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Osseous Projectile Weaponry

Towards an Understanding of Pleistocene Cultural Variability

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Cover illustration: View from inside Vindija Cave, Croatia (Photograph: I. Karavanić), with overlay of Magdalenian antler projectile technology (single bevel based point, baguette demi-ronde, and double bevel based point, all from Isturitz, France), and tracings of Magdalenian parietal images of projectile technology

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Foreword: Invention, Innovation, and Creative Imagination

Originally: An Invention

Hunted prey can be grouped into either aggressive and fierce or timid and cautious animals. To avoid dangerous hand-to-hand combat (with the former) or to catch the animals before they vanish from sight (the latter), hunters have created weapons able to mortally wound animals from a safe distance. This concept of risk reduction, developed alongside increasing efficiency of projectile weaponry in various countries around the world during prehistoric times, constitutes what A. Leroi-Gourhan termed a "tendance" ("general trend") (Leroi-Gourhan 1971). The contributions published in this book demonstrate that these projectile hunting inventions are indeed a worldwide phenomenon.

The primeval invention must have been the spear or javelin made from a single piece of wood, the idea for which must have "sprung" into the hunters' mind since no reference existed concerning a previous device or technique. As noted by Voltaire, "the genius of invention opens a way to where nobody walked before" (as quoted in Héritier [2001]). This first projectile weapon was likely utilized throughout the world; however, only exceptional preservation conditions have permitted the survival to the present day of a very small number of examples. The eight wooden spears from Schöningen (Germany), aged 300 ka, are such an example and are among the oldest identified artifacts of this kind (Conard 2005:302).

Later: Multiple Innovations

"Whereas an invention is the discovery or the recognition of a new process, object, device, or technique, an innovation is the adoption, application, or utilization of a newly founded process, object, device" (Knecht 1991:116). Later, hunters contrived new weapons which included a point tied to a wooden shaft and manufactured in a hard material such as bone, ivory, stone, or in some tropical environments, hardwood. The purpose of this technological alteration was to make the extremity of the weapon more solid and acute, causing the weapon to penetrate deeper and result in a significantly more lethal injury to the prey. This change can be considered as an improvement or an "innovation."

Overall the morphology, volume, and weight of the points fastened onto shaft extremities depended on several variables: the environmental milieu, the system of propulsion utilized, and the technical traditions practiced. In particular, environmental resources determine the raw materials able to be selected for use in weapon construction. Wood was probably the only material used for the fabrication of shafts, since only tree branches split along the grain can yield the required long straight rods. More recent evidence (i.e., Mesolithic, Neolithic) suggests that pine or yew wood may have been used during the European Paleolithic, but other vegetal species would have been selected according to climates and landscapes. The use of driftwood was also certainly not neglected, as it has been shown that this resource was utilized

in Arctic countries (where wood is scarce) for millennia. For instance, in several remarkably preserved archaeological Thule sites, elements of drift conifers (*Picea* sp.) were selected for making weapon shafts along with other objects (Alix 2007). In other geographical areas, ethnographic records provide additional information regarding the use of wood for projectile weapon components. For example, in the archipelagoes of Austral America, the Alakaluf still used branches of *canelo* (*Drimys winteri*) for the shaft of their harpoons at the beginning of last century (Emperaire 2003:329). In the relatively stable environment of this latter area, we might assume that their ancestors did the same 6000 years ago.

The hard animal materials commonly adapted to the manufacture of projectile points are ivory, antler, and bone. Their natural elongate shapes and thick cross sections permit blanks suited to point morphology. Shell elements, which can be very breakable, seem less propitious. Apart from the raw materials supplied through hunting, it has been found that ivory tusks were also recovered from carcasses of animals which died naturally, while antlers that were shed seasonally by the animals were collected from the landscape. The choice of point raw material depended on the animal resources available in each region, with mammoth ivory and reindeer antler constituting choice materials for the European Paleolithic, in addition to antler from *Cervus elaphus* (red deer) in Mediterranean regions where reindeer (*Rangifer tarandus*) did not venture.

The specific origin of the bones utilized in projectile point manufacture in Eurasia is less well documented (apart from mammoth ribs, which are easily recognizable), owing to the complete modification of the point blanks while in manufacture, but in a few cases horse or reindeer bones have been able to be identified. Recently, however, a few projectile points and foreshafts made of whale bone were identified in the French Pyrenees and central German Rhineland, confirming a Paleolithic relationship with the ocean shore (Pétillon 2009; Langley and Street 2013). Ethnographically, whale bones were preferred for manufacturing barbed points and harpoons in the archipelagoes of South America, though some of these items were made from huemul (*Hippocamelus bisulcus*; a small cervid) antler. Apart from possible points in mastodon (*Mammut americanum*) ivory in North America, or of walrus (*Odobenus rosmarus*) and narwhal (*Monodon monoceros*) in Arctic areas, bone and antler are generally the most frequent materials used for projectile points both ethnographically and prehistorically.

The volume and the weight of spearheads should normally be related to the propulsion system, either directly propelled by the strength of the muscles (hand-thrown) or by a range of implements intended for increasing efficiency, such as spearthrowers, bows, and blowpipes ("sarbacanes"). These various devices, which themselves constitute other significant inventions, are relatively common around the globe and together represent another great "tendance" for hunter-gatherer societies. Though very few prehistoric artifacts have been preserved, ethnographic specimens show a precise correlation between the propulsion system, the weight of the head point, the length and diameter of the shaft, and the center of gravity. Since prehistoric osseous projectile points have not preserved their original wooden shafts, numerous experiments have been conducted in order to identify correlations between the morphometric criteria of flint or osseous points and their corresponding propulsion system. In spite of the numerous trials, it appears that the diagnostic correlations remain blurred (e.g., Van Buren 1974; Rozoy 1992; Cattelain 1997; Pétillon 2009).

The existence of Paleolithic spearthrower heads manufactured from reindeer antler confirms the use of this implement from at least the Solutrean until the Magdalenian in Europe; however, their scarcity suggests that many other specimens made from wood may have also existed, and their use was perhaps more extended in time. Moreover, the morphometric standardization of many Gravettian antler points, extracted from blanks by the groove and splinter technique, could be consistent with an early use of the bow (Goutas 2016). And, given the morphometric variability of point types during the Paleolithic, most specialists assume that the two propulsion systems may have coexisted or have been reinvented several times during this period. As far as the very small osseous points are concerned, if they were not inserted in composite weapons, they could only be delivered by a vegetal blowpipe, as is the case in Southeast Asian or Amazonian forests. Blowpipes made of bird bones may have been used in other countries.

Creative Imagination

The technical response of hunter-gatherers to the need to kill animals for subsistence is at the same time universal in its main features and diversified in its execution. The technical determinism—Leroi-Gourhan's "tendance"—was not only confronted with the environmental or "external milieu" (availability of raw materials) but also with the "technical inner milieu" in which previously existing mental traditions influenced the innovation processes. The conception of new weapons certainly included preexisting elements specific to each considered community (Leroi-Gourhan 1973). Thus, the evolution of the European Paleolithic osseous projectile points constitutes an excellent field of investigation given the climatic changes, the relative stability of the animal stock, and the well-known succession of techno-complexes along a long span of time. In parallel to the continuing existence of the long and robust ivory spears which were probably hand-delivered, a wide range of points with a great variety of technological designs appear. The adaptations and improvements, with a possible number of mistaken attempts, have concerned various hafting systems, the insertion of flint bladelets into osseous shafts, the carving of barbs on the shaft itself, the probable coupling of carved barbed and flint inserts into the same point (Julien 1999), the innovation of mobile heads for uniserial and biserial harpoons, and, of course, the invention of throwing implements. In the course of these 30 kyr, everything was probably experimented by European hunter-gatherers except the socket toggle harpoon heads which are found later in the North Pacific regions. In other areas, simple forms predominated, but remarkable technical convergences can be seen between barbed points and the harpoons of the Late Paleolithic, Azilian, and Mesolithic and those of the Pacific Coast of America down to the southernmost extremity of the continent (Christensen et al. 2016). Hypotheses for these patterns are still debated: was it a diffusion process or a simple technical convergence? The very early invention of the Katanga barbed points (~90–60 kyr) in Africa (Backwell and d'Errico 2016) proves that human genius always created specific solutions to predation problems. But if this barbed device was afterward forgotten during tens of millennia, it is probably because the following human groups did not find any interest in adopting it. "It is not enough for an innovation to be possible for getting materialized […], it must above all be thinkable, i.e., accepted in the mind of the people to whom it is proposed…" (Héritier 2001:7).

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Contents

Chapter 9
A Review of the Osseous Projectile Points from the Upper Paleolithic of Portugal

Marina Almeida Évora

Abstract In this chapter, I provide an overview of Portuguese Upper Paleolithic projectile points made from mammal bone and red deer antler. These artefacts were recovered from nine archaeological sites, located in two geographic regions: Estremadura and Algarve. The majority of the Upper Paleolithic osseous assemblages from Portugal come from old excavations, and as early studies of the points are rare or only preliminary in nature, our understanding of this industry in Portugal is poorly understood. Consequently, this chapter will address morphologic and functional variability of the Portuguese technology, and focus on several aspects including fracture and stigmata patterns remaining from their manufacture and use. As a preliminary conclusion, it appears that these osseous projectile points share features with similar others from the Southern Iberian region.

Keywords Gravettian • Solutrean • Magdalenian • Fracture types • Morphology

Introduction

This chapter reviews Portuguese Upper Paleolithic osseous projectile artefacts and the archaeological sites from which they were recovered. The information presented here brings together data from various Portuguese archaeological journals and congress proceedings, much of it never before available in English (e.g., Aubry et al. 1992; Aubry and Moura 1993, 1994; Cardoso and Gomes 1994; Moura and Aubry 1995; Zilhão 1995; Aubry et al. 1997; Chauviére 2002; Almeida et al. 2004; Bicho et al. 2004).

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Most of these assemblages come from old excavations which were often subjected to artefact selection first in the field, and then later, in the museum where they were curated, they must, therefore, be interpreted with caution. A few assemblages such as Vale Boi, Algarve and Buraca Grande, Estremadura come from more recent excavations and can therefore be considered more representative, though with potential sample size problems, of each geographic areas. As for Vale Boi, all sediments were sieved and all artefacts collected, the faunal assemblage is large, well preserved allowing the identification of osseous utensils in the various stages of production.

The Portuguese projectile points described herein were examined first with the naked eye, then with the use of a binocular microscope. All surface alterations and basic morphometric data were recorded.

The Archaeological Sites and the Sample

The archaeological sites that preserved organic projectile points consist of rockshelter and cave sites located mainly in Estremadura (Buraca Grande, Abrigo do Lagar Velho, Lapa dos Coelhos, Gruta do Caldeirão, Casa da Moura, Gruta da Furninha, Lapa da Rainha, Gruta das Salemas). The only site outside of this region is Vale Boi Rockshelter, located in Southwestern Algarve (Fig. 9.1). Table 9.1 provides an overview of the projectile point data described below.

Buraca Grande

The archaeological site of Buraca Grande is a rockshelter located in Serra de Sicó, near Pombal (Leiria). It was discovered in 1990 by T. Aubry and H. Moura and its stratigraphic sequence is characterized by a lower level with no absolute dates, an overlying level with Gravettian, Proto-Solutrean

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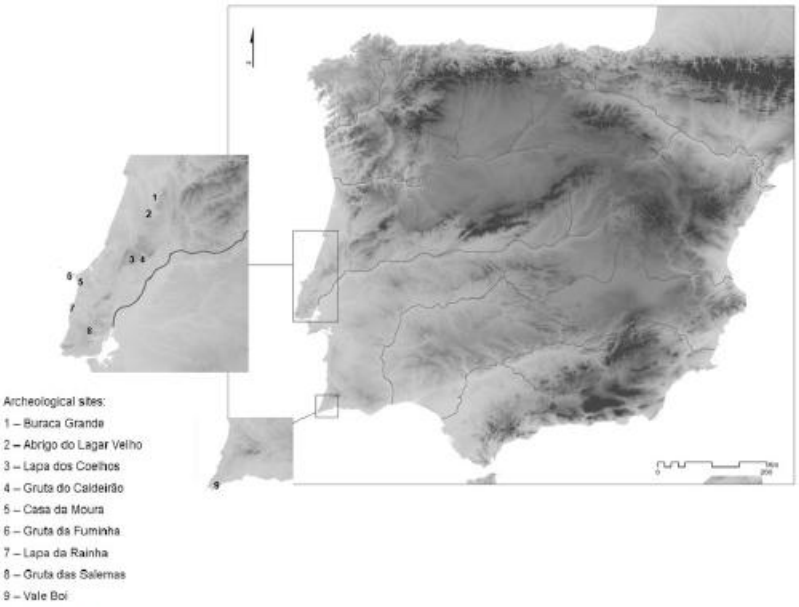

Fig. 9.1 Archaeological sites mentioned in text

and Solutrean artefacts, and at the top of the sequence, another problematic level with mixed artefacts dating from the Upper Paleolithic to modern times (Aubry et al. 1992). The rockshelter is composed of two chambers, but it was from the rearmost chamber (square K17) that a *baguette demi-ronde* fragment was recovered in a mixed sediment, and the resulting date of 13,050 ± 100 years BP provided the chronological placement of the archaeology (Aubry et al. 1997).

Also recovered from this site were eight osseous projectile points. Of these, three are of the simple base type with a convergent morphology, two have plane-convex sections and one an elliptical mesial section. Total length of these points ranges between 52 and 105 mm. One of these artefacts dates to the Gravettian, while the other two are Magdalenian. All are made from red deer antler. There is also a Gravettian single bevel point with a convergent morphology, a plane-convex mesial section and a total length of 67 mm (Fig. 9.2a). A Magdalenian *baguette demi-ronde* made from red deer antler (69 mm total length) was also found. This last artefact has a plane-convex mesial section and several diagonal striations on its inferior face. The superior face is decorated with small concavities, placed in pairs (side by side) along the length of the artefact (Fig. 9.2b). Other fragments were also recovered at Buraca Grande: mesial fragments made from red deer antler and mammal bone with fusiform morphology and diversified mesial sections ranging from 31 to 50 mm in total length and 7 to 10 mm in thickness (Table 9.1).

Abrigo do Lagar Velho

The archaeological site of Lagar Velho rockshelter is located in the Lapedo Valley, near Leiria, on the base of a limestone outcrop facing north. The site was subjected to earthmoving by the land owner with 2–3 m of sediments removed from the rockshelter (Zilhão and Almeida 2002). The archaeological materials recovered from sector TP (Hanging Remnant deposit) include two osseous projectiles. These came from levels TP06 and C6 (terminal Gravettian) dating to 22,000 ± 180 years BP (Angelucci 2002).

Table 9.1 Inventory of Portuguese Upper Paleolithic projectile points: *ind* indeterminate, *G* Gravettian, *PS* Proto-Solutrean, *S* Solutrean, *M* Magdalenian

Archaeological Site	Chronology	Level/Layer	Raw material	Artefact	Type	Morphology	Distal section	Mesial section	Proximal section	Total length (mm)	Total width (mm)	Total thickness (mm)	Deposited in
Buraca Grande	M	K17 A/12	Antler	Whole	Projectile—baguette demi-ronde	Lozange	Elliptic	Plano-convex	Elliptic	69	12	6	DRCC- Leiria
Buraca Grande	M	C8C/C9A	Antler	Mesial	Projectile?—indeterminate	Fusiform	–	Circular	–	41	7	7	DRCC- Leiria
Buraca Grande	G	K20.357.C9B	Mammal bone	Distal/ mesial	Projectile—indeterminate	Fusiform	Fusiform	Elliptic	Elliptic	50	11	9	DRCC- Leiria
Buraca Grande	M	K17 B/6 C9A.C14 (C8c)	Antler	Mesial	Projectile—indeterminate	Indeterminate	–	Circular	–	31	10	10	DRCC- Leiria
Buraca Grande	G	K19.15	Antler?	Whole	Projectile—simple bevel	Lozange	Circular	Plano-convex	Plano-convex	67	8	6	DRCC- Leiria
Buraca Grande	M	K17. C8C-C9A.103	Antler	Whole	Projectile—simple base	Lozange	Plano-convex	Plano-convex	Plano-convex	105	12	6	DRCC- Leiria
Buraca Grande	M	N19.C9A.15	Indeterminate	Proximal/ mesial	Projectile—simple base	Lanceolate	–	Plano-convex	Plano-convex	52	12	6	DRCC- Leiria
Buraca Grande	G	L17A/4 toca	Antler	Whole	Projectile—simple base	Lanceolate	Elliptic	Elliptic	Elliptic	52	10	5	IPA Pombal
Abrigo Lagar Velho	G	C6, parte W, bl abatim.	Mammal bone	Distal/ mesial?	Projectile—indeterminate	Fusiform	Elliptic	Elliptic	–	34	6	5	DGPC-Lisboa
Abrigo Lagar Velho	G	Camada TR08	Antler?	Distal/ mesial	Projectile—indeterminate	Fusiform	Elliptic	Elliptic	–	83	6	5	DGPC-Lisboa
Lapa dos Coelhos	M	C4.NA17.G3.QSE	Mammal bone	Whole	Harpoon—simple base	Lanceolate	Elliptic	Elliptic	Elliptic	44	4	3	DGPC-Lisboa
Lapa dos Coelhos	M	C4.NA12.F3.QNW	Mammal bone	Whole	Harpoon—bipointed	Fusiform	Circular	Elliptic	Elliptic	39	3	2	DGPC-Lisboa
Lapa dos Coelhos	G	NA37.CM8	Mammal bone	Distal/ mesial	Projectile—indeterminate	Fusiform	Elliptic	Elliptic	–	42	11	8	DGPC-Lisboa
Gruta do Caldeirão	M	Eb.O1 3.117.E7	Antler	Whole	Projectile—simple base	Lanceolate	Elliptic	Elliptic	Elliptic	59	13	6	MNA
Gruta do Caldeirão	M	Eb.O11.Sc242.E7	Mammal bone	Proximal	Harpoon?	Fusiform	–	–	Plano-convex	40	8	6	MNA
Gruta do Caldeirão	S-M	Fa.P13.Sc290	Indeterminate	Distal	Projectile—bipointed?	Fusiform	Elliptic	Assymetric	–	33	7	6	MNA
Casa da Moura	G	Unknown	Mammal bone	Whole	Projectile—simple bevel	Lanceolate	Elliptic	Trapezoidal	Trapezoidal	145	13	11	MG
Casa da Moura	G	Unknown	Antler	Proximal/ mesial	Projectile—simple base	Lanceolate	–	Elliptic	Elliptic	80	17	12	MG
Casa da Moura	G	f=1.60	Mammal bone	Proximal	Projectile—simple bevel	Indeterminate	–	Quadrangular	Quandrangular	44	9	6	MG
Casa da Moura	S-M	–	Mammal bone	Distal/ mesial	Projectile	Indeterminate	Circular	Circular	–	54	11	9	MG
Gruta da Furninha	Unknown	Unknown	Antler	Whole	Projectile—simple base	Lanceolate	Oval	Oval	Oval	835	127	67	MG
Lapa da Rainha	M	Corte II sec 7 a 10	Mammal bone	Whole	Projectile—trapue	Lozange	Plano-convex	Plano-convex	Plano-convex	66	14	4	UA
Gruta das Salemas	G	Unknown	Mammal bone	Whole	Projectile—simple base	Lanceolate	Circular	Elliptic	Elliptic	179	14	11	MG
Gruta das Salemas	S	t-c	Mammal bone	Whole	Projectile—bipointed	Fusiform	Elliptic	Elliptic	Elliptic	140	8	6	MG
Vale Boi	G	G24.18	Antler	Whole	Projectile—bipointed	Fusiform	Elliptic	Circular	Elliptic	138	8	8	UALG
Vale Boi	G	H23.13	Mammal bone	Whole	Projectile—bipointed	Fusiform	Circular	Circular	Circular	61	5	5	UALG
Vale Boi	G	H23.13	Mammal bone	Whole	Projectile—bipointed	Lanceolate	Elliptic	Circular	Circular	82	10	8	UALG

(continued)

Table 9.1 (continued)

Archaeological Site	Chronology	Level/Layer	Raw material	Artefact	Type	Morphology	Distal section	Mesial section	Proximal section	Total length (mm)	Total width (mm)	Total thickness (mm)	Deposited in
Vale Boi	G	H24.26	Indeterminate	Distal/mesial	Projectile—indeterminate	Fusiform	Circular	Circular	Elliptic	37	5	4	UALG
Vale Boi	S	J15.B2	Antler	Whole	Projectile—bipointed	Fusiform	Circular	Circular	Circular	896	80	64	UALG
Vale Boi	G	J18.4.9	Antler	Mesial	Projectile—indeterminate	Indeterminate	–	Oval	–	137	81	56	UALG
Vale Boi	G	J18.4.6	Antler	Proximal	Projectile—simple bevel	Fusiform	–	oval	–	135	77	49	UALG
Vale Boi	G	G25.21	Mammal bone	Distal	Projectile—pointed	Indeterminate	Circular	–	–	10	10	4	UALG
Vale Boi	S	G24.9	Mammal bone	Mesial	Projectile—indeterminate	Fusiform	–	Plano-convex	–	28	6	6	UALG
Vale Boi	G	G24.17	Antler	Mesial	Projectile—indeterminate	Fusiform	Oval	Oval	Oval	333	91	69	UALG
Vale Boi	S	J20.19	Antler	Distal	Projectile—indeterminate	Indeterminate	Oval	Oval	–	175	88	67	UALG
Vale Boi	S	J20.16	Antler	Distal	Projectile—indeterminate	Indeterminate	Oval	Oval	–	128	56	47	UALG
Vale Boi	G	H24.9	Antler	Mesial	Projectile—indeterminate	Fusiform	Plano-convex	Plano-convex	–	218	62	52	UALG
Vale Boi	G	G24.20	Mammal bone	Mesial	Projectile—indeterminate	Fusiform	–	Plano-convex	–	185	63	50	UALG
Vale Boi	S	H24.4	Antler	Distal	Projectile—indeterminate	Indeterminate	Plano-convex	–	–	17	71	65	UALG
Vale Boi	G	H24.21	Mammal bone	Mesial	Projectile—indeterminate	Fusiform	–	Elliptic	–	19	4	3	UALG
Vale Boi	G	H24.28	Antler	Mesial/proximal	Projectile—indeterminate	Fusiform	Elliptic	Elliptic	–	58	9	7	UALG
Vale Boi	G	H24.26	Indeterminate	Distal/mesial	Projectile—indeterminate	Fusiform	Oval	Oval	–	513	85	73	UALG
Vale Boi	PS	Z26.12	Indeterminate	Mesial	Projectile—indeterminate	Fusiform	–	Circular	–	108	56	56	UALG
Vale Boi	PS	Z25.5	Mammal bone	Distal	Projectile—indeterminate	Indeterminate	–	Oval	–	117	49	28	UALG
Vale Boi	G	O28.6	Antler	Mesial	Projectile—indeterminate	Fusiform	–	Oval	–	31	79	84	UALG
Vale Boi	G	O28.11	Antler	Mesial	Projectile—indeterminate	Fusiform	–	Oval	–	113	51	39	UALG
Vale Boi	S	H15.5	Indeterminate	Distal/mesial	Projectile—indeterminate	Indeterminate	–	Oval	–	163	57	49	UALG
Vale Boi	G	L20.4.6	Antler	Mesial	Projectile—indeterminate	Indeterminate	–	Plano-convex	–	86	70	60	UALG
Vale Boi	S	J16.C1	Antler	Mesial	Projectile—indeterminate	Indeterminate	–	Oval	–	137	85	66	UALG
Vale Boi	S	I17.B6	Antler	Proximal	Projectile—simple bevel	Fusiform	–	Oval	–	258	11	83	UALG
Vale Boi	S	H17.C1	Antler	Distal	Projectile—indeterminate	Indeterminate	–	Oval	–	191	89	52	UALG

Fig. 9.2 Buraca Grande: (**a**) Gravettian single bevel, (**b**) Magdalenian baguette demi-ronde (photographed by Jaime Abrunhosa); Lapa da Rainha: (**c**) Baguette demi-ronde; Gruta do Caldeirão: (**d**) Magdalenian fragment of an harpoon (?); Gruta da Furninha: (**e**) Incised mark in the proximal end of the simple base point (20× magnification)

One of the recovered projectiles is made from mammal bone, with fusiform morphology and elliptical mesial section (34 mm total length, 5 mm thickness). Since it is a distal/mesial fragment its typology cannot be determined. The second point is also a distal/mesial fragment, possibly made from red deer antler. It also has a fusiform morphology and an elliptical mesial section (83 mm total length, 5 mm thickness).

Lapa dos Coelhos

The Lapa dos Coelhos archaeological site is located near the Almonda spring in Torres Novas. Several archaeological excavations have uncovered an Upper Paleolithic sequence with three human occupations (Almeida et al. 2004). The site has eight stratigraphic layers covering the time span from the Upper Paleolithic to historical periods. Layer 3 has an AMS date of 11,660±60 years BP, while Layer 4 a ^{14}C date of 12,240±60 years BP, corresponding to the Upper Magdalenian period. The artefacts have suffered little post-depositional movement, with several lithic artefacts associated with fish vertebrae and bones, found together with two organic artefacts interpreted as fishhooks (Almeida et al. 2004). Both artefacts are short tools made from mammal bone, one of them has a lanceolate morphology and an elliptic mesial section, the other tool has a fusiform morphology also with elliptic mesial section, and present a longitudinal groove, parallel to the long axis of the tool, that extends from the fracture on the proximal end until the mesial area (see Table 9.1).

Two osseous projectile points were recovered from Layer 4. They are both made on mammal bone; one is a simple base type with a lanceolate morphology and an elliptical mesial section; the second is bipointed with fusiform morphology, also with an elliptical mesial section. Another point was recovered from Layer 8, and is made from mammal bone. It has a convergent morphology and an elliptical mesial section.

Gruta do Caldeirão

Caldeirão cave was first excavated in 1979 and then again from 1982 to 1988 by a team led by J. Zilhão. The cave entrance faces south and is located in limestone hilly country crossed by the Nabão River, near the city of Tomar. The cave contains sediments resulting from erosive processes that took place during the Pleistocene until the Holocene, and has human occupations dating to several periods (Zilhão 1995). The stratigraphic sequence corresponds mainly to Pleistocene deposits: in the base of the sequence are Middle Paleolithic layers (L-Q), rich in hyena remains (Zilhão 1995); next the archaeological layers Fa-K, the top of layer K dating to 28,000 years BP and layer Fc to 18,840 ± 200 years BP (Zilhão 1995). On top of these layers, are layers A, B, C and Ec, with an accumulation of sediments dating from 18,000 years BP to the present (Zilhão 1992); the top of layer Eb dates to 10,700 ± 380 years BP. The levels atop this layer date to the Neolithic (Zilhão 1995).

Two projectile points were recovered from Caldeirão cave. From Solutrean/Magdalenian layer Fa, came a distal fragment with a fusiform morphology and asymmetrical mesial section. From the Magdalenian layer Eb, came a complete antler projectile point with convergent morphology, simple base and elliptical mesial section. From this same layer came a proximal fragment of a possible harpoon made from mammal bone with plano-convex section (Fig. 9.2d). This proximal fragment has parallels with harpoons illustrated in Julien (1999:135, see Figs. 1:1–2 and 6). These harpoons share a small lateral bulge in the proximal end, and as stated by Julien (1999), this is an attribute found in some Spanish Magdalenian unilateral harpoons.

Gruta da Casa da Moura

Casa da Moura cave is located in a limestone outcrop on the Cesaredas plateau, near Óbidos. The cave entrance is a 4 m deep well with access to a wide room, divided in two parts by a substantial block. In 1865 and 1866 N. Delgado performed the first excavations at the site, and recovered artefacts from near the entrance well. Breuil defined an Upper Paleolithic human occupation at the site in 1918 (Zilhão 1995), and in 1987, L. Straus carried out further archaeological work in the cave confirming the stratigraphy proposed by Delgado, along with the fact that the cave entrance was open before the Solutrean, then being occupied by wolfs (Straus et al. 1988). The cave has a date of 25,090 ± 220 years BP obtained from a wolf mandible recovered from the base of the stratigraphic sequence, though above the travertine (Straus et al. 1988; Zilhão 1995). According to Zilhão (1995), the osseous artefacts came from Delgado's 'Inferior Deposit' can be attributed to the Final Gravettian and Upper Solutrean.

From this cave, four osseous projectile points were recovered. A complete single bevel point (Fig. 9.3a) made from mammal bone has a slight lanceolate morphology and a trapezoidal mesial section. The simple bevel has oblique striations that are extended over the entire width and length of the bevel. This point also has a groove located in the center of the inferior face, touching the bevel. There is also a proximal fragment of a simple bevel, also made from mammal bone, though with a quadrangular proximal section. Additionally, a mesial-proximal fragment of a simple base point (Fig. 9.3b) was recovered. This artifact is made from antler, and exhibits a lanceolate morphology and elliptical mesial section. Finally, there is a distal-mesial fragment with an indeterminate morphology (but circular mesial section) made from mammal bone.

Gruta da Furninha

Furninha cave is a karstic cavity forming a littoral scarp at the southern edge of the Peniche Peninsula. The cave is 30 m long and is crossed by horizontal branching. It was first excavated under the direction of N. Delgado during 1879 and 1880. H. Breuil in 1918, mentioned the presence of Paleolithic artefacts in several stratigraphic levels, providing the first recognition of Upper Paleolithic artefacts in this cave, separating them from the Mousterian and Neolithic deposits previously identified. In 1962, O.V. Ferreira and later J. Roche in 1974 recognized the presence of Solutrean stemmed points. J. Zilhão (1995) then worked on the materials from Furninha cave, concluding that the human occupation of the cave was ephemeral and that the stemmed points were from Neolithic or Chalcolithic cultural periods. Bicho and Cardoso (2010) refuted Zilhão's conclusions. According to these last authors, there are two main sedimentary complexes in Furninha with both being excavated in totality by Delgado: (1) the top deposit corresponding to Neolithic burials; (2) the lower deposit dated to MIS 4, 3 and 2 and has almost 9 m of depth. This deposit included faunal remains and many Mousterian lithic artefacts, as well as Solutrean points similar to those found in Vale Boi and in the Spanish Levantine region (Bicho and Cardoso 2010), confirming the earlier interpretation of Ferreira and Roche.

Amongst the artefacts that were recovered from Furninha cave, Bicho and Cardoso (2010) found a complete simple base point, with lanceolate morphology. It has an oval mesial section. Its stratigraphic provenience is unknown, but contrary to what is stated by these authors, this osseous projectile has parallels with a Gravettian bone point from Vale Boi (Évora 2008), and *not* Solutrean bone points. The proximal end has a vertical fracture and on its inferior face a depressed area in which two triangular marks are incised into the bone are visible. These marks are probably owing to hafting techniques (Fig. 9.2e).

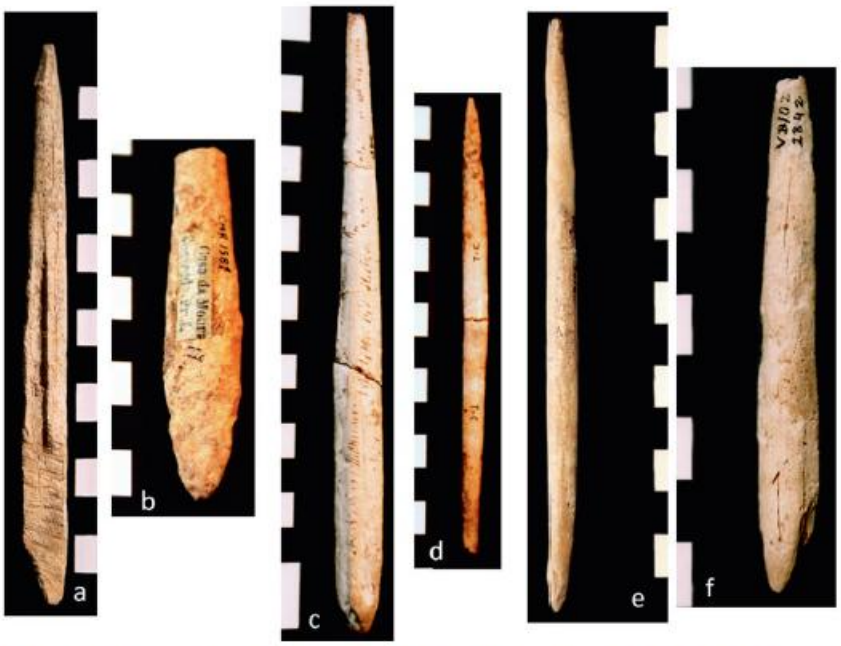

Fig. 9.3 Casa da Moura: (**a**) Single bevel point, (**b**) Simple base point fragment; Gruta das Salemas: (**c**) Simple base point, (**d**) Bipointed point; Vale Boi: (**e**) Gravettian bipointed point, (**f**) Gravettian bipointed point

Lapa da Rainha

This cave is located on the left bank of the Alcabrichel river valley near Torres Vedras. F. Almeida excavated the cave during 1968 and 1969, and a longitudinal profile (II) allows an understanding of the entire stratigraphic sequence, which contains seven layers and two human occupations (layers 4 and 3). In 1987, A. Marks tested the cave and was able to conclude, based on the presence of a Solutrean point, that the earliest human occupation dated to the Solutrean (Cardoso 1993; Marks et al. 1994; Zilhão 1995). The cave was used mainly by carnivores and only as a sporadic shelter by humans (Zilhão 1995).

From this site a whole *baguette demi-ronde* with lozenge morphology and plane-convex mesial section was recovered (Fig. 9.2c). This point has no decoration on its upper surface, but has several diagonal incisions on the inferior face that extend from one edge to the other. The distal end has a perpendicular fracture. This *baguette demi-ronde* has parallels with other Middle Magdalenian artefacts recovered from Mas d'Azil, France (Feruglio and Buisson 1999). The presence of this artefact at Lapa da Rainha may indicate a Magdalenian occupation, probably sporadic, that may have not have been recognized or documented during the 1968–1969 excavation work, owing to the mixed state of the sediments.

Gruta das Salemas

Salemas cave is located on the top of the slope of the Lousã river valley, near Loures. It was discovered by L.A. Castro who worked there in 1959, and latter O.V. Ferreira and J.C. França totally excavated the cave in 1959–1960 (Zilhão 1995). The cave has Neolithic burials, along with Solutrean, Gravettian, and Middle Paleolithic artefacts (Zilhão 1995). The bone tools said to be recovered from level III have an unsecured chronology, but Zilhão (1995) attributes the bone industry to the Aurignacian or Gravettian, the latter being the

best represented level in the cave stratigraphy, along with the Solutrean. However, Bicho (2000, 2005) does not agree with this proposition, instead considering the Aurignacian occupation of the cave doubtful, arguing that the Dufour bladelets identified came from the Gravettian layer together with the backed bladelets. For this reason, the assignment of the bone industry to Gravettian or the Solutrean is not secure.

From Salemas cave was recovered a complete simple base projectile point (Fig. 9.3c), made from mammal long bone, with lanceolate morphology and a plane-convex mesial section. It is decorated over the entire surface with small, short oblique incisions from the proximal end to the distal end. The distal end exhibits a perpendicular fracture. Another complete projectile, also made from mammal bone, is a bipointed point (Fig. 9.3d), with fusiform morphology and elliptical mesial section.

Vale Boi

Vale Boi is a rockshelter discovered in 1998 by a team led by N. Bicho. It is located in a limestone valley, facing west, near Vila do Bispo, in Southwestern Algarve, about 2.5 km from the Atlantic Ocean (Manne et al. 2012; Bicho et al. 2013). The cave sediments contain evidence for human occupation covering every techno-complex from the Gravettian to the Neolithic. There are three excavation areas in Vale Boi: the shelter itself, the slope, and the terrace. In 2000, the first test pits were excavated in the slope, and in square G25, human occupation levels with Magdalenian, Proto-Solutrean, Gravettian and possibly Mousterian associations were recorded (Bicho et al. 2004). These were found without sterile layers between them. Three AMS dates exist for this sequence: c. 24,500 years BP, c. 17,600 years BP and c. 18,500 years BP (Bicho et al. 2004). Additionally, for square Z27, there is an age determination of c. 22,500 years BP. The deposits held *in situ* artefacts, including body ornaments, bone tools, portable art, well preserved terrestrial and marine fauna, and lithic assemblages. The rockshelter area corresponds to a shelter that collapsed at the end of the Last Glacial Maximum (LGM). The chronology covers the Solutrean and Magdalenian cultural periods. The terrace has the longest sequence at the site, with the Neolithic being represented by ceramics, lithics, and wild and domestic animals. A single human tooth dates from the Mesolithic. It also has Solutrean and Proto-Solutrean occupations. Bellow this layer (layer 4), there is a Gravettian occupation dating to c. 25,000 years BP, which is represented by lithic tools, adornments, marine and terrestrial fauna, and portable art. Layer 5 and 6 date to c. 28,000 years BP.

From Vale Boi were recovered four whole projectiles and 23 fragments of projectiles (see Table 9.1). The complete artefacts include bipointed points, three with fusiform morphology and only one lanceolate example (Fig. 9.3e and f). Their mesial sections are all circular. Two are made from mammal bone, while the other two are made from red deer antler. The fragments are mainly made from antler (n = 14), though a few are made from mammal bone (n = 5), and four are indeterminate. For the Gravettian and Solutrean fragments, the main mesial section is oval or circular. For those that permit analysis, the predominant morphology is fusiform.

Functional aspects

Surface Modifications

These Upper Paleolithic osseous projectile points present several *stigmata* on their surfaces resulting from their manufacture and use. A great number of the points preserve longitudinal stria made during their manufacture. These stria are of two types: those made by retouched lithic tools and those made by unretouched lithic tools, with each leaving characteristic traces on the bone surface. Retouched edges leave a *stigmata* composed of longitudinal stria, parallel to the long axis of the artefact, sometimes grouped together in sets, sometimes deep with other thin stria inside them. These stria are present all over the surface. A micro-wave pattern is also present (d'Errico and Giacobini 1985). These waves are perpendicular to the longitudinal stria and can be seen at 40x magnification. These marks are the result of the attrition of the lithic edge when passing over the bone surface (d'Errico and Giacobini 1985; Évora 2008). The unretouched tool, on the other hand, leaves a different type of stria. These stria are also longitudinal and parallel to the long axis of the artefact, but are thin, not too deep, and are usually not grouped in sets (d'Errico and Giacobini 1985; Évora 2008). Additionally, some stria are probably the result of using abrasives, such as sand or a stone with coarse grains in the final part of the manufacturing process, or even perhaps, left as a result of the resharpening of the distal end. This scenario appears to be the case for a Gravettian point from Lapa dos Coelhos.

Some projectile points also show near their distal end, short striations with an oblique and transversal orientation in relation to the long axis of the artefact that could be the result of use. In the case of the Furninha projectile point, a slight concavity can be seen close to the proximal end and may have resulted from the hafting of the point causing a compression of the bone in this specific location.

The Gravettian bone point from Gruta das Salemas has a faceted surface and presents short horizontal and oblique incisions along the entire surface. These incisions have a V section and some are deeper than others. Inside some of the incisions, we can see fine longitudinal striations. These incisions were made after the longitudinal striations which

resulted from the manufacture of the bone point. The *baguette demi-ronde* from Buraca Grande also has decorations on its superior surface as mention above. Similarly, the Gravettian point from Cova da Moura has its surface faceted and several oblique lines incised along its single bevel. All projectiles with bevel bases have oblique incisions located on this section and are part of the hafting techniques. This same method is seen on the inferior surface of the *baguette demi-ronde* from Lapa da Rainha.

Fracture Types

In general four types of impact fractures are represented in the assemblages: oblique, *languette*, perpendicular and splinter, though some points present on their distal end three or four negative scars resulting from direct impact, as is the case for a Casa da Moura Gravettian projectile point (for example).

For the Gravettian assemblage, the predominant fractures for the distal end are perpendicular and oblique; for the mesial section: *languette*; and for the proximal end, oblique. For the Solutrean, there are fewer artefacts and only two oblique and one vertical fractures for the distal end were recorded, as was one splinter fracture for the proximal end. For the Magdalenian phase, the predominance is *languette* fractures for the distal end, oblique and vertical types on mesial sections, and the oblique type on the proximal end. These types of fractures indicate that the osseous points have all been used as they are characteristic of direct impact against a hard surface (such as bone) during hunting. In particular, oblique and *languette* fractures result from flexion, voluntary or accidentally, in a specific area of the projectile point that was not attached or hafted to the spear (Bertrand 1999; Pétillon 2006).

Discussion and Conclusions

Presented above are the osseous projectile points that have thus far been recovered from Upper Paleolithic contexts in Portugal. There are certain limitations which are mainly owing to:

1. Sample size: only a few complete points are known;
2. Preservation: although most faunal assemblages are well preserved as they were recovered from rockshelters;
3. Taphonomic modifications: only a few points have well preserved surfaces. This situation is mainly owing to bone fragmentation, carbonate coating on surfaces, rodent teeth marks, manganese oxide stains, trampling, cracks, osseous dissolution, and varnish. The varnish that was used in the laboratory to mark the museum inventory numbers remains a problem, making it very difficult or even impossible to observe and record manufacturing traces left on the surfaces; and
4. Almost all of the archaeological sites were excavated in the nineteenth or early twentieth centuries, and thus, not all osseous fragments were recovered in the field. Additionally, materials were sorted again in museums and more material may have been lost.

Each of these factors limit the identification of the manufacturing process of the Portuguese osseous tool tradition. Furthermore, it was only after 1990 that archaeologists began to pay more attention to this type of material culture, providing the first technological analyses.

In summary, seven Portuguese archaeological sites have Gravettian occupations, three Solutrean, and four Magdalenian occupations. The typology of the artefacts shows a predominance for the simple based and bipointed types of projectile points with a fusiform or convergent morphology. Relating to raw material choices, there is not a clear distinction between antler or mammal bone during the Gravettian (in terms of point morphology) as both were used for point manufacture during this period. A similar determination cannot be made for the Solutrean, owing to the small quantity of complete points preserved. In the Magdalenian, however, there seems to be a preference for antler to manufacture simple based points with a convergent morphology, which may be owing to the hafting techniques used as well as to the kinds of fish and game hunted. Since the points are mostly fragmented, it is difficult to make informed inferences about these choices, however, the fact that there are more distal and mesial fragments than complete elements, may indicate that Upper Paleolithic hunter-gatherers transported and butchered captured game at the habitation sites or butchering sites rather than at the killing sites. This suggestion can be made as broken point fragments remain inside the carcass until it was butchered, the fragments then being retrieved and discarded at the sites where they were preserved and later discovered.

Interestingly, only two points are decorated: a Gravettian point from Gruta das Salemas and a Magdalenian *baguette demi-ronde* from Buraca Grande. Could this lack of decorated points be interpreted as a stylistic preference within these groups of hunter-gatherers? The absence of decoration on osseous projectile points could indeed be a stylistic mark (LeMoine 1999), differentiating human groups living in Estremadura from those in Algarve. As both decorated points came from Estremadura, none from Vale Boi (Algarve), and there are several decorated stone plaquettes at this Algarve site (demonstrating the use of decoration on other media), this suggestion seems possible.

Most Portuguese Upper Paleolithic archaeological sites are located in Estremadura, perhaps resulting from the fact that this area was intensively surveyed since the nineteenth

Century, and has received much attention from archaeologists since that time. The survey for Upper Paleolithic archaeological sites in Algarve only began in 1998 with a project named "*A Ocupação Humana Paleolítica do Algarve*" (Paleolithic Human Occupation in Algarve), led by N. Bicho. This difference in the number of sites and osseous projectiles between the regions could thus be explained by the intensity of archaeological surveys and the number of sites found and excavated so far. Despite this fact, however, Vale Boi remains the archaeological site with the largest sample of Upper Paleolithic projectile points and other osseous tools in Portugal.

The Portuguese Upper Paleolithic bone industry as a whole share features with Southern Iberia. Here, some of the osseous projectiles points were recovered from rockshelter sites located near the coast where hunter-gatherers exploited coastal resources, while others are from rockshelter sites located inland from where they could exploit land and fluvial resources as well (see Villaverde et al. 2016). Besides hunting ungulates, some points appear to have been used for fishing (Évora 2013). Marine resources were exploited from the Gravettian and it is during this period that we recorded more osseous points entering the archaeological record. Examples include two projectiles from Lapa dos Coelhos that were recovered in association with fish remains. Also a number of artefacts classified as fishhooks: one from the Gravettian deposit in Vale Boi (Portugal) and another one from the Magdalenian of Nerja (Spain) which share similar morphology (Aura and Pérez 1998; Bicho et al. 2004; Évora 2008, 2013). The opposite correlation occurs during the Solutrean, when a regression of the coastline takes place as a consequence of the Last Glacial Maximum. The sites located near the shoreline from this period are presently most probably under water. Then, during the Magdalenian, the coastline reached near today's limits (Haws et al. 2011).

Another similarity to Southern Iberian archaeological sites is the fact that during the Gravettian there is a high frequency of projectile points, as opposed to the Solutrean and, to a lesser extent the Magdalenian. This observation cannot be solely attributed to a change in climate, as during the Upper Paleolithic, major climatic changes did not affect Southern Iberia like it did other regions to the north (Salgueiro et al. 2010). This fact is demonstrated in faunal assemblages previously published (Yravedra 2001a; Manne 2010), which show that the animal resources hunter-gatherers exploited continued to be the same, although not in the same frequencies. Thus, mammal bone and antler were always available as a raw material (as shed antler or hunted red deer) during the whole of the Upper Paleolithic (Évora 2013). The lower frequency of organic projectiles points and other categories of osseous artefacts during the Solutrean, and even during the Magdalenian phases, could instead be owing to a change in raw material choices for manufacturing points for hunting and fishing.

Furthermore, the osseous industry has been shown to have been adapted to all environments that hunter-gatherers exploited in Southern Iberia as shown by archaeological sites located in coastal areas like Vale Boi, Furninha, Rainha, Moura (Portugal), Nerja, Mejillones, Cendres (Spain), and other sites located inland and in fluvial areas, like Buraca Grande, Lagar Velho, Coelhos, Caldeirão, Salemas (Portugal), Pirulejo, Ambrosio and Parpalló (Spain) which are close to major rivers (Évora 2013). These locations allowed the exploitation of different kinds of habitats and their diverse resources (fish, shellfish, birds and mammals) (Villaverde et al. 1998; Yravedra 2001a, b; Davis 2002; Asquerino and Riquelme 2005; Bicho et al. 2006; Manne 2010; Villaverde et al. 2012).

In conclusion, more research is necessary to understand the technological processes of manufacturing osseous tools during the Upper Paleolithic in Portugal. In particular, it is necessary to review faunal assemblages in order to identify bone and antler fragments with debitage and manufacturing marks. This task is what we expect to accomplish in the future in order to enrich our picture of Upper Paleolithic hunter-gatherers living in these territories.

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