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The Initial Magdalenian mosaic: New evidence from Urtiaga cave, Guipúzcoa, Spain

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ABSTRACT

Transitional moments in prehistory are of broad interest in archaeology. Immediately following the Last Glacial Maximum, two technological shifts occurred in SW Europe: in France, at ~18,000 uncal. BP, an industry characterized by large Solutrean projectiles was replaced by the well-defined Badegoulian industry; a thousand years later in Vasco-Cantabrian Spain, Solutrean technologies were gradually replaced by Magdalenian antler point (*sagaie*) and lithic inset composite weapons. The Solutrean–Magdalenian transition remains ill-defined in Vasco-Cantabria, where very few "transitional" assemblages dating to the c. 17–16,000 uncal. BP interval have been identified, leaving questions as to how the changes occurred and what kinds of relationships existed between French and Spanish groups during this period. Urtiaga cave (Guipúzcoa) Level F (17,050 ± 140 uncal. BP) contributes a new Initial Magdalenian archaeological sample to the discussion of Last Glacial behavioral change during a technological transition. This paper synthesizes the results of a detailed lithic analysis with findings from previous studies of fauna and osseous industry from Urtiaga Level F. Then, the analysis explores Initial Magdalenian organizational behaviors through a series of lithic procurement/mobility models that show dynamic land use in eastern Vasco-Cantabria. Finally, Urtiaga Level F was compared to four other Initial Magdalenian occupations in the region, demonstrating that lithic maintenance—in manufacture, use, and rejuvenation—was a significant factor in how Initial Magdalenian groups organized their landscape-level behavioral strategies. The archaeological assemblages from Urtiaga cave are important contributions to archaeological questions surrounding the Solutrean–Magdalenian transition, providing further evidence for *in situ* technological change in Vasco-Cantabria. Additionally, the economic analyses discussed in this paper provide new attributes that archaeologists can use to identify Initial Magdalenian sites on the landscape. This study develops a methodological procedure that is broadly applicable to archaeological studies related to prehistoric cultural transitions and to those studies that apply data from collections recovered during the early 20th century to modern interpretive frameworks.

1. Introduction

Archaeologists have a longstanding interest in understanding continuity and change, stemming from the work of the discipline's early culture historians who created chrono-cultural technocomplexes as way to describe prehistoric behavioral shifts. These units have a legacy in modern archaeology: researchers are still asking how cultural traditions changed and what factors influenced the material culture variations recognized in each period (see examples in Cascalheira and Bicho, 2013; Schmidt et al., 2012; Straus, 2015). One challenge that archaeologists face is how to utilize archaeological collections that were recovered long ago, without the precision of modern excavation and recording techniques, and incorporate these data into modern interpretive frameworks. This case study approaches a particular chrono-cultural transition in prehistory, the Solutrean–Magdalenian interval c. 18–16,000 uncal. BP, using a multi-faceted and broadly applicable methodology that incorporates materials (lithic, osseous, and faunal) analysis with spatial and landscape modeling and inter-site comparisons.

In the Upper Paleolithic period, the first material culture analyses at the turn of the 20th century used "type" sites to characterize the artifact variations that marked particular culture-historical divisions (e.g., Solutrean at Solutré and Laugerie-Haute, Magdalenian at La Madeleine and Laugerie-Basse). In the past fifty years, excavations that employed modern techniques, including water-

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screening and radiocarbon dating, have revealed that regional geographic variation (e.g., lithology, available comestible resources, environmental patches) substantially affected Upper Paleolithic technology in Vasco-Cantabrian Spain, and by proxy, how archaeologists made culture-historical attributions and compared Spanish and French lithic and osseous industries (Barandiarán, 1985; Freeman et al., 1998; González Echegaray, 1960; González Echegaray and Barandiarán, 1981; Straus, 1992, 2005). This work has shown that while groups who lived in France and Spain traveled similar trajectories in having to deal with major climatic shifts throughout the Upper Paleolithic, important differences in lithic technologies, subsistence strategies, art motifs, and chronology led to distinct regional "expressions" of these western European archaeological cultures (Aura et al., 2012; Banks et al., 2009; Straus, 1992, 2005, 2013; Utrilla, 1981).

Advances in archaeological techniques have also provided archaeologists a more precise lens through which to view technological developments and their co-occurrence with climatic shifts and ensuing environmental change (Schmidt et al., 2012). Immediately following the Last Glacial Maximum, c. 18–16,000 radiocarbon years uncal. BP, when the western European climate was gradually and unevenly beginning to warm, large, "expensive" Solutrean point technology was replaced by "maintainable" composite antler point and microlith insert projectiles (see Bleed, 1986; Straus, 1991, 1993). In the past two decades, researchers working in Vasco-Cantabria and southwest France have identified many sites with "intermediate" assemblages that date to the Solutrean–Magdalenian transition. In France, this transition is marked by the Badegoulian industry, whose assemblages are typically raclette-rich (but see Clottes et al., 2012) and generally versatile in addressing tool blank production needs (i.e., thick and thin flakes) (Ducasse, 2012; Ducasse and Langlais, 2007). In contrast to the well-defined Badegoulian industries, the Solutrean–Magdalenian transition in Vasco-Cantabria is marked by very few occurrences of so-called Initial Magdalenian assemblages dating to c. 17,000 uncal. BP: El Rascaño Level 5 (Cantabria), El Mirón Levels 117–119.3 (Cantabria), and now, Urtiaga Level F (Guipúzcoa); and chronologically late Solutrean levels: La Riera 17 (Asturias); Las Caldas Pasillo 4 (Asturias); Chufín (Cantabria); Aitzbitarte IV (Guipúzcoa) and Arlanpe II (Vizcaya) (Altuna, 1972; Aura et al., 2012; Corchón, 1999; González Echegaray and Barandiarán, 1981; Straus, 1983; Straus and Clark, 1986; Straus et al., 2014; Rios-Garaizar et al., 2013). Thus, the Solutrean–Magdalenian transition is not nearly as well documented in northern Spain as it is in France, making it difficult to understand exactly *how* this technological change occurred, specifically, whether it was the result of gradual *in situ* adaptations to organizational strategies or more drastic cultural shifts (see Bosselin and Djindjian, 1999). This paper presents results from Urtiaga Level F lithic analyses and synthesizes these findings with those from previous studies of osseous industry (Mugica, 1983) and faunal remains (Altuna, 1972) from the level, thoroughly describing the Initial Magdalenian occupation at this location. This analysis then explores Initial Magdalenian land use through a series of mobility/lithic procurement models. In synthesis, Urtiaga Level F is compared to four other archaeological levels dating to c. 17,000 uncal. BP in order to address *what organizational aspects* contributed to the Solutrean–Magdalenian technological shift in Vasco-Cantabria. Together, these contexts demonstrate that assemblage maintenance—in manufacture, use, and rejuvenation—was an important aspect of Initial Magdalenian lithic technology. Additionally, the Urtiaga cave assemblage contributes to archaeological understanding of the Solutrean–Magdalenian transition in Vasco-Cantabria, providing further evidence of *in situ* regional "desolutreanization" and economic attributes that archaeologists can use to recognize Initial Magdalenian contexts. This study is broadly analogous to archaeological research in Europe and other world regions related to: (a) understanding changes between cultural-historical units against the backdrop of major climatic changes (in this case, from the Last Glacial Maximum to the Oldest Dryas within MIS 2) and/or (b) applying data collected from assemblages that were recovered using early recording systems to modern interpretive frameworks.

2. The Solutrean–Magdalenian transition

How archaeologists investigate Upper Paleolithic archaeological cultures has been influenced both by long term research histories (i.e. the archaeological record from this period in the Vasco-Cantabrian region has been under-researched relative to the same period in France, due in part to early chrono-cultural systematization by French prehistorians (notably H. Breuil, D. Peyrony and D. de Sonneville-Bordes) who then sometimes applied their temporal systems on the Spanish record) and by regional cultural-historical trajectories (Straus, 2013, 2015). Despite the fact that archaeological cultures in the Franco-Cantabrian region (the Vasco-Cantabrian northern Spanish coast and the southern Aquitane) share some common lithic and osseous artifacts and artistic similarities at various points in the Upper Paleolithic chronology (e.g., during the Upper Magdalenian), there are major differences in these two landscapes (Straus, 2015). While mountain chains and coasts geographically bound both areas (Vasco-Cantabria by the Picos de Europa and Cantabrian Cordillera to the south, the Bay of Biscay to the north; Aquitane by the Pyrenees to the south and Massif Central to the north, the Atlantic Ocean and Mediterranean Sea to the west and east, respectively), the Vasco-Cantabrian region is characterized by short, steep river valleys with diverse local environments, while the Aquitane had great plains with steppe–tundra vegetation during the Oldest Dryas (Straus, 2015). These environmental differences—including terrain, lithology, vegetation, and comestible resources—no doubt influenced how the human groups who inhabited these areas organized their territories, their mobility and subsistence strategies, and the unique regional cultural trajectories that developed in each area throughout the Upper Paleolithic (Straus, 2015). The Solutrean–Magdalenian transition is one cultural-historical "moment" where the hunter-gatherer groups living in western Europe took separate paths (Straus, 2013). In the Vasco-Cantabrian region, the transition can reasonably be summarized by the following chronological trajectory (Straus, 2015):

– Solutrean: 21,000–17,000 uncal. BP.
– Initial Magdalenian: 17,000–16,000 uncal. BP.
– Lower Magdalenian: 16,000–14,300 uncal. BP.

By comparison, the French Badegoulian archaeological culture dates to c. 18,200 – 16,500 uncal. BP (Banks et al., 2011).

The Solutrean period is archaeologically known by its large, single-lithic tip projectile weaponry, which was likely used as a component of atlatl-propelled or thrusting spears (Straus, 1992, 2005, 2009). In Vasco-Cantabria, the period is also known for its evidence of situational subsistence specialization, with groups killing red deer and ibex in their respective habitats (coast and montane) and overall diversification, with incidences of hunters taking boar, reindeer, fox, and roe deer, probably opportunistically, to such extent that Straus and Clark (1986) called it an early "broad spectrum revolution". As the Solutrean period progressed, hunter-gatherer groups developed diverse regional projectile point styles (e.g., shouldered or concave base)—and perhaps also distinct regional identities—that may have in turn influenced their social organization, ideology, territoriality, and (reduced) interaction networks (see Aura et al., 2012; Banks et al., 2009; Straus, 1983;

Tiffagom, 2006; de la Rasilla Vives, 1989, 1994; Villaverde and Fullola, 1990; and Zilhão, 1997). These Solutrean regional shifts may have been a key factor in the development of separate Badegoulian and Initial Magdalenian archaeological cultures in France and Spain, respectively (Aura et al., 2012; Banks et al., 2009).

The Badegoulian archaeological culture is principally recognized by diagnostic raclettes—quadrangular lithic artifacts made on flakes with near-parallel faces and generally backed on all or several sides—and by assemblages that indicate flexible tool-blank production (Banks et al., 2011; Ducasse, 2012; Ducasse and Langlais, 2007; see also Clottes et al., 2012). Since the raclette is a lithic tool type that is very common only in the Badegoulian, it has been used to define the spatiotemporal extent of this industry (Banks et al., 2011). Transverse burins are also common in some Badegoulian assemblages, but seem to be less diagnostic as "fossil directors". Despite considerable debate about the presence/absence of Badegoulian industries in the Iberian Peninsula and central Europe based on archaeological assemblage attributes (see Aura Tortosa, 2007; Bosselin and Djindjian, 1999; Straus and Clark, 2000; Terberger and Street, 2002; Zilhão, 1997), the data do not convincingly indicate that the Badegoulian culture extended beyond modern-day France (Banks et al., 2011). Archaeologists have argued that the Upper/Final Solutrean regional territories were essential to how the Badegoulian developed and was maintained (see Banks et al., 2011). Additionally, the reduced inter-group social contacts at the Upper/Final Solutrean—Badegoulian juncture in France could relate to why archaeologists have recovered scant evidence of characteristic Badegoulian artifacts (especially raclettes and transverse burins) in Initial Magdalenian contexts (Straus, 2013): there may have been very little contact between groups in these two regions at this time.

Due in part to the still-limited Initial Magdalenian archaeological record, the nature of the Solutrean–Magdalenian transition in Vasco-Cantabria is still the subject of considerable debate. Archaeologists generally agree that the process was a gradual one, wherein Solutrean lithic projectiles were replaced by the antler *sagaie* and lithic inset composite systems common in the Lower Magdalenian period (Corchón, 1981, 1984; Straus, 1983, 2000, 2013; de la Rasilla Vives and Straus, 2006). Archaeologists have also noted other characteristics of Initial Magdalenian assemblages: "mixed" weaponry assemblages, some "archaic" tool types (notches, denticulates) made on local non-flint raw materials (though this characteristic varies, perhaps as a consequence of local lithology), and osseous industries that include very large antler *sagaies* (Aura et al., 2012; Straus and Clark, 1986; Straus et al., 2014). Of course, these assemblages have also been identified through stratigraphic contexts: underlying well-defined, rich Lower Magdalenian levels and overlying equally diagnostic, projectile-rich Solutrean ones (Straus, 2015). Unlike the Badegoulian, with its fossil director—the raclette—the Initial Magdalenian cannot be defined by a single artifact, and is thus recognized by its transitional nature: it was a variable shift from the preceding Solutrean (Straus, 2015). This "desolutreanization" has been documented at several sites (e.g. La Riera, Las Caldas, El Mirón), and occurred approximately 1000 years after the Badegoulian industries swept through France (Corchón, 1994; Straus, 1983, 2015; Straus and Clark, 1986; Straus et al., 2014).

Thus, while it is widely accepted that there was some degree of continuity between the Solutrean and Initial Magdalenian (see Aura Tortosa, 2007; Corchón, 1981, 1994; Straus and Clark, 1986; de la Rasilla Vives, 1994; de la Rasilla Vives and Straus, 2006; Straus, 2015), the relationships that existed between the Upper Solutrean, Badegoulian, and Initial Magdalenian were complex ones (Aura et al., 2012). It is possible that the Initial Magdalenian trajectory known in Spain was a cultural choice, that hunter-gatherer groups selected maintainable technologies without making other adaptive changes. For example, at El Mirón cave (as at other sites such as La Riera), the Solutrean–Magdalenian transition occurred without a corresponding subsistence shift: red deer, ibex, and salmon remained the principally exploited comestible resources at the site from the Solutrean through the Magdalenian (Straus et al., 2014; Straus, 2015). It is also possible that the differing Badegoulian/Initial Magdalenian trajectories related to demographic dynamics: the changes could have been influenced by territorial/site distributions initiated in the Upper Solutrean (Aura et al., 2012; Straus and Clark, 1986). Recently, archaeologists have used multi-dimensional models to explore these hypotheses (see Banks et al., 2009, 2011). This paper also explores the Solutrean–Magdalenian transition using a multi-faceted approach, focused on the assemblages recovered from Urtiaga cave, which are a window to how environmental and social factors may have influenced Initial Magdalenian regional adaptations.

3. Urtiaga cave

3.1. Geographic and lithological setting

Urtiaga cave is located in the barrio of Itziar, Deva, Guipúzcoa (Basque Autonomous Region), on the SSW slope of Salbatoremendi hill at 43°16′55″ north latitude and 2°18′55″ longitude west of the Greenwich meridian (Fig. 1; Altuna, 1972). The cave vestibule looks over a small valley that is situated between the Deva and Urola river drainages. The site is 130 m above sea level and is a linear distance of 1.5 km from the present day coast, perhaps an additional 10–15 km from the Last Glacial coast (Altuna, 1972). Urtiaga is located in an area rich in limestone mountains and escarpments, including the geographically closed Lastur basin and the Izarriatz-Erlo massif (elevation 1026 m) to the south. The landscape is dramatically mountainous with substantial elevational variation in short distances and in some sectors of the coast, very striking cliffs (Fig. 1 inset). During the Final Solutrean, c. 18,000 uncal. BP, the Greenland Stadial 2 (Wurm IIIb) climate in Vasco-Cantabria was both cold and dry, gradually fluctuating to cool and humid during the Laugerie and Lascaux interstadials between 18,000 and 15,000 uncal. BP, when the Initial Magdalenian occurred. By 15,000 uncal. BP, when Lower Cantabrian Magdalenian (LCM) groups inhabited Vasco-Cantabria, Dryas I brought cold and slightly humid conditions to the region (Altuna, 1972; Hoyos, 1995). As a consequence of these climatic shifts, Urtiaga cave's Initial Magdalenian occupants would have known a diverse environmental patchwork: grass- and heathlands, slowly expanding woods, and barren north-facing slopes with the remnants of montane glaciers (Hoyos, 1995; Pokines, 1998; Straus, 1992). From this location, hunter-gatherers would have been able to easily access comestible resources provided by two river valleys and the sea (fish and shellfish), montane ridges (ibex), and geographically circumscribed lowlands (red deer), undoubtedly making the cave an attractive settlement location.

Archaeopetrology is a growing field in Vasco-Cantabrian Upper Paleolithic research (see Bernaldo de Quirós and Cabrera, 1996; GonzálezSainz, 1992; Rissetto, 2009; Sarabia, 1990a,b; Straus et al., 1986, and Tarriño et al., 2014). Urtiaga cave is proximal to several high-quality lithic toolstones (Fig. 1). Gaintxurizketa flysch flint (Campanian, Upper Cretaceous), a very dark brown to black flint that is fine-grained, though not always homogenous, which occurs in brecciated formations near Gaintxurizketa, Guipúzcoa, is the raw material outcrop closest to Urtiaga, c. 40 km away (Tarriño et al., 2014). Urbasa flint (Paleocene) outcrops in the Sierra de Urbasa, NW Navarra, Spain, some 50 km SSE of Urtiaga cave. This flint is generally streaky gray colored, and visually distin-

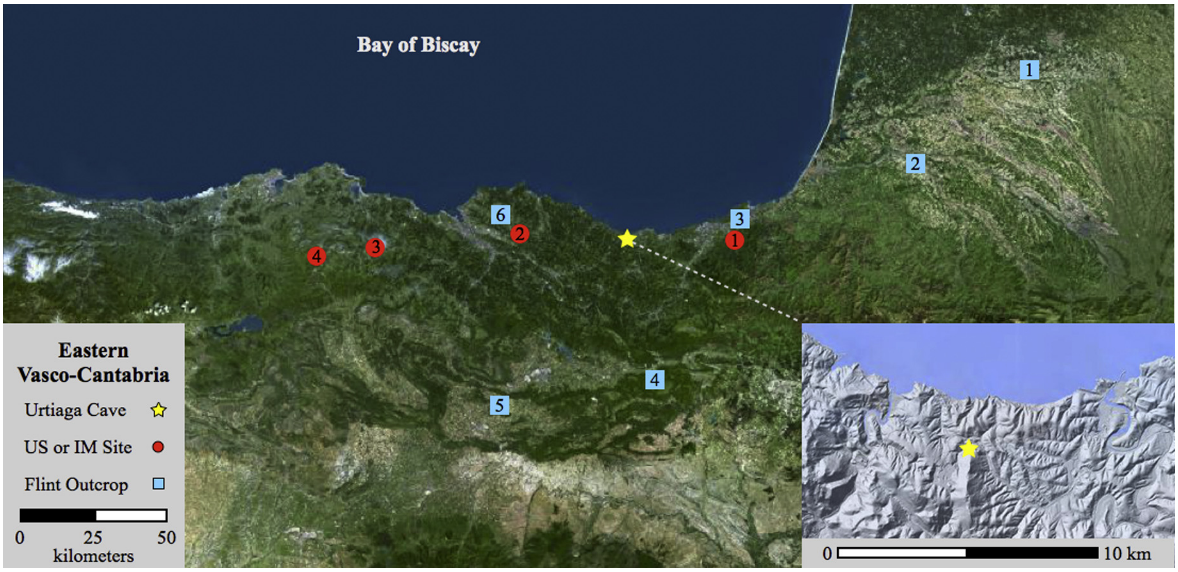

Fig. 1. Map of eastern Vasco-Cantabria showing location of Urtiaga and nearby Upper Solutrean (US) and Initial Magdalenian (IM) sites: (1) Aitzbitarte IV (US, Guipúzcoa), (2) Arlanpe (US, Vizcaya), (3) El Mirón (IM, Cantabria), and (4) El Rascaño (IM, Cantabria); and raw material outcrops: (1) Chalosse, (2) Bidache, Microcrystalline, and Chalcedonic flysch flints (with (6) as a possible alternate outcrop at Kurtzia), (3) Gaintxurizketa flysch flint, (4) Urbasa flint, and (5) Treviño flint.

guished by macroforaminifera, echinoderms, and microdolomitization (Tarriño et al., 2014). Treviño flint (Miocene) occurs c. 70 km SW of Urtiaga cave in the Miranda-Treviño Depression (Álava, Spain) (Tarriño, 2007, 2012; Tarriño et al., 2014). The toolstone is brown and extremely fine-grained. Several flysch flint outcrops occur c. 100 km to the NE of Urtiaga cave in the Pyrénées-Atlantiques region. These include Bidache (Campanian, Upper Cretaceous), which occurs along the Gaves Réunis and Adour rivers between Bidache and Biarritz, and is visually distinguished by parallel turbidic laminations that appear when the stone patinates. Chalcedonic and microcrystalline flysch flints, which contain distinct fossil echinoderms, also outcrop in this area, though it is possible that there were additional sources of these materials along the now-submerged Basque coastline (Fig. 1). Finally, Chalosse flint outcrops ~150 km from Urtiaga cave, in an Upper Cretaceous marine carbonate platform in southern Les Landes, southwest France (Tarriño et al., 2014). This toolstone is typically translucent gray/black, but when patinated it has yellowish–whitish patches. The flint also has many bioclastic inclusions, including *Lepidorbitoides* sp., a macro-foraminifer that is easily recognizable (Chalard et al., 2010; Tarriño et al., 2014). Each of these lithic raw materials has been identified in archaeological sites throughout the Vasco-Cantabrian region because of its unique visual characteristics (Corchón et al., 2007; Fontes et al., in press-a; Tarriño, 2000, 2006, 2012; Tarriño and Aguirre, 1997; Tarriño and Normand, 2002; Tarriño et al., 2013; Tarriño et al., 2014). Additionally, several of these visually distinct toolstones (Bidache, Chalosse, Treviño, and Urbasa), are considered tracer flints that archaeologists have used to reconstruct prehistoric territories and networks (Chalard et al., 2010; Fontes et al., in press-a).

3.2. Excavation and dating

J.M. Barandiarán discovered Urtiaga cave on July 21, 1928 (de Barandiarán, 1974, 1978a–d, 1979). The cave appeared quite small from its narrow, short vestibule, perhaps ten meters in length and only 1.2 meters width (de Barandiarán, 1978a). Barandiarán began excavating the following day with T. de Aranzadi, and continued to work at the site from 1928 to 1936, then again after the war in three additional campaigns (de Barandiarán and Elosegui, 1978). Eleven sectors were excavated, numbered sequentially from the cave entrance (Fig. 2); the first eight removed in the earlier campaigns and the latter three in the recent excavations (de Barandiarán, 1978a–d). As the upper levels were removed, they revealed a much longer interior gallery that had been blocked by a stalactite formation (Fig. 3); a stalagmitic surface underlies the lowest archaeological levels (Altuna, 1972). Barandiarán took detailed notes of important finds, depths, etc. during the excavations (see de Barandiarán, 1978a–d). He distinguished 13 archaeological levels in Urtiaga (Fig. 4), identifying the location as one of the most important Upper-Final Magdalenian sites on the Cantabrian coast, located at a crossroads between the areas settled in Asturias and Cantabria and those inhabited in the Pyrenees, including Mas d'Azil (Altuna, 1972; de Barandiarán, 1974, 1978a–d, 1979).

From the earliest excavations, Urtiaga Level F was poorly defined, located underneath the impressive, in some areas over two meter thick, Upper/Final Magdalenian Level D. Barandiarán initially considered Level F, only some 50 cm thick, though nearly a meter in the rear sectors of the vestibule, to be Aurignacian in

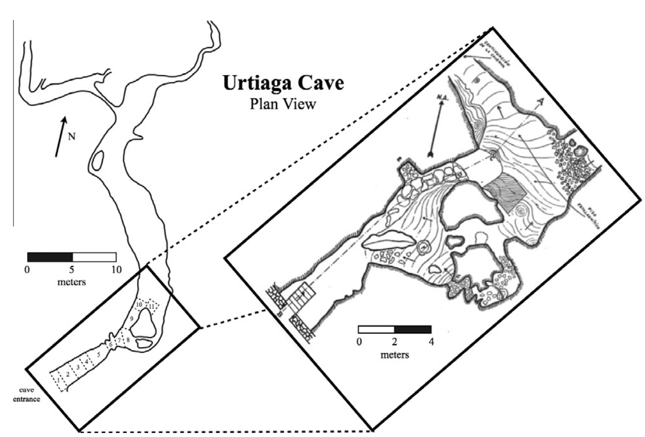

Fig. 2. Urtiaga cave plan view drawings following de Barandiaran (1978a) (left) and de Barandiarán and Elosegui (1978) (inset image). Points "A" and "B" in the inset plan view correspond to those presented in the cave cross section view in Fig. 3.

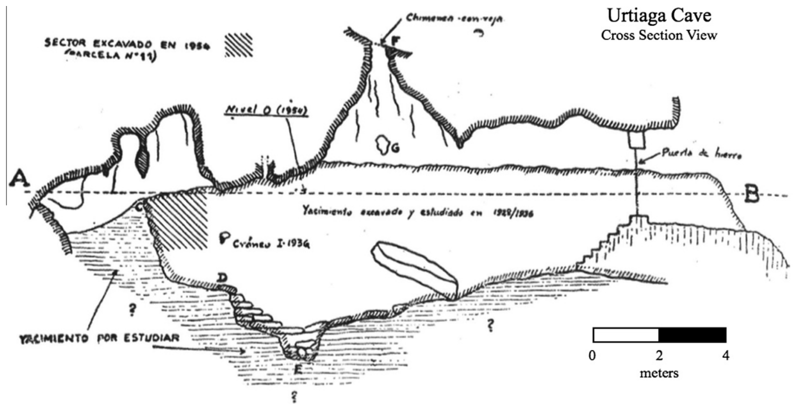

Fig. 3. Cross section view of Urtiaga cave showing excavated area and major features (from de Barandiarán and Elosegui (1978)). Features (from left to right) include: area excavated in sector 11; location of a human crania found in 1936; major stalactites; boundary of level D; the location of a large boulder unearthed in sectors 6–7 (also shown in the inset image of Fig. 2); the natural chimney (also shown and labeled "F" in Fig. 2 inset image); and the modern day cave entrance.

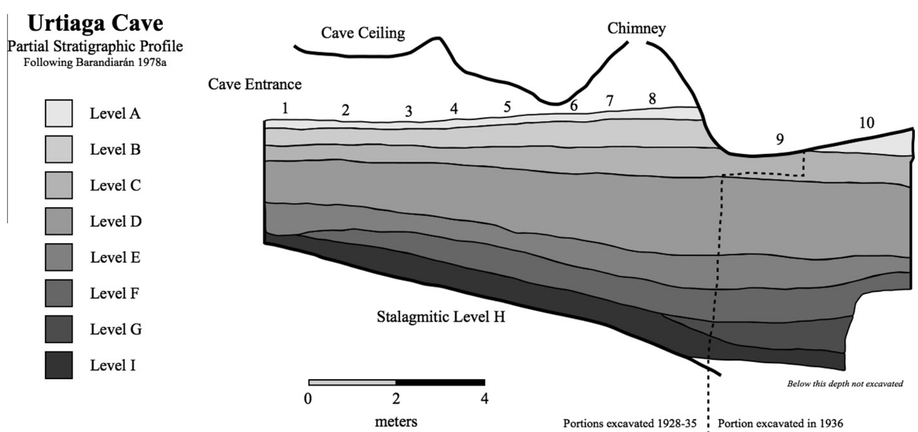

Fig. 4. Urtiaga cave partial stratigraphic profile, drawn following de Barandiaran (1978a). Numbers above Level A indicate the approximate locations of each excavated sector. A dotted line indicates materials removed before and after 1936.

age. A later partial study of the lithic toolkit conducted by de Barandiarán and de Sonneville-Bordes (1964) diagnosed the level as another Upper Magdalenian component based on its statistical tool type distribution. Altuna (1972) consulted J.M. Merino about the lithic toolkit; Merino felt there were clear differences between Levels D and F, citing that based on his small study of the materials Level F contained a flake-dominated lithic industry, while Level D had more equal proportions of blade and flake debitage. Altuna (1972) additionally noted that Level F's radiocarbon date, 17,050 ± 140 uncal. BP (GrN-5817), placed this occupation well before the Upper Magdalenian.

However, the cultural determination of Level F remained disputed. Following Altuna's (1972) analyses, Barandiarán (1973) remarked that the level could be considered a Lower Cantabrian Magdalenian (LCM) that was slightly older than other occurrences of this type in the Vasco-Cantabrian region. Later, Barandiarán and Utrilla (1975) affirmed that there were some elements in the osseous industry from Level F that were attributable to the LCM, including tectiform engravings on an antler *sagaie*. Later, Utrilla (1976) proposed that the materials could be from an earlier moment in the Magdalenian chronology, perhaps a Magdalenian II (in Breuil's (1912) stage system), with some functional differences that distinguished it from other sites. In her 1981 monograph, Utrilla presented the level as one with an industry that was poorly defined archaeologically, neither confirming nor denying whether the component pertained to the LCM or to an earlier Magdalenian occupation (but also see her more recent views of the nuances within the Urtiaga Level F assemblage in Utrilla, 1989, 1994, 1996, 2004; and Domingo et al., 2012)

In the 30 years since Utrilla's (1981) seminal work, relatively little analysis has been done of Urtiaga materials. Mugica (1983; also spelled "Mujika") studied Urtiaga Level F's osseous industry as part of his regional study; among the 65 pieces in this collection (of which he studied 56), he identified only a few objects that he felt could sensibly be attributed to the LCM, the rest were inconclusive as to their provenance. Later, Mujika Alustiza and Peñalver Iribarren (2012) renewed the stratigraphic profile that remained from Barandiarán's last excavation in Sector 11 (the profile they made, and thus its exact correlation to Barandiarán's work, remains unpublished), and published several radiocarbon dates from Level F. Two were from an arbitrary spit in contact with Level E, a more recent deposit (15,620 ± 290 and 15,530 ± 70 (I-14.858 and GrA-28317, respectively). However, in the lower part of Level F assays returned two Initial Magdalenian dates: 17,170 ± 350 (I-16,039) and 17,730 ± 290 (I-14,857) (Mujika Alustiza and Peñalver Iribarren, 2012). Thus, an Initial Magdalenian (or Solutrean–Magdalenian transition) age occupation has thrice been demonstrated by radiocarbon dates, though not definitively in discussions of Level F's archaeological remains (fauna, osseous industry, lithics, etc.). In part, this is due to when these studies were made and how Paleolithic archaeologists temporally characterized industries at particular times (see Straus and González Morales, 2012 for a succinct temporal summary). The identification (and widespread acknowledgment among prehistorians) of an Initial Magdalenian period resulted from excavations and analyses (especially radiocarbon dating) made in the late 20th century at sites in eastern and central Asturias (La Riera, Las Caldas) and Cantabria (El Mirón), coupled with comparisons of materials from the small-scale 1974 excavation in El Rascaño Level 5 (González Echegaray and Barandiarán, 1981; Straus and González Morales, 2012; Straus and Clark, 1986; Straus et al., 2014). That is to say, within the past two decades there have been major shifts in studies of the Solutrean–Magdalenian transition and that Urtiaga Level F was not identified as an Initial Magdalenian context is simply due to the fact that when most studies of its materials were made, this transitional archaeological "culture" did not exist.

4. The Urtiaga F lithic assemblage

4.1. Analytic methodology

Lithic artifacts were analyzed individually and classified using a debris typology that distinguished: microdebitage (<1 cm shatter and trimming flakes); whole and fragmentary cortical and non-cortical flakes, blades (parallel sided and >2 cm), and bladelets (<2 cm); chunks (non-Hertzian angular debris); microburins (made using the notch/snap break technique), burin spalls, platform renewal flakes, splintered pieces, and uni- and bi-directional crested blades; and flake, prismatic blade(let), pyramidal blade (let), and mixed cores (modified from Straus et al., 2008). Tools were classified using the de Sonneville Bordes and Perrot (1954, 1955, 1956a,b) Upper Paleolithic tool typology, which was modified to include "Juyo" type retouched bladelets as type 90 (instead of traditional twisted Dufour bladelets, following Barandiarán, 1985 as a standard typological modification for the Vasco-Cantabrian region). Up to three de Sonneville Bordes and Perrot tool types were used to describe multi-tools that fall into type 92: "Diverse". Additionally, a series of qualitative and quantitative attributes that provide information about all stages of lithic technological organization were recorded for each artifact; these are described in Appendix A.

4.2. Assemblage summary

The Urtiaga Level F lithic assemblage is a total of 1551 artifacts weighing 5762 g (Table 1). 345 of these pieces were tools. The assemblage was manufactured using 20 visually distinct lithic raw materials: 13 flints, one quartzite, one mudstone/lutite, and five unidentified stones. Seven of the flint raw materials were attributable to geologic outcrops on both sides of the Pyrenees, demonstrating that Initial Magdalenian hunter-gatherers moved lithic raw materials significant distances (>100 km in some cases) (Fig. 1). Only 27 artifacts (1.74% of the assemblage) were burned, a very small portion that does not indicate regular flint heat treatment. The lithic artifacts were relatively large in size (36% were >2 cm^2; Table 2), making them conducive to use: just under a quarter of the assemblage—361 pieces—showed signs of use damage, which was continuous on 299 artifacts and discontinuous on only 62. Nine artifacts showed use damage in multiple locations, though only two lithics were used in three locations. This indicates that while nearly a quarter of the assemblage was modified into formal Upper Paleolithic tool types, sharp flake/blade edges were also utilized as expedient "tools". The majority of the assemblage (69%) is comprised of whole debris, and an additional 26% of the artifacts are distal portions (Table 2). Other lithic portions are rare. This breakage pattern cannot be attributed to post-depositional trampling alone (otherwise proximal and distal fragments would be more or less equal), thus, it is likely that proximal flake and blade portions were removed from the site as part of a mobile toolkit, as blanks or tools for use in another location. Finally, cortex/reduction ratios for whole debitage indicate very little cortex (most pieces with cortex have it on less than one third of the exterior surface) and three or more previous removals (Table 2). Overall, 62% of the assemblage (964 artifacts) is non-cortical. With the closest geographically known source outcrop, Gaintxurizketa flysch flint, some 40 km from Urtiaga cave (Fig. 1), it makes sense that Initial Magdalenian foragers would reduce cortical portions of distant raw materials at settlements located at or nearer to these outcrops in order to reduce transported raw material weight (see Beck et al., 2002 and associated field processing models: Barlow and Metcalfe, 1996; Bettinger et al., 1997; Bird and Bliege Bird, 1997; and Metcalfe and Barlow, 1992).

4.3. Debris and reduction process

Microdebitage comprise a very small portion (3%) of the Urtiaga Level F lithic assemblage. It is possible that these artifacts make up such a small portion because of early 20th century excavation techniques. Though Barandiarán did screen as he excavated, this process would not have been as rigorous as modern-day water screening operations typical at Vasco-Cantabrian Upper Paleolithic sites (see Freeman et al., 1998). On the other hand, even some modern excavations from LCM sites (e.g., Altamira) in the region have yielded very small portions of microdebitage, which is to say that the small numbers of trimming flakes may represent behavioral patterns (i.e., little use of hard hammer production and tool retouching at the site) (Freeman and González Echegaray, 2001).

Flakes were the most commonly produced lithic artifact in Urtiaga Level F occupations. Plain flakes are the largest portion (20%) of the Level F assemblage; they are followed by secondary decortication flakes (16%) (Table 1). An additional 18% of the assemblage is comprised of fragmentary cortical and non-cortical flakes. There were only nine primary decortication flakes (0.58%), indicating that early stage reduction occasionally occurred at the site despite its distance from raw material sources (Fig. 1). The majority of whole flakes ($n = 569$) have flat platforms (68%), with lesser values for cortical platforms (14%), abrasive platforms (11%), and complex platforms (6%), which indicate earlier reduction stages, use of direct soft-hammer reduction techniques (two antler percussors were documented by Mugica (1983)), and platform shifting, respectively (Table 3). One artifact had a platform that was later retouched. 60% of the whole flakes had feathered terminations, indicating well-controlled flake propagation (Cotterell and Kamminga, 1987). However, 23% of flakes had step terminations (due to insufficient force and/or crack arrest), 15% hinge terminations (from flake initiations directed into flattish core faces, resulting in insufficient energy in the propagation phase to remove the expanding developing flake), and 2% overshot terminations (caused by sharp cornered distal sections of nuclei) (see Cotterell and Kamminga, 1987). Thus, in 40% of cases flake initiations were mislaid and/or force was misjudged by knappers, which could indicate that at least some flake manufacture resulted from inexperienced hands. Overall, flake reduction at the site was mid-late stage, indicating that primary raw materials exploitation occurred off-site, probably at sites closer to and/or at raw material source outcrops.

Collectively, blades are one fifth of the Urtiaga Level F lithic assemblage; more than half of these are non-cortical (Table 1). As is the case with flakes, many more blades are whole than fragmentary. Again, the lack of cortex among blades shows that primary reduction stages for these cores likely occurred elsewhere. Flat platforms were equally prevalent among blades as flakes,

Table 1
Urtiaga F debris summary and breakdown by major flint types. Raw material types are abbreviated as follows: Bidache (BID), Chalosse (CHAL), Chalcedonic flysch (CHF), Gaintxurizketa flysch (GXF), Microcrystalline flysch (MF), Treviño (TR), Urbasa (URB), all other toolstones (OT), and microdebitage (MD). Assemblage portion is based on the total number of each debris type.

Debris type	BID	CHAL	CHF	GXF	MF	TR	URB	OT	MD	Total	Assemblage portion (%)
Non-cortical trimming flake	–	–	–	–	–	–	–	–	29	29	1.87
Cortical trimming flake	–	–	–	–	–	–	–	–	9	9	0.58
Non-cortical shatter	–	–	–	–	–	–	–	–	7	7	0.45
Cortical shatter	–	–	–	–	–	–	–	–	5	5	0.32
Plain flake	9	22	98	30	39	18	69	26	–	311	20.05
Frag. plain flake	1	6	76	13	20	9	42	14	–	181	11.67
Primary decortication flake	1	–	2	3	1	–	2	–	–	9	0.58
Secondary decortication flake	9	30	79	25	15	10	56	25	–	249	16.05
Frag. cortical flake	4	2	41	9	9	4	20	14	–	103	6.64
Plain blade	1	6	53	23	15	6	32	9	–	145	9.35
Frag. plain blade	1	4	34	7	9	9	14	8	–	86	5.54
Primary decortication blade	–	–	2	–	–	–	–	–	–	2	0.13
Secondary decortication blade	2	2	19	18	6	4	12	1	–	64	4.13
Frag. cortical blade	1	–	9	6	1	8	3	3	–	31	2
Plain bladelet	–	2	8	4	1	–	5	1	–	21	1.35
Frag. plain bladelet	–	–	10	5	1	3	7	1	–	27	1.74
Secondary decortication bladelet	–	–	1	–	–	–	1	–	–	2	0.13
Frag. decortication bladelet	–	–	2	4	–	–	–	2	–	8	0.52
Non-cortical chunk	–	–	9	1	3	–	3	–	–	16	1.03
Cortical chunk	1	1	10	5	–	2	5	3	–	27	1.74
Microburin	–	–	–	–	–	–	2	1	–	3	0.19
Burin spall	–	8	26	15	10	26	24	3	–	102	6.58
Unidirectional crested blade	–	–	8	1	1	1	1	2	–	14	0.90
Bidirectional crested blade	–	–	1	–	–	–	–	–	–	1	0.06
Platform renewal flake	1	2	9	3	5	3	4	4	–	31	2
Splintered piece	–	3	11	1	5	2	6	3	–	31	2
Flake core	–	2	7	3	2	–	4	3	–	21	1.35
Prismatic blade core	–	–	–	–	2	–	–	–	–	2	0.13
Prismatic bladelet core	–	–	–	1	–	–	–	1	–	2	0.13
Mixed flake/blade core	–	–	2	2	2	–	1	–	–	7	0.45
Mixed flake/bladelet core	–	1	–	–	–	–	1	–	–	2	0.13
Mixed blade/bladelet core	–	–	–	1	1	–	1	–	–	3	0.19
Total	31	91	517	180	148	95	315	124	50	1551	

Table 2
Lithic Attribute Summary Urtiaga Level F. Portions were classified as: W = Whole, P = Proximal, M = Mesial, D = Distal, L = Longitudinal, and I = Indeterminable. Cortex/Reduction summarizes the relationship between cortex and dorsal removal scars on whole debitage following the attributes described in the text (e.g., C1D3 refers to pieces with <1/3 cortical surface and three or more dorsal removal scars).

Size (cm^2)	Count	Portion	Count	Cortex/Reduction	Count
1	145	W	1067	C0/D3	505
2	854	P	7	C0/D2	56
3	433	M	57	C0/D1	5
4	98	D	401	C1/D3	190
5	20	L	8	C1/D2	61
6	1	I	11	C1/D1	17
				C2/D3	20
				C2/D2	20
				C2/D1	16
				C3/D3	4
				C3/D2	9
				C3/D1	23
				C3/D0	11

Table 3
Urtiaga Level F whole debitage platforms and terminations. Platforms are abbreviated as follows: A = Abrasive, C = Cortical, CX = Complex, F = Flat, and R = Retouched. Abbreviations for terminations are: F = Feathered, H = Hinge, M = Modified (partially retouched or burinated), O = Overshot, and S = Step.

Flakes (n = 569)		Blades (n = 211)		Bladelets (n = 23)	
Platforms	Count	Platforms	Count	Platforms	Count
A	63	A	55	A	9
C	82	C	10	C	1
CX	36	CX	16	CX	–
F	387	F	130	F	13
R	1	R	–	R	–
Terminations	Count	Terminations	Count	Terminations	Count
F	324	F	152	F	14
H	88	H	8	H	3
M	16	M	12	M	–
O	12	O	16	O	–
S	129	S	23	S	6

indicating similar initiations and propagations for both artifact types. However, whole blades (n = 211) do show greater instances of abrasive platforms (26%), indicating greater use of soft percussors in conjunction with pressure-flaking techniques to remove long, narrow products. Terminations area also overwhelmingly feathered; hinge, step, overshot, and modified terminations were collectively 26% among blades, far less than the same attributes among flakes. Bladelets (3.74% of the assemblage) were mostly fragmentary and non-cortical; those whole bladelets (n = 23) in the assemblage show reduction attributes similar to those of blades, with overwhelmingly feathered terminations and evidence of soft-hammer reduction techniques (Table 3). Blade(let) reduction at Urtiaga cave was likely the result of a continuous reduction schema that gradually decreased in size, ultimately passing the blade/bladelet boundary (2 cm length), shortly before cores were abandoned. These blade(let) reduction sequences appear better controlled and more standardized than their flake counterparts.

The most significant type of debris in the Urtiaga Level F assemblage are burin spalls, (n = 102, or 6.58%). A quarter of these artifacts rejuvenated previously retouched portions of flakes, indicating that the burination technique was employed for the dual purpose of creating dihedral tools and repurposing previously retouched blanks, effectively conserving lithic raw materials via reuse. Other debris comprise small portions of the assemblage. Cortical and non-cortical chunks are collectively 2.77%. There are only three microburins (generally rare in Vasco-Cantabria), which were made using the notch and snap technique (see Inizan et al., 1992:69). Uni- and bi-directional crested blades constituted barely 1% of the assemblage, indicating that some blade reduction schemes began at Urtiaga cave. Platform renewal flakes are more abundant, indicating mid-sequence core renewal wherein knappers shifted nuclei to exploit multiple surfaces. This also corresponds to instances of complex platforms among flake debitage, demonstrating that knappers used diverse means to remove flakes from cores in contrast to the rigorous structure and standardization of the blade(let) reduction schemes. Finally, 2% of the debris assemblage is splintered pieces (classified as both tools and debris), indicating that bipolar reduction techniques were also used in small amounts at the site in order to exploit small and/or refractory stones. Overall, the lithic debris assemblage from Urtiaga Level F is similar to others dating to c. 17,000 uncal. BP in the region (e.g. El Mirón) and demonstrates the importance of flake reduction in the Initial Magdalenian.

4.4. Tools

Barandiarán recovered 345 artifacts from Urtiaga Level F that had been modified into formal tools. A significant number of these were multi-use "Diverse" pieces, bringing the total tool (i.e., modified edges) count to 410 (Table 4). The summary presented here is based on the number of artifacts, while Table 4 presents the tools both as portions of the artifact assemblage and total tool count. "Diverse" tools are discussed in detail later in this section.

There were 32 endscrapers (9.3%) recovered from Urtiaga Level F; nucleiform endscrapers were the most abundant type. Together with atypical carinated and carinated varieties, the steep-angled scrapers comprise half of this tool type. Steep scrapers, particularly core scrapers, are a defining characteristic of the LCM (González Echegaray, 1960). Burins comprise 10.7% of the Urtiaga Level F tool assemblage; most of these are angle on break burins, which are also typical of the LCM. There are only three burins on truncations. Transverse burins ($n = 7$) were made on lateral retouch and notches; these burin types are more common in Solutrean than LCM assemblages. Continuously retouched pieces, typically on single sides, are 11% of the assemblage, pointing to intensive flake/blade use and retouch at the site. "Archaic" pieces (collectively notches, denticulates, splintered pieces, sidescrapers, and raclettes) are the majority of the Urtiaga Level F assemblage (31%). Notches and denticulates were the most common "Archaic" pieces. There were only two pieces classifiable as raclettes. One, a true parallel flake with backing on three sides; the other, a preform made on a parallel flake with backing on one side and a small notch on the distal portion. The prevalence of these tools in the Urtiaga Level F assemblage—in single-purpose and multi-purpose "Diverse" varieties—affirms the hypotheses proposed by Straus (2013) and Aura et al. (2012) that "Archaic" tools were a major component of Initial Magdalenian toolkits.

There are ten composite tools (per de Sonneville-Bordes and Perrot's definition) in the assemblage (2.9%). Seven of these tools included a burination (tool types 17 and 22) and eight a perforator (tool types 20, 21, 22). There are 23 perforators (6.7%), most are the atypical "stubby" variety. Truncations are also small in number—13 artifacts, 3.8% of the assemblage—most are oblique. Backed pieces (also 3.8%) are varied, and include typical and atypical Gravette points, a microgravette point, a few backed and partially backed blades, and a shouldered piece that was part of a composite "Diverse" tool. Bladelet tools were collectively 3.2% of the assemblage and included backed, truncated, and "Juyo" bladelets, though overall, backed pieces, whether blade or bladelet, were uncommon at Urtiaga. Finally, Aurignacian blades and Solutrean pieces are collectively 1% of the Urtiaga Level F assemblage. The Solutrean piece is a distal fragment of a unifacial point made on Treviño flint (Fig. 5 Sample E), broken via a snap and dulled through use. Its exterior surface is cortical, with invasive retouch more prominent on the left side of the piece. This artifact is similar to Solutrean point fragments recovered from the Upper Solutrean level at nearby Arlanpe cave (Vizcaya), where Solutrean retouch also did not cover whole surfaces (Rios-Garaizar et al., 2013). Collectively, these minor tool types indicate mixture of Solutrean and Magdalenian elements in the weapons technology used by Initial Magdalenian occupants of Urtiaga cave.

After "Archaic" tools, "Diverse" pieces are the largest portion of the Urtiaga Level F tool assemblage (17.1%). There are a total of 124 individual tools distributed among the 59 artifacts that constitute this category. More broadly, "Diverse" pieces comprise nearly a third (30.2%) of the overall number of tools ($n = 410$) recovered from Level F. The majority of "Diverse" tools are attributable to notches ($n = 23$), denticulates ($n = 20$), continuously retouched pieces ($n = 16$), sidescrapers ($n = 12$), splintered pieces ($n = 7$), angle on break burins ($n = 7$), and perforators ($n = 5$). All other de Sonneville Bordes and Perrot types have four or fewer "Diverse" tools. "Diverse" modifications overwhelmingly echo tool types already prominent in the assemblage ("Archaic" and continuously retouched pieces) and/or incorporate burination(s), which, as indicated by the burin spalls, were often used to rejuvenate retouched tools. The prevalence of "Diverse" pieces in the Level F assemblage demonstrates that tool reuse and rejuvenation was an important aspect of Initial Magdalenian lithic technology at Urtiaga cave.

4.5. Cores and nucleiform endscrapers

Urtiaga Level F yielded 37 cores (Table 1). 31 of the 37 cores had at least one flake removal; four of the flake cores were discoidal. The core types reflect the proportions of flake and blade debitage identified in the assemblage (Table 1). All of the cores were made on flints; most cores were microcrystalline or chalcedonic flysch flint ($n = 16$), followed by Gaintxurizketa flysch flint ($n = 7$), Urbasa ($n = 7$), Chalosse ($n = 3$), and unknown flints ($n = 4$). 19 of the cores were tools, though only 14 of these were nucleiform endscrapers with retouched and regularized platforms. Nucleiform endscrapers averaged 29 mm length × 25 mm width × 23 mm thickness. Seven of the fourteen endscrapers were cortical; all cores made on Gaintxurizketa flysch flint (some 40 km distant) had cortex. Most nucleiform endscrapers had one or two platforms ($n = 7$ and 5, respectively), though there are two cores with three or four platforms. Single platform cores had a cumulative total of 30 removals, 18 of which showed hinge or step terminations (60% error rate) (Table 5). Hinge and step terminations are difficult to correct in lithic manufacture, particularly as core size diminishes under 3 cm in each dimension: these features indicate core exhaustion (and correlate to the high percentages of hinge and step terminations among debitage summarized in Table 2). Those nucleiform endscrapers with the most platforms were also the most exhausted, with 75% error for a three-platform core and 88% for a four-platform core (Table 5). These pieces were likely transformed into endscrapers because they lost their utility as cores that could produce viable flakes, yet were not so disfigured by multi-platform exploitation as to be discoidal and/or globular, losing the functional profile typical of steep "goat's hoof" endscrapers.

The remaining 23 cores averaged 27 mm × 29 mm × 25 mm ($L \times W \times Th$), only slightly larger than the nucleiform endscrapers. All but four were cortical, and every core from the most proximal raw material outcrop, Gaintxurizketa flysch flint, had cortex. No clear distance–decay relationship is indicated by the other lithic raw materials; even cores from the far off Chalosse outcrop are

Table 4
Lithic tools from Urtiaga Level F. Tools were classified using the de Sonneville Bordes and Perrot (1954, 1955, 1956a,b) Upper Paleolithic tool typology. Parenthetical values represent the distribution of tools on pieces classified as "Diverse". Totals are summarized for each tool category, with the parenthetical value as the sum of the "Diverse" tools distributed among the category. Two portions were calculated: (1) assemblage portion: the percent contribution of each tool category to the assemblage (n = 345 artifacts); and (2) tool portion: the percent contribution of each tool category to the total number of tools identified at the site (n = 410 with the addition of 124 tools classified as "Diverse").

Tool type	Count	Tool type	Count
Endscrapers		**Composite Tools**	
Simple endscraper	3 (1)	Endscraper-burin	2 (1)
Atypical endscraper	3	Perforator-truncated piece	1
Double endscraper	1	Perforator–endscraper	2
Endscraper on retouched flake/blade	5	Perforator-burin	5
Endscraper on flake	1	**Totals (#)**	**10 (1)**
Carinated endscraper	2	*Assemblage portion (%)*	*2.9*
Atypical carinated endscraper	3 (1)	*Tool portion (%)*	*2.7*
Thick nosed endscraper	1		
Flat nosed/shouldered endscraper	(1)	**Perforators**	
Nucleiform endscraper	13 (2)	Perforator	4 (1)
Totals (#)	**32 (5)**	Atypical perforator	16 (5)
Assemblage portion (%)	*9.3*	Multiple perforator	1 (2)
Tool portion (%)	*9*	Microperforator	2 (2)
		Totals (#)	**23 (10)**
Burins		*Assemblage portion (%)*	*6.7*
Straight dihedral burin	2 (3)	*Tool portion (%)*	*8*
Slanted dihedral burin	3 (3)		
Angle dihedral burin	(1)	**Backed Pieces**	
Angle on break burin	15 (7)	Gravette point	4
Multiple dihedral burin	5	Atypical Gravette point	1
Burin on oblique retouched truncation	2	Microgravette	1
Burin on concave retouched truncation	(1)	Shouldered piece	(1)
Transverse burin on lateral retouch	6	Completely backed blade	2 (4)
Transverse burin on notch	1 (3)	Partially backed blade	5
Multiple burin on retouched truncation	1	**Totals (#)**	**13 (5)**
Multiple mixed burin	2	*Assemblage portion (%)*	*3.8*
Flat face burin	(2)	*Tool portion (%)*	*4.4*
Totals (#)	**37 (20)**		
Assemblage portion (%)	*10.7*	**Truncated Pieces**	
Tool portion (%)	*13.9*	Straight truncated piece	2 (1)
		Oblique truncated piece	7 (1)
"Archaic" Pieces		Concave truncated piece	2
Notch	50 (23)	Convex truncated piece	1
Denticulate	28 (20)	Bitruncated piece	1
Splintered piece	26 (7)	**Totals (#)**	**13 (2)**
Sidescraper	2 (12)	*Assemblage portion (%)*	*3.8*
Raclette	1 (1)	*Tool portion (%)*	*3.7*
Totals	**107 (63)**		
Assemblage portion (%)	*31*	**Bladelet Tools**	
Tool portion (%)	*41.5*	Backed bladelet	6
		Truncated backed bladelet	2
Continuously Retouched Pieces		Retouched bladelet	3
Continuously retouched piece 1	35 (16)	**Total (#)**	**11**
Continuously retouched piece 2	3	*Assemblage portion (%)*	*3.2*
Totals (#)	**38 (16)**	*Tool portion (%)*	*2.7*
Assemblage portion (%)	*11*		
Tool portion (%)	*13.2*	**Other Tools**	
		Aurignacian blade	1 (2)
Diverse		Solutrean unifacial point	1
Diverse	59	**Totals**	**2 (2)**
Total (#)	**59**	*Assemblage portion (%)*	*0.6*
Assemblage portion	*17.1*	*Tool portion (%)*	*1.0*

cortical. Single platform cores had lower error rates than the equivalent nucleiform endscrapers (44% compared to 60%). However, multi-platform cores demonstrate high error rates. Overall, these cores indicate production intensity: exploiting a nucleus from multiple directions to utilize as much of the raw material as possible. At Urtiaga, multi-platform cores are more common than single platform cores, which is likely a dual reflection of far away flint outcrops and settlement structure: the hunter-gatherers who occupied the cave may have conserved high-quality stones by working nuclei to utter exhaustion. Nucleiform endscrapers represent yet another reuse of raw material: these cores were repurposed into steep scrapers instead of being discarded. This practice is extremely common during the Lower Magdalenian in Vasco-Cantabria, with such intensity that these artifacts are a temporal marker for the period (González Echegaray, 1960; Straus, 1992, 2005; Straus et al., 2008; Utrilla, 1981). The cores recovered in Urtiaga Level F indicate that this behavior was also practiced in the Initial Magdalenian.

4.6. Raw materials

The majority of the Urtiaga Level F lithic assemblage was manufactured using flysch flint from outcrops ~100 km to the NE of Urtiaga in southwest France (Fig. 1): chalcedonic (37.3%), microcrystalline (13.3%) and Bidache (2.6%) varieties (Table 6). The next most abundant flint identified is Urbasa (17.2%), which occurs in northern Spain some 50 km SSE of Urtiaga. Gaintxurizketa flysch flint, though the toolstone that outcrops closest to Urtiaga, is only

Fig. 5. Selected lithic tools from Urtiaga Level F, including: multi-tools (a, b, m); scrapers (c, j, n, o, and p); a splintered piece (d); a Solutrean point fragment (e); microliths (f, g, h, i); and burins (k and l), with each removal taken indicated by an arrow.

Table 5
Cores and Nucleiform Endscrapers, Cores are summarized based on the number of platforms. Cumulative removal summarizes the total number of removals taken from all cores in each platform category. Cumulative hinge or step quantifies the number of those removals that have hinge or step terminations. The error rate is the portion of cumulative removals that have hinge or step terminations.

No. of platforms	Count	Cumulative removals	Cumulative hinge or step	Error rate (%)
Nucleiform endscrapers				
1	7	30	19	60
2	5	26	10	38.5
3	1	8	6	75
4	1	8	7	88
Total	14			
Cores				
1	10	18	8	44
2	7	23	21	91
3	3	15	9	60
4	3	20	19	95
Total	23			

10.3% of the assemblage. Two other distant flints contribute small portions of the Urtiaga F assemblage: Chalosse (5.5%) and Treviño (3%). In addition to these geographically known toolstones, small portions (each <3% of the total) of the Urtiaga assemblage are comprised of other flints, lutites, quartzites, and unidentified stones. The latter three kinds of materials are presumed local in origin, taken from riverbeds near the site to manufacture expedient tools.

Raw material use at Urtiaga cave demonstrates that Initial Magdalenian mobile toolkits balanced long-term toolstone usage with long distance mobility and settlement needs. Based on the assemblage's composition, groups principally used two or three major materials for short-term activities—the lion's share of the mobile toolkit upon a group's arrival at Urtiaga and what was manufactured in quantity there—while safeguarding other materials for long-term transport and special uses. For example, artifacts made using Treviño indicate mid-stage reduction and a high proportion of burin spalls relative to other kinds of debris; this flint was clearly preferred for manufacturing dihedral tools (see Fig. 5. Sample L). This kind of mobile toolkit is in stark contrast to that identified at a nearby Upper/Final Solutrean site, Arlanpe (Vizcaya, 17,260 ± 70 (Beta-261388) and 17,160 ± 70 uncal. BP (Beta-261389)), where flint raw materials were also transported long

Table 6
Lithic raw materials from Urtiaga Level F. Unidentified flints are distinguished based on their reference letter in the ad hoc raw material collection Fontes created for the Vasco-Cantabrian region (information are available upon request). Distance measures are approximate linear ranges from Urtiaga. Counts are the total number of artifacts identified in each raw material; tools are inclusive in this number. Weight is cumulative for all artifacts manufactured in each raw material. Assemblage portion was determined based on toolstone weights. There are five different unidentified stones. Bidache, microcrystalline, and chalcedonic flysches outcrop in southwest France and in Kurtzia, near Bilbao, Spain. Stemming from direct comparisons with A. Tarriño's reference collection made for Aitzbitarte III, the materials from Urtiaga are from the French outcrop based on matching macroscopic fossilized sponge spicules (see Tarriño (2007) and (2012), for further information about French and Spanish flysch outcrops). It is additionally possible that flysches were procured from coastal outcrops that are now submerged. Raw materials were not identified for microdebitage <1cm.

Raw material	Distance (km)	Count (#)	Tools (#)	Weight (g)	Portion (%)
Major Toolstones					
Chalcedonic Flysch	100	517	123	2148.9	37.3
Urbasa Flint	50	315	71	990.8	17.2
Microcrystalline Flysch	100	148	43	766.4	13.3
Gaintxurizketa Flysch	40	180	23	590.9	10.3
Chalosse Flint	150	91	22	318.5	5.5
Treviño Flint	70	95	28	266.2	4.6
Flint VC_F110	N/A	34	8	191.8	3.3
Bidache Flysch	100	31	11	151.9	2.6
Flint VC_F117	N/A	43	12	104.6	1.8
Flint VC_F118	N/A	22	1	58.1	1
Flint VC_F116	N/A	5	–	25.1	0.4
Flint VC_F1	N/A	1	–	12.1	0.2
Flint VC_GF_5	N/A	4	1	11	0.2
Mudstone/Lutite	N/A	3	2	74.1	1.3
Unidentified Stone	N/A	11	–	33.5	0.6
Quartzite	N/A	1	–	8.4	0.1
Unclassified Microdebitage	N/A	50	–	9.7	0.2

distances, but were reserved exclusively for blade reduction (Rios-Garaizar et al., 2013). Flakes at Arlanpe, only a quarter of the assemblage, were manufactured on local lutites (Rios-Garaizar et al., 2013). Thus, changes in lithic technology that occurred during the Initial Magdalenian were not restricted to weapons production and a switch to predominantly flake-based manufacture: toolstone organization shifted—not just in what materials were used, but *how* they were used. While hunter-gatherer use of Treviño and Urbasa remained constant throughout the Last Glacial, that the groups who occupied Urtiaga cave chose to manufacture nearly their entire toolkit (flakes, blade(lets), etc.) out of flints—some from very far away—indicates that they chose to depend on these materials (and pay the price for carrying them) rather than to rely on local, lower quality stones. Initial Magdalenian raw material provisioning was a complex balance between task-necessities and movement across changing landscapes: depending on a single kind of material, flint, for (nearly) all aspects of lithic manufacture may have been a more adaptive in the face of environmental fluctuations than differentiating *chaînes opératoires* by raw material. However, long-distance flint transport would have created another problem: conserving high-quality toolstones for sufficient lengths of time so that costly procurement trips were minimized (see Gould, 1980). It is possible that toolkit changes seen in the LCM—specifically those related to *maintaining* (i.e., Bleed, 1986) assemblages, correspond to shifts in raw material management: increased occurrence of nucleiform endscrapers, which repurpose cores; increase in bladelet technology, which uses diminutive blanks; and prevalence of bipolar reduction techniques in areas with poorer local lithologies, among others (Fontes, 2014a; González Echegaray, 1960; Straus, 1992, 2005; Straus et al., 2008).

5. Osseous industry and faunal remains from Urtiaga Level F

5.1. Osseous industry

The osseous industry from Urtiaga Level F is diverse. Mugica's (1983) inventory summarized 56 pieces, including 28 antler *sagaies*, in addition to awls, needles, spatulas, perforated shells, percussors, and other worked bones (Fig. 6). The *sagaies* can be summarized as follows:

(a) one *sagaie* fragment with a double beveled base and biconvex cross section;
(b) ten *sagaie* fragments with varying circular cross sections: four circular, two sub-circular, two semi-circular, and two with double beveled bases;
(c) one double point with a circular cross section;
(d) one double beveled base fragment of a rectangular cross section *sagaie*;
(e) three centrally flattened *sagaie* fragments, two with double beveled bases;
(f) two triangular cross section *sagaies*;
(g) four quadrangular cross section *sagaies*: two fragments; one with a double bevel base; and one with tectiform engravings (pictured in Fig. 6 Sample A); and
(h) six fragments of sub-quadrangular cross section *sagaies*, one with so-called "hunting [tally] marks" on one side.

This projectile assemblage is remarkably variable; the pieces have nine different kinds of cross sections. All artifacts with intact proximal ends have double beveled bases, many with "anti-skid" marks. Similar *sagaies* have been identified in the Initial Magdalenian levels at El Mirón cave, some 70 km west of Urtiaga, in Levels 117–119.3, where artifacts have oval, circular, centrally flattened, oval-quadrangular, quadrangular, and semi-convex cross sections (Straus et al., 2014). Thus, Vasco-Cantabrian Initial Magdalenian technological variability was not restricted to lithic toolkits, but also a component in changing osseous industries, evidence that these hunter-gatherers experimented with different artifact forms—including stylistic and/or functional embellishments—as they designed new composite tool industries (Solutrean *sagaies* can also be diverse in cross section, though they are not abundant in assemblages) (Straus et al., 2014). Furthermore, the osseous industry from Urtiaga Level F demonstrates that the site was used

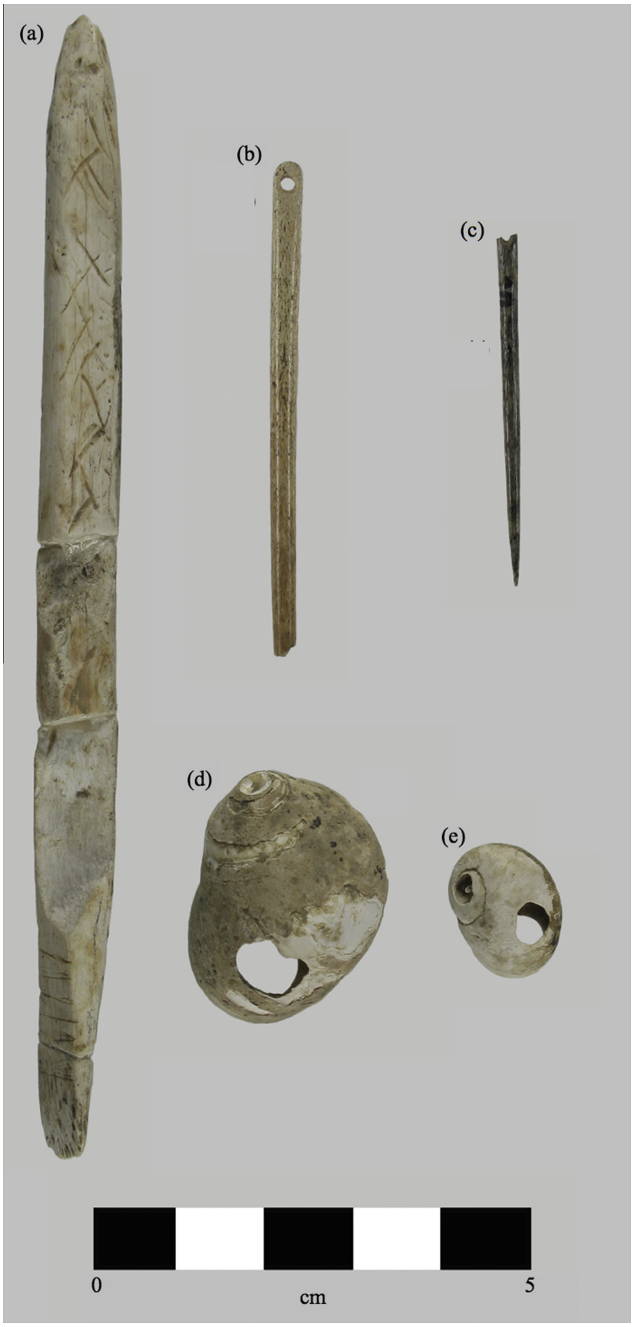

Fig. 6. Selected osseous industry from Urtiaga Level F, including whole and fragmentary needles (items b and e); perforated *L. obtusata* (c) and *L. littorea* (d); and a double bevel base *sagaie* with tectiform engravings located within a lateral groove (a).

for myriad activities during the Initial Magdalenian, including hunting, sewing, manufacturing shell ornaments, and other domestic activities, all in addition to lithic manufacture. Later LCM residential sites show similar characteristics in their osseous industries, although portable art items, especially engraved red deer scapulae, are more abundant in these more recent occupations (Barandiarán, 1985; Freeman and González Echegaray, 2001; González Morales and Straus, 2009).

5.2. Faunal remains

The most prevalent fauna recovered from Urtiaga Level F was red deer, which comprise 60.1% of the assemblage (based on the NISP, see Table 7; Altuna, 1972). Ibex and chamois were the second most abundant species (all were adults); fox and roe deer (six adults and three juveniles) were less frequent (Table 7). There is also evidence of cold faunas, including reindeer and bison/aurochs. Finally, there are also small amounts of other large game species and carnivores: horse, cave bear, lion, and lynx; and small game: European moles and water voles, hares, weasels, and polecats (Altuna, 1972). Initial Magdalenian hunter-gatherers complimented these terrestrial game species with limited shellfish gathering (Altuna and Mariezkurrena, 2010). Limpets (most were *Patella vulgata*) were the most common comestible mollusc in Level F (38% of the malacofauna NISP). *Littorina obtusata* were also collected (38%), but these were used exclusively for use as ornaments (Fig. 6 Sample E; this is the only level in Urtiaga where *L. obtusata* were collected and perforated). *Littorina littorea* were also collected in small amounts; one of these was perforated (Fig. 6 Sample D). Overall, the diverse faunas recovered from Urtiaga Level F indicate a climate that was still cold—the Lascaux Interstadial—but also warming, as forest species (deer) were hunted in quantity (Altuna, 1972). The presence of montane, coastal, and valley/forest species indicate that Initial Magdalenian groups exploited a variety of environments located near Urtiaga cave. Additionally, their catch differed slightly depending on species: for example, adult mountain goats were obtained while adult *and* juvenile deer were acquired (Table 7). It is possible that hunter-gatherer groups who settled at Urtiaga were beginning to develop techniques well documented in later Magdalenian periods, including intensive environmental exploitation within site catchment zones, animal mass slaughter, and utilizing landscape features (i.e., pursuing animals on migratory paths or as they traversed closed basins and/or narrow landscape features) (Freeman, 1973; Kuntz and Costamango, 2011; Marín Arroyo, 2009; Straus, 1992).

6. Activity areas in the Urtiaga cave vestibule

Barandiarán and his team excavated an approximately 12 m^2 area in the narrow Urtiaga vestibule, dividing the cave into eleven sectors (de Barandiarán, 1978a). The widest excavated portion of the vestibule is in sectors 7–9; a natural chimney is located in the cave ceiling between sectors 7 and 8 (Fig. 4). Faunal remains (analyzed by Altuna (1972)) were most densely concentrated to the north of the chimney, in sector 9; this cluster contained a third of the faunal assemblage. A second concentration of faunal remains was located in sectors 5 and 6, though generally, the fauna were more evenly distributed throughout the Urtiaga vestibule than were the lithic artifacts. Lithics were distinctly clustered in sectors 4 and 8, with slightly smaller densities in sectors 6 and 9 (Fig. 7). However, it is also important to note that due to early 20th century excavation techniques, the excavated sectors in Urtiaga cave are not equal in size; this could potentially bias density data toward larger sectors. On the other hand, the temporal density patterns indicate reuse of the same sectors throughout the Initial Magdalenian period (Fig. 8), which implies that the site's occupants may have had spatial preferences. It is possible that the lithic and faunal concentrations were related to the vestibule dimensions, with one cluster in the outer vestibule before a constricted passage in sector 6, and a second at a wider inner vestibule section with a chimney that could have provided natural light and/or ventilation. Faunal remains were deposited to the north of lithic artifacts in both areas (e.g., lithics in sector 4, fauna in 5 and 6). In the outer vestibule, this could reflect cultural and/or natural formation processes: discard preferences associated with well-defined activity areas or depositional context due to the Level F occupation surface, which gradually sloped downward as it progressed inward (Fig. 4). While it is certainly possible that natural taphonomic processes moved faunal

Table 7
Fauna and Malacofauna from Urtiaga Level F. Data are from Altuna (1972) and Altuna and Mariezkurrena (2010). Assemblage portion is based on the NISP.

Faunas	Common name	NISP	MNI	Adults	Juveniles	Portion (%)
Cervus elaphus	Red deer	557	17	11	6	60.1
Capra pyrenaica	Ibex	112	9	9	–	12.1
Rupicapra rupicapra	Chamois	73	4	4	–	7.9
Vulpes vulpes	Fox	67	6	–	–	7.2
Capreolus capreolus	Roe deer	43	9	6	3	4.6
Bison priscus & Bos primigenius	Bison/Auroch	20	2	2	–	2.2
Arvicola terrestris	European water vole	16	4	–	–	1.7
Rangifer tarandus	Reindeer	12	2	1	1	1.3
Equus caballus	Horse	8	1	1	–	0.9
Mustela putorius	European polecat	7	2	–	–	0.8
Talpa europaea	European mole	3	1	–	–	0.3
Panthera leo	Lion	3	1	–	–	0.3
Lepus sp.	Hare	2	1	–	–	0.2
Mustela erminea	Stoat	2	1	–	–	0.2
Ursus spelaeus & Ursus arctos	Cave bear	1	1	–	–	0.1
Felis lynx	Lynx	1	1	–	–	0.1
Total		**927**	**62**	**34**	**10**	
Malacofaunas	Common name	NISP	MNI			Portion (%)
Patella sp.	Limpet	45	44			38
Littorina obtusata		45	44			38
Littorina littorea		27	25			22.9
Osilinus lineatus		1	1			0.8
Cerastoderma sp.		1	1			0.8
Total		**118**	**115**			

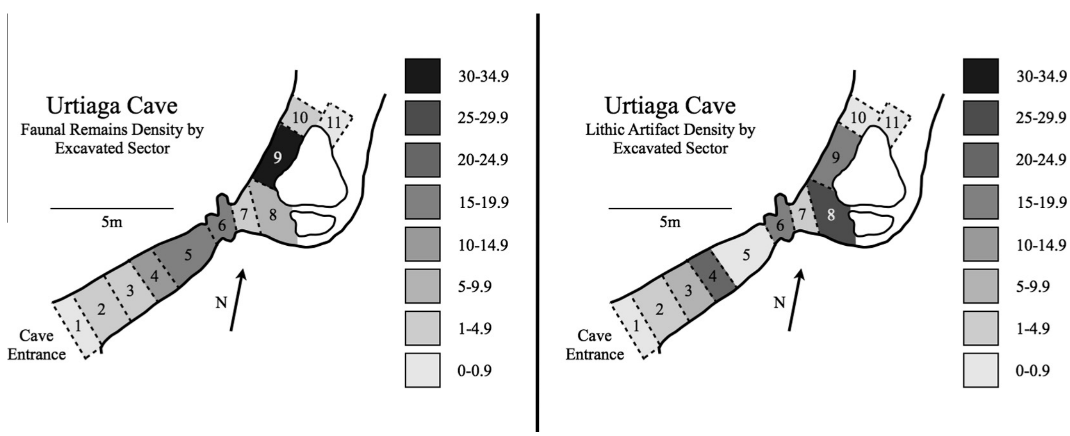

Fig. 7. Densities of lithic artifacts and faunal remains in the Urtiaga cave vestibule, by sector. Cave vestibule image was drawn following de Barandiaran (1978a).

remains downslope in the outer vestibule, the duplicate depositional pattern in the rear sectors, where the occupational surface was nearly level, may be contextual evidence of patterned refuse disposal in an area where slope would not have been a significant taphonomic factor. Additionally, the inner vestibule sectors were the most densely occupied areas within Level F; here the layer is its at thickest. It is possible that this was a preferred activity area in Urtiaga cave due to its relatively spacious dimensions and chimney, which may have led to the large concentrations of lithic artifacts and faunal remains in these sectors.

While it is impossible to effectively correlate depths and spatiotemporally relate archaeological materials across Level F due to old excavation techniques and slope, each sector can be compared to the others in terms of its general density pattern (Fig. 8). The temporal lithic density data show relatively continuous occupations in sector 9, demonstrated by a long sequence with moderate concentrations of lithic artifacts. In contrast, the outer vestibule sectors indicate intermittent settlement of the cave with infrequent high-density clusters (Fig. 8). These varied spatiotemporal patterns could have been caused by differential settlement in Urtiaga cave (possibly different groups, seasons, and/or at different points in a settlement pattern), perhaps with long-term occupations based out of the inner vestibule and short-term visits focused in the outer area. Faunal remains do provide some additional evidence to this hypothesis: while remains of major species (red deer, ibex, and chamois) were distributed throughout the entire excavated area, some species were only identified in the outer vestibule: European mole, hare, European water vole, European polecat, and stoat (Altuna, 1972). While some of these species are classified as microfauna (e.g., European water vole) and are thus often considered to be non-anthropogenic "background" elements, Pleistocene human groups have also been known to procure small game like these when other resources were scarce (Jones, 2007); for example, at Aitzbitarte IV (17,950 ± 100 uncal. BP, GrN-5993), an Upper Solutrean site ~30 km from Urtiaga, small moles and voles are the greatest portion of the faunal assemblage (Altuna, 1972) and moles are very common in the Abri Dufaure on the border between the French

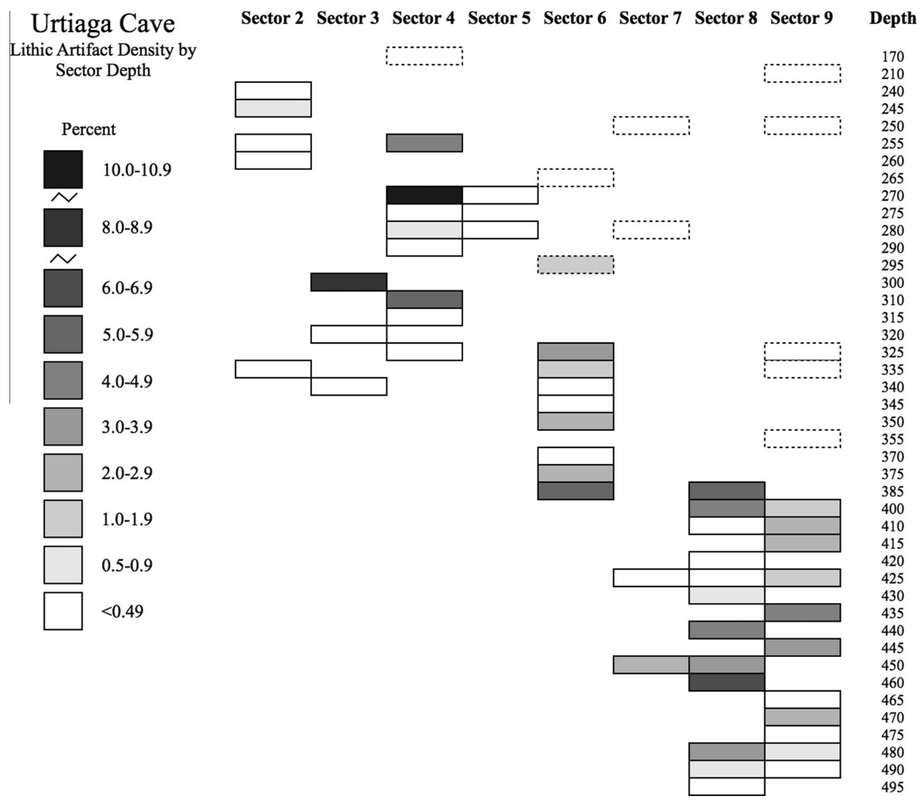

Fig. 8. Change in lithic artifact density as a percentage of the entire assemblage, based on depths identified in Urtiaga Level F. Depth listing is based on numbers represented in order from smallest to largest and is not to scale. Depth rectangles with incomplete borders represent those whose values also correspond to depths recorded in Level E.

Basque Country and Chalosse (Eastham, 1995). Consequently, the fact that the small animal remains were clustered within the same area of Urtiaga cave is contextual evidence that Initial Magdalenian foragers processed these animals at the site rather than that they were left by owl activity. Therefore, the Urtiaga outer vestibule testifies to some occupations wherein groups intensified (albeit in diminutive amounts, collectively 3.2% of the assemblage) a primarily large game-based diet with smaller species. While lithic density data support areas of intermittent and continuous occupation, it is also not possible to rule out that these areas were used concurrently, i.e., the vestibule rear was continuously occupied and an occasional second activity area was concentrated in the outer sectors. Overall, spatial and temporal deposition of lithic artifacts and faunal remains suggest patterned activity areas in Urtiaga cave that may have been similar to those that have been identified at another Initial Magdalenian site, El Mirón, where an extraordinarily large quantity of lithic tools were deposited in a 2 m^2 area between a large block and the cave wall within that cave's huge vestibule (Straus et al., 2014). Defining spatial areas (and by proxy, investment in site structures), may have been as important to Initial Magdalenian hunter-gatherers as it was to those living during more recent Magdalenian periods in Spain, France, Switzerland and Germany (see examples in: Arambourou, 1978; Audouze and Enloe, 1997; Bosinski, 2007; Fontes et al., 2013; Leesch et al., 2004; Straus, 1987, 1992, 1995, 2013; Zubrow et al., 2010).

7. Initial Magdalenian mobility

Urtiaga cave is an excellent location to explore Initial Magdalenian human mobility for two reasons: first, Barandiarán excavated and recorded contexts meticulously, and second, the vast majority of lithic artifacts could be attributed to geographically known outcrops. To assess the relationship between changing landscape use and lithic procurement, six samples were examined in detail, two each from sectors 4 (Units 270 ($n = 160$) and 310 ($n = 81$)), 6 (Units 325 ($n = 50$) and 385 ($n = 85$), and 8 (Units 400 ($n = 76$) and 460 ($n = 100$)) (hereafter abbreviated e.g., 6.325). Collectively, these samples comprise just over a third of the Urtiaga Level F assemblage and represent some of the richest depth units excavated in the level. Each sample is a heuristic unit and considered as a patterned occupational residue (contiguous for comparative utility, but not necessarily indicating a single event) of that sector of the Urtiaga vestibule. All units were examined individually; lower and upper units were not collectively considered as residues of single occupations spanning the length of the cave. Considering these units separately provided more detailed models of Initial Magdalenian behavioral patterns.

Several assumptions about Initial Magdalenian behavior were made to construct these models:

(a) raw materials identified in archaeological samples were considered proportionally equivalent (by weight) to their behavioral counterparts in mobile toolkits (i.e. if Treviño was 10% of an archaeological unit, it was also 10% of the toolkit when that occupation was made);
(b) provisioning events that occurred more recently were represented by higher portions (by weight) of raw material assemblages than those that occurred less recently. However, assuming that groups would have maximized weight efficiency in raw material transport by reducing the amount of cortex in the mobile toolkit and that early reduction stages occurred closest to outcrops (Beck et al., 2002; Elston, 1990; Kuhn, 1994), exceptions were made for raw materials in earlier reduction stages that indicated recent toolstone procurement. Reduction stages were standardized by comparison of debris types, size grades, and cortex/

reduction (i.e., Table 2). Distance decay was assumed for the latter two variables, i.e., that flakes became progressively smaller as they were reduced and cortical portions waned. Primary cortex is considered a hallmark of early stage reduction; platform renewal, crested blades, and burin spalls, diagnostic of mid-stage reduction; and cores and bipolar pieces indicative of late stage reduction;

(c) Initial Magdalenian groups employed a foraging strategy (Binford, 1980) that involved residential moves throughout a large territory (eastern Vasco-Cantabria is ~12,000 km^2) and acquired all of their raw materials through direct outcrop access. This assumption simplifies several dimensions of mobility behavior that are difficult to discern archaeologically, including the frequency of residential/logistical moves, who made them (individuals or groups), the possibility that materials were acquired via trade, and how groups managed other resources within their territory (Djindjian, 2009, 2012; Gould, 1980; Kelly, 1992). Additionally, this opposes the common Magdalenian territorial management model wherein groups focused their occupations at (typically coastal) residential bases and made logistical forays to specialized sites where they exploited different local catchment zones (González Morales and Straus, 2009). While a collector–based system with logistical moves may be reasonable for Lower (and perhaps Initial) Magdalenian occupations in Cantabria province, valley-based coastal to montane site movement cannot explain the complexity of lithic sources used at Urtiaga and the large territorial area those toolstones represent (see also a summary by Rios-Garaizar et al., 2013 for the Upper Solutrean at Arlanpe cave in Vizcaya). While Initial Magdalenian groups could have traded for lithic raw materials (and some inter-group trade/interaction/diffusion is thought to have occurred during the period based on artifact similarities (Aura et al., 2012)), this would have been an exceptionally risky technological strategy to provision any large portion of a mobile toolkit, particularly in fluctuating Last Glacial environments (Altuna, 1972; Jones et al., 2003). Additionally, Urtiaga Level F was intermittently occupied (at least in the outer vestibule), with lithic debris from mid-stage reduction and osseous industry indicating diverse activities; these attributes do not reflect a residential base, but a site occupied at a mid-point during a settlement round—certainly, proximal debitage fragments were removed from the site for later use and initial reduction stages occurred before groups arrived there. Further, were the site a base camp in a logistical system, it would have been cumbersome to schlepp any of the raw materials used at Urtiaga (the closest of which is 40 km away) to the cave, particularly any of the flysch flints, the most common materials in the Level F assemblage, ~100 km from their outcrops in southwest France;

(d) finally, all raw materials without geographically known outcrops were not considered.

In sum, the settlement analysis presented here combines patterns of lithic procurement, manufacture, use, and discard to ultimately model Initial Magdalenian mobility systems.

7.1. Mobility models

The least abundant raw material in Unit 4.270 was Chalosse (2.4%) (Table 8). This outcrop was the earliest visited by Initial Magdalenian groups in this scenario (Fig. 9). Though not abundant, the debris at Urtiaga indicate mid-stage reduction, demonstrating that this high-quality material may have been conserved for still-later occupations of other sites in the group's settlement system. After Chalosse, the next most abundant material in Unit 4.270 is Treviño (14.6%), which was also in mid-stage reduction. Also mid-stage, Gaintxurizketa flysch flint (16.8%) is slightly more prevalent. These materials are followed by chalcedonic and microcrystalline flysch flints (together 35.5%); these debris indicate early to mid stage reduction. Debris from Urbasa (25.5%) indicate all stages of a lithic reduction sequence ending with a bipolar piece; with a whole reduction sequence present, Urbasa was the source most recently visited in this mobility model.

In Unit 4.310, Treviño (mid-stage, 3.5%) is the least abundant raw material, followed by Chalosse (mid-stage, 7.4%). From Chalosse, this model hypothesizes group movement along the coast to Gaintxurizketa flysch flint outcrops (mid-stage, 8.5%) before visiting Urbasa (late stage, with flake and bipolar reduction techniques, 21.1%). Finally, chalcedonic and microcrystalline flysch flint debris indicate recent procurement of these materials. Chalcedonic flysch flint (29.4%) debris demonstrate an entire reduction sequence, beginning with blade reduction through mixed flake/bladelet production. Microcrystalline flysch flint (19.4%) was reduced using bipolar techniques. This model suggests that groups traversed a very large territory while also balancing long- and short-term raw material needs, conserving small amounts of materials like Treviño and Chalosse and utilizing flysch flints in greater quantity. However, it is important to note that Unit 4.310 has a small sample size; these results should be observed with caution.

While the Gaintxurizketa flysch flint outcrop would seem a logical location to procure toolstone in quantity before visiting Urtiaga cave, the model generated using debris from Unit 6.325, another unit with a small sample size, shows this material as a minor (4%) contributor to the mobile toolkit. Unlike the models from Units 4.270 and 4.310, where different reduction stages were discernable, all toolstones identified in Unit 6.325 were mid-stage; the order of material access is based solely on toolstone abundance. Treviño was the next most prevalent material (10.7%), followed by Chalosse (13.5%), Urbasa (27.9%), and flysch flints (chalcedonic, 28.7% and microcrystalline, 13.2%). Unlike the other settlement models, which have circular/spiral patterns across the

Table 8
Reduction stages and raw material composition in sampled contexts. Reduction stages are abbreviated: all (A), early (E), middle (M), and late (L).

Sample	4.270		4.310		6.325		6.385		8.400		8.460	
	Stage	%	Stage	%	Stage	%	Stage	%	Stage	%	Stage	%
Bidache flysch	–	–	–	–	–	–	M	6.5	M	4	M	2.4
Chalosse flint	M	2.4	M	7.4	M	13.5	L	5.3	M	1.1	M	3.5
Chalcedonic flysch	E/M	31	A	29.4	M	28.7	M/L	22.6	M/L	37.5	M	48.6
Gaintxurzketa flysch	M	16.8	M	8.5	M	4	M/L	18	M	11.4	M	7.5
Microcrystalline flysch	M	4.5	L	19.4	M	13.2	M	9.2	M	3.9	M/L	20.4
Treviño flint	M	14.6	M	3.5	M	10.7	M	3.7	M	7.1	M	6.4
Urbasa flint	A	25.5	L	21.1	M	27.9	M	19.8	M	7.9	M	6.4
All other toolstones	–	5.3	–	10.7	–	2.1	–	14.8	–	27.3	–	4.7

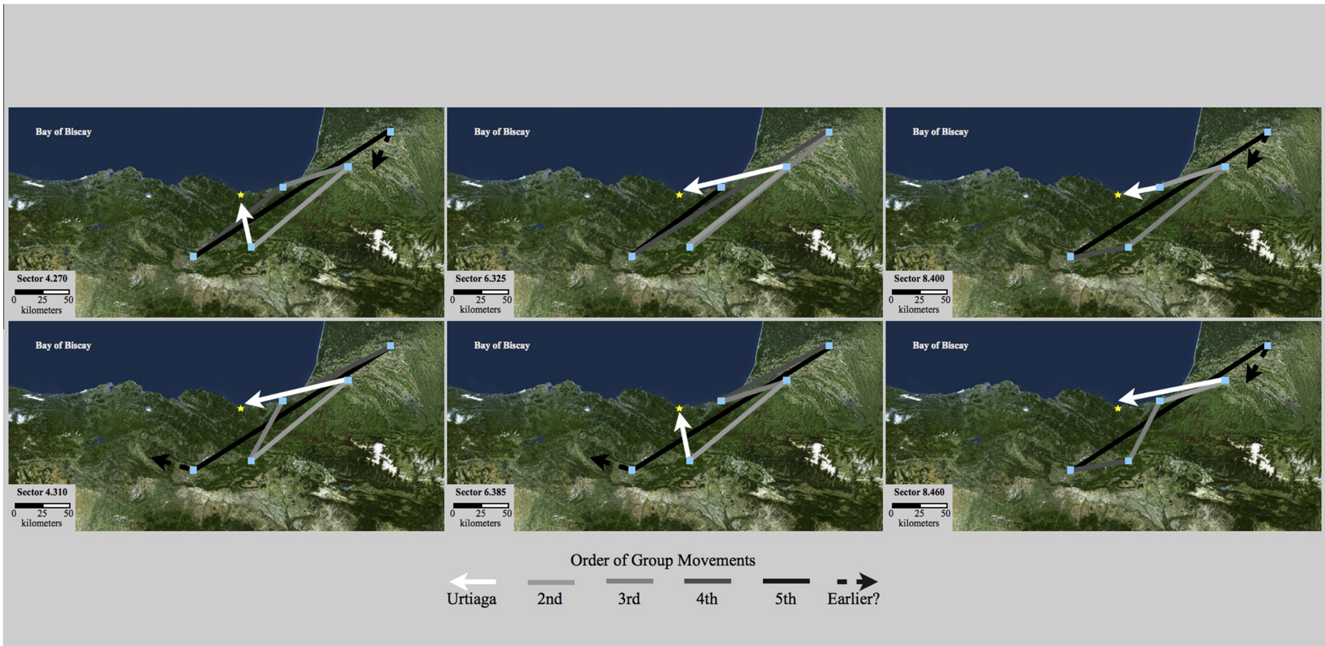

Fig. 9. Mobility models based on six samples from Urtiaga Level F. Order of residential moves is distinguished based on line color. White arrows represent the most recent (last) procurement events, progressing through several grays, finally to black lines, which indicate the toolstones procured first.

eastern Vasco-Cantabrian landscape, the Unit 6.325 model is a regional zigzag of large-scale territorial moves. Such movements could have been the result of unstable, fluctuating local environments and/or limited available resources, making smaller scale moves unrealistic.

Treviño is the least abundant material in Unit 6.385 (3.7%, mid-stage), followed by Chalosse (5.3%, late stage), then Gaintxurizketa flysch (mid-late stage, 18%). All three French flysch flints are present in this sample: chalcedonic (mid-late stage, 22.6%), microcrystalline (mid-stage, 9.2%), and Bidache (mid-stage, 6.5%). Finally, Urbasa is the most abundant mid-stage toolstone (19.8%), indicating that it was the outcrop most recently visited by foragers in this model. This scenario, another model relying on a small sample size, shows greater mobility within southwest France between the area bounded by the Gaintxurizketa, Chalosse, and flysch flint outcrops. This model contrasts the zigzag settlement indicated shown by Unit 6.325; this difference may be attributable to environmental and/or territorial shifts occurring within the Initial Magdalenian period.

In Unit 8.400, over a quarter of the raw materials (27.3%) are not attributable to a geographically known outcrop; all identifiable flints are in lesser abundance than in previous models. Chalosse (mid-stage, 1.1%) is the least abundant material, then, Treviño and Urbasa (mid-stage, 7.1 and 7.9% respectively). While chalcedonic flysch flint is prevalent (37.5%), it is mid-late stage. Other flysche flints (Bidache and microcrystalline, both mid-stage) are only 4% each. Gaintxurizketa flysch flint was the most recently procured toolstone (mid-stage, 11.4%) before groups arrived at Urtiaga; though it is less abundant than the chalcedonic flysch flint, it is not as reduced. The Unit 8.400 model shows a large circular territory extending through the $\sim$12,000 km^2 eastern Cantabrian zone, however, both the small sample size and large percentage of unidentifiable toolstones in this sample make this hypothesis a tenuous one.

Finally, the Unit 8.460 assemblage has very little Chalosse (mid-stage, 3.5%) and equal amounts of Treviño and Urbasa (mid-stage, 6.4%) (Treviño is shown as accessed first in Fig. 9 following precedent set by the other scenarios, but really either outcrop could have been). There is also a small amount of Gaintxurizketa flysch flint (mid-stage, 7.5%) in this sample. The majority of the raw materials in Unit 8.460 are chalcedonic (48.6%, mid-stage) and microcrystalline (20.4%, mid-late stage) flysch flints. This unit suggests that French flysch flint outcrops (a combined 69% of the Unit 8.460 toolstone assemblage) were important locations within Initial Magdalenian settlement systems; these flints may have been a major resource for hunter-gatherer groups who lived in eastern Vasco-Cantabria.

7.2. Summary

While heuristic, these six mobility models show that Initial Magdalenian land use was dynamic; no two scenarios are the same. These models provide several scales of behavioral data, including flint preferences, toolkit management, and landscape use. Five major conclusions can be drawn:

(a) Despite its proximity to Urtiaga, Gaintxurizketa flysch flint was the most recently accessed toolstone in only one model (Unit 8.400). That this material was not preferred is perhaps due to occasional large inclusions found in it, which would have made it a less reliable material than the other flysch and non-flysch flints discussed here, particularly for blade (let) reduction. Initial Magdalenian hunter-gatherers may have considered raw material quality as they formed their mobile toolkits.

(b) Initial Magdalenian mobile toolkits were likely designed to provision long-term raw material needs. In every settlement model, Chalosse and Treviño debris comprise small portions of mobile toolkits that are still in mid-stage lithic reduction: assuming the models accurately reflect human behavior, these stones may have been accessed first, yet conserved as groups continued to traverse eastern Vasco-Cantabria. This kind of raw material management would have been necessary (and an asset) to lithic economies with mobile flint foundations and limited local (lower quality) toolstone provisioning.

Table 9
Urtiaga Level F tools in sampled contexts. Sample contexts are abbreviated by sector and depth as discussed in the text. Parenthetical values represent the distribution of tools on pieces classified as "Diverse".

Tool type	4.270	4.310	6.325	6.385	8.400	8.460
Simple endscraper	–	–	–	–	1	–
Atypical endscraper	2	–	–	–	–	–
Double endscraper	1	–	–	–	–	–
Endscraper on flake	–	–	–	–	–	1
Carinated endscraper	1	–	–	–	–	–
Thick nosed endscraper	–	–	–	1	–	–
Nucleiform endscraper	–	–	–	2	–	–
Perforator-truncated piece	1	–	–	–	–	–
Perforator–endscraper	–	–	1	–	–	–
Perforator	–	1	–	1	–	–
Atypical perforator	–	–	2 (2)	1	1	1
Microperforator	–	–	–	–	–	1
Straight dihedral burin	–	–	(1)	–	–	1
Slanted dihedral burin	–	–	1	–	–	–
Angle dihedral burin	–	–	–	(1)	–	–
Angle on break burin	(1)	(1)	2	–	–	(1)
Burin on oblique retouched truncation	–	–	–	–	–	1
Transverse burin on notch	–	–	(1)	–	–	–
Multiple burin on retouched truncation	1	–	–	–	–	–
Multiple mixed burin	1	–	–	–	–	–
Flat face burin	–	–	–	–	–	(1)
Gravette point	–	1	–	–	1	1
Completely backed blade	1	1 (1)	–	–	–	–
Partially backed blade	2	–	1	–	–	–
Straight truncated piece	–	–	–	–	–	1
Oblique truncated piece	2	–	–	2	1	–
Concave truncated piece	–	1	1	–	–	–
Convex truncated piece	–	–	–	–	–	1
Bitruncated piece	–	–	–	1	–	–
Continuously retouched piece 1	1 (1)	1 (2)	2 (2)	2	1	5 (1)
Continuously retouched piece 2	–	–	–	–	1	–
Notch	3 (1)	1	1 (3)	1 (2)	–	4 (1)
Denticulate	1 (1)	–	(1)	2 (2)	1 (1)	4
Splintered piece	2	2	–	–	–	1
Sidescraper	–	–	(1)	–	(1)	–
Raclette	1	–	–	–	–	–
Backed bladelet	1	1	–	–	–	–
Truncated backed bladelet	–	1	–	–	–	–
Retouched bladelet	–	–	–	–	1	1
Diverse	2	2	4	3	1	2

(c) In addition to long-term raw material stockpiling within mobile toolkits, Initial Magdalenian groups also may have procured materials for short-term use: Urbasa and French flysch flint. In all but one settlement model, foragers visited Urtiaga following raw material acquisition at one (or both) of these sources. These samples show that Initial Magdalenian toolkits were probably multi-purpose, balancing long- and short-term lithic reduction needs and movement within the large eastern Vasco-Cantabria territory. Thus, Initial Magdalenian groups would have had to plan their moves in advance (perhaps seasonally) in order to adequately provision their mobile toolkits.

(d) While mobile toolkit composition shifted throughout the Initial Magdalenian (or at least in each detailed sample considered here), the tools deposited at Urtiaga cave did *not* change (Table 9). Though the samples are small, they indicate that the same kinds of tools were deposited at the cave throughout the period as shown in the cumulative tool summary: notches, denticulates, continuously retouched pieces, and burins are most prevalent in each unit. Despite raw material fluctuations, the activities that occurred in Urtiaga cave appear to have remained consistent during the Initial Magdalenian.

(e) Finally, these models propose that Initial Magdalenian groups diversified their mobility following two general patterns: either (1) concentrating settlement in small areas within the large eastern Vasco-Cantabrian territory (e.g., Units 4.310 or 4.270); or (2) traversing (nearly) the entire landscape (e.g., Units 6.325 or 8.400). Collectively, the six samples suggest Initial Magdalenian territorial shifting that was likely related to local (perhaps seasonal) environmental patchworks, resource availability, and/or cultural boundaries. Modifying mobility strategies, and especially employing long-term mobility systems, is one strategy hunter-gatherers employ to respond to subsistence stress (Hames, 1987; Kelly, 1992). During the Initial Magdalenian, residents of Vasco-Cantabria were in flux: environmentally, territorially, and technologically as they sought the most effective organizational solutions to a challenging subsistence context. It is possible that by the LCM, when technology and environment stabilized (Aura et al., 2012), that Vasco-Cantabrian groups were able to restructure their territories into the valley-based framework proposed by Straus (1986) and González Morales and Straus (2009) and form a distinct regional band identifiable by unique portable art objects: engraved scapulae.

8. The Initial Magdalenian mosaic

The multifaceted analysis presented here suggests Initial Magdalenian behavioral complexity beyond the artifact traits routinely discussed by prehistorians as diagnostic features of the Solutrean–

Magdalenian transition: flake production, increasing backed bladelets and corresponding decrease in Solutrean points, an "Archaic" toolkit, occasional raclettes, increasing prevalence of osseous *sagaie* industry, and local raw material use (Aura et al., 2012; Straus, 2013; Straus et al., 2014). Materials from Urtiaga Level F conform to these traits (except in the case of local raw material use), but also indicate that Initial Magdalenian hunter-gatherers may have: exploited comestible resources that lived in environmental zones near their habitation sites; spatially defined activity areas within caves; reused sites as part of patterned settlement systems; strategically managed their mobile lithic toolkits to meet long/short term technological goals, both in toolstone provisioning and tool production (blank selection and subsequent transport offsite); shifted their mobility and lithic procurement strategies within a large eastern Cantabrian territory; and employed myriad strategies to maintain their lithic toolkits in order to effectively exploit shifting environments in the region following the Last Glacial Maximum. This synthesis explores whether or not these behaviors were unique to groups who used Urtiaga cave or are features that could distinguish Initial Magdalenian adaptations from the Solutrean and Lower Magdalenian periods by focusing on the trend that defines this transition: a shift from reliable to maintainable technology.

Maintainable technology is designed to be easily repaired and retooled, extending artifact use lives (Bleed, 1986). This kind of technological system allows groups to efficiently exploit variable, fluctuating, and/or unpredictable environments (Pereira and Benedetti, 2013). Since maintainability is an organizational characteristic, its features can be traced within artifact assemblages. In lithic reduction, toolkit maintenance is demonstrated by burin rejuvenation, bladelet production, bipolar reduction, used debitage, multi-platform cores, nucleiform endscrapers, and composite tools (see Appendix B). Additionally, four other traits testify to maintainable organizational systems: diverse *sagaies* in toolkits; blank selection and transport; consistent, redundant site activities; and flint dependence (see further explanation in Appendix B). In order to assess how extensively Initial Magdalenian groups maintained their assemblages, each of these 11 attributes was evaluated using published results from analyses made at four other Initial Magdalenian/Upper Solutrean sites in Vasco-Cantabria: La Riera Level 17 (Asturias, 16,900 ± 200 (GaK-6445) and 17,070 ± 230 (GaK-6444) uncal. BP); El Rascaño Level 5 (Cantabria, 16,430 ± 130 uncal. BP (B.M. 1455)); El Mirón Levels 117–119.3 (Cantabria, Level 117 17,050 ± 60 uncal BP, GX-25857); and Arlanpe Level 2 (Vizcaya) (González Echegaray and Barandiarán, 1981; Rios-Garaizar et al., 2013; Straus and Clark, 1986; Straus et al., 2014); results are summarized in Table 10.

While four maintenance characteristics discussed here (burin rejuvenation, used debitage, multiplatform cores, and blank selection/transport) cannot be effectively evaluated because they lack reference in the published data, the seven characteristics compared in Table 10 demonstrate that Initial Magdalenian hunter-gatherers maintained their lithic assemblages. Some lithic toolkits were maintained during manufacture (La Riera and El Mirón), showing high proportions of bladelets in debris assemblages: 37% at El Mirón and 23% at La Riera, with moderate amounts of nucleiform endscrapers (c. 20% of cores) and very few "Diverse"/composite tools at each site. In contrast, the Urtiaga, El Rascaño, and Arlanpe assemblages indicate use-related maintenance. "Diverse"/composite tools at Urtiaga (20%) and Arlanpe (17%) are significantly higher than at El Mirón and La Riera; El Rascaño is a middle ground at 7%. Cores were repurposed into nucleiform endscrapers at rates of 38% and 42% at Urtiaga and El Rascaño, respectively. Arlanpe had no nucleiform endscrapers, but a higher percentage of blade(let) production (15%) than the other two sites. Bipolar reduction was under 2% at all Initial Magdalenian sites (in later LCM contexts, they can be as much as a sixth of an assemblage (Fontes, 2014a)). Finally, osseous industry and site activities offered no significant trends: diverse *sagaies* were absent from the Upper Solutrean sites (Arlanpe and La Riera) and site activities were (spatio) temporally consistent when this was evaluated. Flint dependence in assemblages correlated to site proximity to high-quality lithic raw materials; the greatest concentrations were in eastern Vasco-Cantabria, where Urtiaga has an almost entirely flint-based assemblage, decreasing westwardly toward Asturias, where flint is a small portion of the La Riera assemblage.

All five assemblages evaluated here indicate aspects of toolkit maintenance that are prominent characteristics of later LCM assemblages (González Echegaray, 1960; Utrilla, 1981). However, unlike LCM assemblages, Initial Magdalenian toolkits reflect selective use of maintenance strategies. That an assemblage indicates particular maintenance strategies may not have related to a single approach (e.g., groups choosing to maintain during manufacture *or* use), but instead, a behavioral continuum. Since lithic reduction

Table 10

Maintenance in Vasco-Cantabrian Upper Solutrean and Initial Magdalenian Assemblages. Data are from: Rios-Garaizar et al. (2013)°, Straus et al. (2014)†, González Echegaray and Barandiarán (1981)$^{\Delta}$, and Straus and Clark (1986)$^{\Omega}$. Burin rejuvenation refers to the percentage of burin spall that removed previously retouched edges. Bladelet production is the percentage of bladelets in the lithic debris assemblage (exclusive of microdebitage). Bipolar reduction is indicated by splintered pieces as a portion of the lithic debris assemblage (exclusive of microdebitage). Multi-platform core indicates the percentage of all core types with multiple platforms. Used debitage proportions the percentage of the lithic assemblage with regularized edge damage/use. Nucleiform endscrapers are marked by their percentage of the total number of cores. "Diverse"/Composite tools indicate the portion of the tool assemblage comprised by de Sonneville-Bordes and Perrot types 17–22 and 92. All site/landscape level attributes are marked as present (+), absent (–), or not applicable/indeterminate from published analysis (NA). *Percentage for Arlanpe includes all laminar debitage because analysts did not distinguish between blades and bladelets. **Fontes' (2014) analysis of Rascaño Levels 4/4b yielded significantly large quantities of bipolar debris that were not identified in analyses by González Echegaray and Barandiarán (1981); this value may underrepresent the assemblage.

Attribute	Urtiaga F	Arlanpe II°	El Mirón 117–119.3†	El Rascaño 5$^{\Delta}$	La Riera 17$^{\Omega}$
Lithic Industry					
Burin rejuvenation (%)	25	NA	NA	NA	NA
Bladelet production (%)	4	15*	37	NA	23
Bipolar reduction (%)	2	0.2	0.01	0.7**	0.1
Used debitage (%)	19	NA	NA	NA	NA
Multi-platform cores (%)	54	NA	NA	NA	NA
Nucleiform endscrapers (%)	38	0	17	42	21
"Diverse"/Composite tools (%)	20	17	1	7	0.7
Site/Landscape					
Diverse *Sagaies*	+	–	+	+	–
Blank selection/transport	+	NA	NA	NA	NA
Consistent site activities	+	NA	+	+	+
Flint dependence	+	–	–	+	–

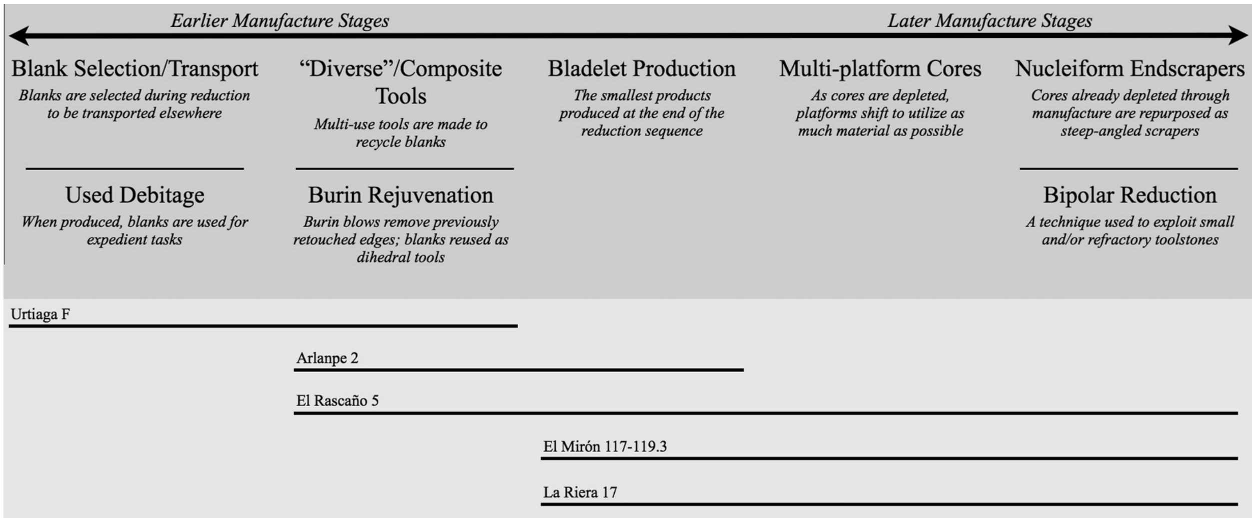

Fig. 10. Maintenance continuum. Maintenance behaviors are listed relative to lithic reduction stages (earlier through later). Beneath the continuum, lines indicate which maintenance behaviors occurred at Initial Magdalenian sites.

follows predictable patterns, maintenance behaviors should correlate to specific moments in the lithic reduction sequence where each strategy would prove most effective at conserving raw material and prolonging toolkit use-life (Fig. 10). How maintenance strategies were used likely related to the conditions of mobile toolkits upon arrival at a location, occupation span, site position within a settlement pattern, and raw material availability (both local and distant) (Bleed, 1986). For example, the La Riera and El Mirón assemblages both indicate later stages of lithic reduction based on their lithic debris—lots of plain flakes and bladelets—with corresponding late stage maintenance behavior (Fig. 10; Straus and Clark, 1986; Straus et al., 2014). In contrast, the Urtiaga Level F lithic assemblage testifies to mid-stage reduction and earlier stages of toolkit maintenance: debitage use, blank selection, "Diverse"/composite tools, and burin rejuvenation (though there are high percentages of multi-platform cores and nucleiform endscrapers, these are comparatively few artifacts relative to the number of used and "Diverse" pieces (see Tables 1, 4 and 5)). Thus, maintenance strategies suggest that specific lithic reduction stages occurred at different locations, reinforcing the aforementioned hypothesis that Vasco-Cantabrian Initial Magdalenian groups were highly mobile. Were these groups occupying sites for long intervals, i.e., seasonally, a greater range of maintenance behavior would be evident in each lithic assemblage. For example, at the LCM residential base in El Mirón, all of these maintenance strategies were commonplace, the result of complex occupations that required a broad range of lithic reduction/products (Fontes, 2014a,b; Fontes et al., in press-b; González Morales and Straus, 2009; Straus et al., 2008). In contrast, at the LCM hunting stand at El Rascaño, maintenance strategies indicate late-stage reduction with high amounts of nucleiform endscrapers and bipolar pieces, consistent with an occupation that was limited in its scope and logistically provisioned (Fontes, 2014b; González Echegaray and Barandiarán, 1981). Thus, the maintenance strategies and reduction characteristics that indicate residential mobility patterns in the Initial Magdalenian also correspond to the logistical mobility systems hypothesized for the LCM *and* explain some of the known variation in LCM assemblages (González Echegaray, 1960; González Morales and Straus, 2009; Straus, 1992, 2013; Utrilla, 1981). In sum, maintenance strategies are not only important in terms of understanding the Solutrean–Magdalenian transition from a technological standpoint, but in reconstructing the Initial Magdalenian mosaic: *how* groups utilized the Vasco-Cantabrian landscape and importantly, how their strategies gradually shifted into well-defined LCM patterns (González Echegaray, 1960; González Morales and Straus, 2009; Straus, 1992, 2005, 2013; Straus et al., 2008; Utrilla, 1981).

9. Urtiaga cave and the Solutrean–Magdalenian transition

This analysis of the Urtiaga Level F assemblage advances archaeological understanding of the Solutrean–Magdalenian transition in several ways. First, the lithic assemblage, which includes mixed Solutrean and Magdalenian artifacts and whose toolstone proveniences indicate a settlement pattern that did not extend beyond Landes, France, provides further evidence of *in situ* cultural change during the c. 18–16,000 uncal. BP interval in Vasco-Cantabrian Spain. These assemblage features reinforce the hypothesis that the Initial Magdalenian was a regional archaeological culture only peripherally related to the French Badegoulian, which developed c. 1000 years earlier (Corchón, 1981, 1994; Straus, 1983, 2000, 2013, 2015; Straus et al., 2014; de la Rasilla Vives and Straus, 2006). Second, this analysis has shown that though the Initial Magdalenian may not be traceable by a single artifact type (unlike the Badegoulian, with its diagnostic raclettes), it can be summarized based on its *economic* characteristics: flake reduction; a mixed toolkit indicative of gradual replacement of one armature system (Solutrean points) with another (*sagaies* and microblade insets); assemblage maintenance via burin rejuvenation, bipolar reduction, bladelet production, composite tools, etc.; and evidence that groups managed toolkits to adapt to long- and short-term needs within a mobile economy. These economic characteristics are neither Badegoulian nor Solutrean, but are unique to the Initial Magdalenian and could have related to environmental and/or cultural factors that influenced regional technological solutions (e.g., limited social networks during the Solutrean–Magdalenian transition or local resource shifts in the Last Glacial Vasco-Cantabrian environmental patchwork). Thus, Urtiaga cave is an important reference site that archaeologists can compare with other assemblages from the Solutrean–Magdalenian interval in order to better understand the "desolutreanization" processes in Vasco-Cantabria.

The Urtiaga cave case study serves as a metaphor for how archaeologists can investigate regional cultural trajectories in the Upper Paleolithic: by synthesizing site- and landscape-level datasets (see also Banks et al., 2009, 2011). Through multi-faceted studies, archaeologists can explore inter-group interactions, human-environmental dynamics, and large scale technological and cultural change. These issues are at the heart of the Solutrean–Magdalenian transition, but also broader questions in Upper Paleolithic archaeology. Throughout the Upper Paleolithic, there are traces of regional histories having a significant influence on broader cultural trajectories (e.g. artistic or technological diffusion) (González Morales and Straus, 2009; Otte, 2012). The Badegoulian and Initial Magdalenian may have been two differing regional solutions to a broader "desolutreanization" problem—both archaeological cultures diverge, albeit in different ways, from the Solutrean, whose technological (and cultural?) behaviors were no longer adaptive. Whether the impetus for the transitions were climatic, environmental, socio-cultural, or some combination therein, the nature of Badegoulian and Initial Magdalenian adaptations was likely influenced by the cultural-historical trajectories established at the end of the Solutrean period in these respective regions, which in turn would have informed the kinds of cultural processes—technologies, territories, inter-group connections—that would succeed.

10. Conclusions

This paper synthesized results from analyses of Urtiaga Level F lithic industry, osseous industry (Mugica, 1983), and faunal remains (Altuna, 1972), and presented an intra-site spatial comparison and a series of mobility models as part of a multi-faceted methodological procedure. Additionally, assemblages from Urtiaga Level F were compared with those from four other sites in the Vasco-Cantabrian region that were occupied at c. 17,000 uncal. years BP to assess an important feature of the Solutrean–Magdalenian transition: toolkit maintenance. Together, these analyses provide a holistic behavioral perspective of Initial Magdalenian hunter-gatherer adaptations and indicate that maintenance was a key component of technological organization during this period. Further, these analyses suggest that there was no typical Initial Magdalenian assemblage, just as there were no typical Solutrean or LCM assemblages: technological and associated mobility strategies likely varied to confront local geographic circumstances, including topography, lithology, and ecology (Straus, 1992, 2012; Straus and Clark, 1986; Straus et al., 2014). That this technological variation persists in the Vasco-Cantabria throughout the Upper Paleolithic is itself evidence of *in situ* regional adaptations that were probably related to this unique, highly variable, geographically circumscribed environmental zone whose resources differed fundamentally from those in France and therefore would have required different kinds of technological and settlement flexibility than those found in transitional Badegoulian industries (see Banks et al., 2011; Ducasse, 2012; Ducasse and Langlais, 2007; but also Bosselin and Djindjian, 1999). This interpretation is analogous to differences in faunal exploitation and settlement strategies in the two regions: while French Magdalenian groups in areas like the Paris Basin were residentially mobile serial specialists, Vasco-Cantabrian groups had more broad spectrum diets, incorporating significant amounts of fish and shellfish into their diets long before their French counterparts (Altuna, 1972; Audouze, 2006, 2007; Freeman and González Echegaray, 2001; Barandiarán, 1985; Straus, 1992, 2005). Regional cultural "expressions" were an enduring feature in the western European Upper Paleolithic, even during technological transitions (Aura et al., 2012).

Urtiaga Level F, together with the records of four other c. 17,000 uncal. BP occupations, suggests an Initial Magdalenian mosaic, largely continuous with its preceding Solutrean and succeeding LCM, that was created by highly mobile hunter-gatherers who may have shifted their movements within large territories, creating patterned large- and small-scale settlement systems where caves like Urtiaga were likely reused for similar purposes through time. These groups may have spatially defined their sites, reusing activity areas and exploiting faunas that lived locally. Their lithic technology may have been strategically managed, balanced for long- and short-term needs, with blanks selected during reduction so that non-specialists could maintain the toolkit when the need arose. Maintenance strategies paralleled reduction sequences, with separate *chaînes opératoires* for flakes and blade(let)s. These groups made "archaic" tools a technological focus, and developed bladelet armatures alongside a diverse *sagaie* industry. They probably adjusted their strategies to meet the demands of local, poorer lithologies in western Vasco-Cantabria. Over the course of some 2000 years, these groups would establish LCM behavioral patterns—smaller territories, intensive site-catchment zone exploitation, wild harvesting, aggregation, extensive use of bipolar reduction, and unique portable art—traces of which are evident in the five Initial Magdalenian assemblages examined here. Those groups who visited Urtiaga during the Initial Magdalenian were planting their cultural roots—technologies, networks, traditions—grounded in their "Solutrean" history, gradually branching into a "Magdalenian" future that would continue to grow across the European landscape until the end of the Last Glacial.

This case study from the Solutrean–Magdalenian transition in northern Spain, Urtiaga cave, has described and operationalized some kinds of methodological procedures that archaeologists can use to effectively incorporate artifacts recovered from early 20th century archaeological excavations into modern interpretive frameworks. The significant results yielded by this study convey how important it is that archaeologists consider these data sources (albeit within recording limitations) as they frame their current research. As this study has shown, archaeologists can use data from these sources to examine prehistoric continuity and change between cultural-historical units. Incorporating materials recovered using different procedures, where applicable, has the potential to not only increase anthropological understanding of prehistoric lifeways, but can ensure that important elements of the prehistoric archaeological record do not become lost to history simply because they were obtained using excavation methods that may not meet today's standards. Furthermore, studies of this type become increasingly important as archaeological methodologies become more advanced each year. After all, current archaeological methods will eventually also be outdated. Old stones serve as a humble reminder of a responsibility to document archaeological research methods and data as accurately as possible as the discipline moves forward.

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Appendix A. Lithic debris analysis

In addition to the debris classification described in the main text, a series of qualitative and quantitative attributes were recorded for each lithic artifact:

(a) raw material type, which was determined using an *ad hoc* reference collection whose samples were then directly compared to a similar reference collection made by geologist A. Tarriño (2012) for Aitzbitarte III (a site located approximately 30 km from Urtiaga cave) in order to make geographic source determinations. This reference assemblage included samples of Gaintxurizketa, Bidache, chalcedonic, and microcrystalline flysches, and Chalosse, Treviño, and Urbasa flints;
(b) artifact size, which was recorded using a square centimeter size chart, and length, width, and thickness measurements (on whole debitage, tools, and cores) to the nearest millimeter;
(c) artifact weight, which was measured to the nearest 0.1 g;
(d) manufacture variables, including debitage fragmentation (whole, proximal, mesial, distal, longitudinal or indeterminable), and, where applicable: platform type (following Andrefsky, 2005), termination type (following Cotterell and Kamminga, 1987), dorsal flake scar count (following Andrefsky, 2005; whole debitage only), and dorsal cortex amount (modified from Andrefsky, 2005 to consider four stages: absent, <1/3 exterior cortical surface, 1/3–2/3 cortical, and 2/3 to complete; whole debitage only);
(e) presence or absence of two taphonomic processes: patina and burning. Burning was distinguished based on the presence of crazing and pot-lidding;
(f) edge damage/use, which was measured in up to three locations on each artifact. Location was recorded (i.e., proximal, right margin, etc.) and type of use: flake snaps, dulling, nibbling, and edge concavities ("half moons"). Each type of damage was recorded as continuous or discontinuous (e.g. continuous on the entire right margin vs. discontinuous on the distal portion of the left margin); and,
(g) for cores (and core tools), three additional variables were recorded: the number of platforms, the number of removals struck from these platforms, and the number of those removals that had hinge or step terminations.

These attributes, together with the debris classification, provide information about all stages of lithic technological organization at Urtiaga cave.

Appendix B. Toolkit maintenance

The following assemblage features indicate toolkit maintenance in lithic reduction:

(a) *burin rejuvenation*, when burin blows removed previously retouched edges and thereby repurpose tool blanks;
(b) *bladelet production*, which utilizes raw material as it diminishes in size, avoiding toolstone waste;
(c) *bipolar reduction*, a manufacturing technique that can effectively reduce refractory and/or small raw materials, allowing toolstone to be processed even as its size and/or quality diminished within the mobile toolkit;
(d) *used debitage*, which demonstrate that groups intensified use of manufacturing debris beyond blanks that they modified into formal tools—available, suitably sized and/or shaped debitage cutting edges were utilized for expedient tasks;
(e) *multi-platform cores*, which indicate cores that were manufactured using exhaustive core reduction techniques that utterly depleted lithic raw materials;
(f) *nucleiform endscrapers*, whose manufacture repurposed exhausted cores into functional steep scraping tools (see Keeley, 1988 and Domingo et al., 2012); and
(g) *"Diverse"/composite tools*, which efficiently combine formal tools on single blanks, (re)utilizing raw material.

Each of these traits is associated with raw material conservation; all are characteristics of LCM assemblages in Vasco-Cantabria (Fontes, 2014a, b; González Echegaray, 1960; Straus et al., 2008). Additionally, four other traits testify to maintainable organizational systems:

(h) *Diverse* sagaies *in toolkits*, evidence that groups experimented with varying forms of antler insets before selecting the quadrangular cross-section design most common in the LCM. *Sagaies* were an essential component of the modular, maintainable Magdalenian weapon technology;
(i) *blank selection and transport*, wherein groups retained blanks in mobile toolkits for future use. These pieces would have not only made the toolkit a predictable resource, but also enabled non-specialists to select pieces from those already produced to retool in the event that an item broke or its use was depleted. Non-specialist toolkit maintenance is a major characteristic of maintainable technological organization (Bleed, 1986);
(j) *consistent site activities*, which testify to groups not only maintaining their toolkits, but translating modular design to their mobility strategies, regularizing site use and site position in a settlement system; and
(k) *flint dependence*, wherein groups maintained the kinds of raw materials they used, and perhaps regularized toolstone access within a modular settlement system.

Each of these traits is discussed in the main text in the context of Vasco-Cantabrian Initial Magdalenian/Upper Solutrean sites.

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