalenian. By comparison, just the Magdalenian levels from the small rescue excavation in El Rascaño Cave (Barandiarán 1981) produced 72 sagaies (in addition to uncounted antler points from the various excavations of El Rascaño in the early part of this century). The first two seasons of new excavations et El Juyo Cave (Barandiarán 1985) yielded 122, adding to the scores of sagaies found in El Juyo in the original 1955–56 excavations. Just these two Magdalenian sites probably yielded as many or more sagaies than the entire group of over two dozen Solutrean assemblages inventoried by me – and they are fairly typical of Magdalenian sites in the region in terms of their richness in sagaies and other antler artifacts. Even in the absence of comparative wear and breakage studies, the case for functional replacement of large, elegant, but often fragile and "expensive" Solutrean lithic points by small, "cheap" backed bladelet elements and resilient, "cheap" antler points seems a strong one.

So What Was the Solutrean Experiment : Why did it Occur and End ?

Within the grand scheme of the development of Upper Paleolithic technology, the Solutrean phenomenon represents an attempt (or various semi-autonomous attempts ?) at using large leaf-shaped and shouldered stone points as tips for weapons (and as knives). It was certainly by no means the only time such artifacts were tried in the search for efficient, effective weaponry. The nature of lithic reduction as a manufacturing mode has led repeatedly to similar solutions, not only in Europe but also in various regions of the Old and New World at different periods. In my opinion, phylogenetic searches for the origins of the Solutrean are sterile. The Solutrean technology clearly continued and built upon the developments in stone-working of the early Upper Paleolithic. But to think of the Solutreans as a tribe or actual ethnic group of some other kind, is a chimera. This was the point that I tried to make when I argued (Straus 1975) that it was difficult (futile) to distinguish some Cantabrian Solutrean and Lower Magdalenian assemblages. Indeed, in the Basque Country, many other Solutrean assemblages (were it not for the presence of one or a few Solutrean points) could be classified as Gravettian with Noailles burins (Straus 1974, 1976a,n.d. a).

The objective of these arguments is not a normative one (i.e., to seek putative relationships between ethnic groups created by the archeologists). It is to point out that the Solutrean represented the addition of certain kinds of artifacts (probably weapon tips, made by particular techniques of invasive and backing retouch) to a generalized Upper Paleolithic technological repertoire. We have seen at La Riera (as at Combe Saunière and other sites) that this experiment in armament was not the only one going on at the time. Antler sagaies were also being used sometimes in association with backed bladelets, the latter probably as elements in weapon tips and barbs. Why after 1000–3000 years the large stone points were finally phased out and completely replaced by the sagaie + microlith system is a matter that must now be seriously investigated from a functional stand-point. The fact that the Solutrean weapons solution seems to have started earlier, ended later or lasted longer in some regions or sites than in others, is as indication of its technological (as opposed to ethnic) nature.

One other fact seems worth repeating in conclusion: the Solutrean was a phenomenon of the Last Glacial Maximum in the refugium of SW Europe. The foliate and shouldered points were probably parts of a weapons technology developed in the face of worsening climatic conditions. The technological development was a means of survival in regions rich in game, but harsh in climate and relatively densely settled as a result of the southward contraction of the human range. This was a world of possibilities for hunters (and gatherers of shellfish), but it was a more physically circumscribed, environmentally unforgiving world than of the early Upper Paleolithic. The new weapons may have helped cushion the unfavorable effects of the harsh environment, broaden the margin of error, and make long-term survival more probable even in hunting most of the same animal species as before. The Solutrean solution seems, at least in some sites, to have been acquired (whether by independent invention, wholesale borrowing from cultural contacts, or borrowing with local modification) rather suddenly in some cases.

Unfortunately we have but very few cases of chronometrically dated Solutrean levels directly overlying early Upper Paleolithic ones. At such important sites as Laugerie-Haute, Solutré, La Salpêtriere, l'Arbreda, Amalda, Cueva Morin, Parpalló and Les Mallaetes, there exist possibilities for studying the nature and timing of the development of the Solutrean technology, however at some of these sites the existence of natural or anthropogenic hiati is already known or suspected. The conditions of the initation of Solutrean point manufacture/use in each site and region would be data of capital importance to acquire, as would be microwear data on the points themselves. Also needed are petrographic data from the points to ascertain whether they are, in each case, made of local or distant lithic raw materials. If non-local, the distance(s) and direction(s) of the sources from the sites, as well as data on lithic reduction patterns and venues, would be invaluable indicators of Solutrean mobility and territorialism – and possible changes therein *vis à vis preceding and succeeding periods/adaptive systems.*

Finally, if „the Solutrean" was not a tribe or ethnic group per se, but rather a set of technological solutions, its makers and users were certainly organized into bands – both local microbands with fluid membership and regional with a far lower degree of face-to-face interaction. Indeed, we observed earlier that the distribution of Solutrean site clusters was geographically uneven, there being a few areas rich in sites and other areas of SW Europe totally or virtually devoid of Solutrean (or other Last Glacial Maximum) traces of human settlement. The cluster might well be indicative of at least the most frequently utilized parts of LGM hunting territories, even if expeditions did occasionally venture out onto the fringe lands (e.g., the Spanish mesetas and the unglaciated mountainous areas of France, Spain and Portugal).

People, objects and ideas indoubtedly did flow among the regional bands, either as a result of accidental direct contacts during such hunting expeditions, or more-or-less planned direct contacts at the time of major ceremonies, or (in the case of objets and ideas) via indirect, down-the-line contacts among bands from one end of the Solutrean oikumene to the other. Although technological convergence is a powerful fact and an often under-rated cause of perceived similarities in the archeological record, such contacts must be considered together with independent invention, in trying to decipher the general phenomenon of the development of the Solutrean technology within a relatively short period of time. More specifically, such contacts must be seriously contemplated when trying to explain, for example, the presence of Cantabrian-type shouldered points and especially the even more exotic stemmed Parpalló points in Portugal or the presence of a few Asturo-Santanderine concave base points in the Basque Country. After all, people faced with real technological needs (i.e., more efficient, more effective weapons to hunt for a living) will not only invent; they will borrow good ideas when they see them. Very much as in the present arms race, technology transfer was a fact of life in the Europe of the Last Glacial Maximum.

The Solutrean did not "end" ; it changed, adapted and became the Magdalenian, a time of expansion after the contraction of the Last Glacial Maximum, a time when some of the technological experiments of the Solutrean were downplayed and others accentuated. Large lithic points made a bit of a comeback in the Upper Magdalenian, but the antler + microlith combination seems to have become and remained the key weapons system, with increasing use of light projectiles shot by atl-atl (and possibly bow). The pendulum had swung once again in favor of antler in the Lower Magdalenian, but dampened somewhat in the Upper Magdalenian. Indeed, in the overall scheme of the Upper Paleolithic one can observe a certain degree of cyclicity in the relative importance of osseous and lithic weapon types superimposed upon the cumulative technological advances in efficiency and effectiveness. The Chatelperronian saw the appearance of osseous points which developed greatly in the Aurignacian. The Gravattian emphasized lithic points, although in its late phases "sagaies d'Isturitz" gained some importance. But with the Solutrean lithic points were once again mostly used. The Lower Magdalenian emphasized sagaies (combined with microliths), and, while they – plus the new antler harpoons – remained very important weapon tips in the Upper Magdalenian, lithic points did reappear in northern Europe and France. The increased importance of lithic elements continued apace in the Azilian, whereas many Mesolithic industries emphasized the combination of geometric microliths and elements. If such a cyclical pattern is real, then its explanation presents a fascinating challenge to processual prehistorians !

The Solutrean is not a mystery to be explained away in terms of folk origin myths, but rather a technology to be understood in terms of adaptive processes in the context of specific environmental and social milieux.

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