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A North American perspective on the Volgu Biface Cache from Upper Paleolithic France and its relationship to the "Solutrean Hypothesis" for Clovis origins

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ABSTRACT

The "Solutrean hypothesis" for the origins of the North American Clovis Culture posits that early North American colonizers were direct descendants of European populations that migrated across the North Atlantic during the European Upper Paleolithic. The evidential basis for this model rests largely on proposed technological and behavioral similarities shared by the North American Clovis archaeological culture and the French and Iberian Solutrean archaeological culture. The caching of stone tools by both cultures is one of the specific behavioral correlates put forth by proponents in support of the hypothesis. While more than two dozen Clovis caches have been identified, Volgu is the only Solutrean cache identified at this time. Volgu consists of at least 15 exquisitely manufactured bifacial stone tools interpreted as an artifact cache or ritual deposit, and the artifacts themselves have long been considered exemplary of the most refined Solutrean bifacial technology. This paper reports the results of applying methods developed for the comparative analysis of the relatively more abundant caches of Clovis materials in North America to this apparently singular Solutrean cache. In addition to providing a window into Solutrean technology and perhaps into Upper Paleolithic ritual behavior, this comparison of Clovis and Solutrean assemblages serves to test one of the tangible archaeological implications of the "Solutrean hypothesis" by evaluating the technological and behavioral equivalence of Solutrean and Clovis artifact caching. The hypothesized historical connection is evaluated based on the attributes of the caches themselves, the evidence for geographic and temporal continuity in caching between the two cultures, and the proposed uniqueness of this behavior to Solutrean and Clovis. Results from the comparison of Volgu to Clovis caches indicate that they are divergent with regard to a number of important attributes and appear to represent neither equivalent behaviors nor a historical connection.

1. Introduction

Early twentieth century discoveries of Clovis artifacts in stratified contexts at Blackwater Draw, NM and Dent, CO (Figgins, 1933; Howard, 1935; Hester, 1972), along with subsequent finds in buried and surface contexts throughout much of North America established Clovis as the basal culture from which all known later Native American cultures appear to have been derived. The ancestors of Clovis people are, in turn, traditionally thought to have arrived in the New World from Siberia. As early as the sixteenth century Jesuit priest *José de* Acosta (1590) speculated that the ancestors of Native Americans had entered the American continent by land from northeast Asia, albeit relatively recently. This observation proved to be somewhat prescient, as the preponderance of archaeological, genetic, and linguistic data appears to support a model wherein Upper Paleolithic hunter-gatherers made their way along a land bridge – perhaps along the coastline, inland, or both – that connected Siberia and Alaska during times of lowered sea levels between 14,000 and 18,000 years ago. It is believed that these pioneering populations ultimately gave rise to the Clovis culture, which appears to have occupied nearly all of the North American continent between the ice sheets and the Tropic of Cancer by about 13,000 BP.

Beginning in the late 1990's Dennis Stanford of the Smithsonian Institution and Bruce Bradley of the University of Exeter began publicly promoting an argument that the origins of New World populations might be more geographically complex. Their ideas were initially presented in the popular media (e.g., Holden, 1999; Stanford and Bradley, 2000), and later in scholarly publications (Bradley and Stanford, 2004; Stanford and Bradley, 2002, 2012). Specifically, they argue that Ice Age Europeans reached the American continent 20,000 or more years ago,

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earlier than people of Asian origin and substantially earlier than the Clovis period. This idea had been proposed previously (e.g., Greenman, 1963; Hibben, 1941) but had failed to gain widespread support among archaeologists (e.g., Jelenik, 1971). Stanford and Bradley posit that technological and behavioral characteristics of the European Solutrean culture (22,000–17000 BP [Straus, 2000a,b]) and the American Clovis culture (13,400–12,900 BP [Fiedel, 1999; Haynes, 1992; Prasciunas and Surovell, 2013]) are so consistent that they must reflect a descendant relationship. Dubbed the "Solutrean hypothesis" (Straus, 2000a), the idea has gained abundant media attention (e.g, Preston, 1997 in *The New Yorker*, Begley and Murr, 1999 in *Newsweek,* Vastag, 2012 in the *Washington Post,* along with numerous web sites and blogs) and public popularity (complete with a slogan, "Iberia, not Siberia"), while it has remained at best controversial among professional archaeologists (e.g., Straus, 2000a; Straus et al., 2005; Eren et al., 2013; O'Brien et al., 2014a; b).

2. The "Solutrean Hypothesis"

Stanford and Bradley lay out their most detailed version of the model in their 2012 book *Across Atlantic Ice: The Origin of America's Clovis Culture*; wherein they present a detailed scenario in which Solutrean people gradually adapted to coastal and estuarine environments beginning around 22,000 years ago, developing a maritime technology and knowledge base. This adaptation ultimately led them to venture farther and farther along a biologically rich North Atlantic ice shelf to hunt sea mammals, until at last they reached the coast of Eastern North America, perhaps earlier than 20,000 years ago (Fig. 1). These Solutrean colonizers expanded into America, and ultimately gave rise to the ubiquitous Clovis culture.

In *Across Atlantic Ice* and in earlier publications (Stanford and Bradley, 2002; Bradley and Stanford, 2004), the Solutrean Hypothesis is presented as a solution to a problem. The proposed problem is a lack of satisfactory evidence for a Clovis progenitor in Northeast Asia or Beringia. The authors identify a suite of attributes that should be expected in a "developmental" Clovis assemblage (Bradley and Stanford, 2004; Stanford and Bradley, 2012), including formal tools, large bifaces, large blades, thin bifacial projectile points, end and side scrapers, along with bone and ivory tools. They also expect specific manufacturing techniques to be present, including overshot flaking, basal thinning of projectile points, and pressure flaking. Bradley and Stanford review the technological characteristics of Beringian archaeological assemblages (with particular emphasis on microblade technology, and its absence in Clovis) and conclude, "the bottom line is that there are no pre-12,000-year-old sites in Beringia that contain a lithic technology that even remotely resembles anything we would be expecting as a precursor to Clovis" (Bradley and Stanford, 2004, p. 462). They insist that as a result we must begin to look elsewhere for Clovis origins.

The solution they propose is to consider that the acknowledged similarities between Clovis and the Upper Paleolithic cultures of Europe (e.g., Jelenik, 1971) are not merely analogous, but reflect direct historical connection. They argue that the expected developmental attributes are present in Solutrean assemblages, stating that, "Solutrean is the only Old World archaeological culture that meets our criteria for an ancestral Clovis candidate. It is older than Clovis, its technology is amazingly similar to Clovis down to the minute details of typology and

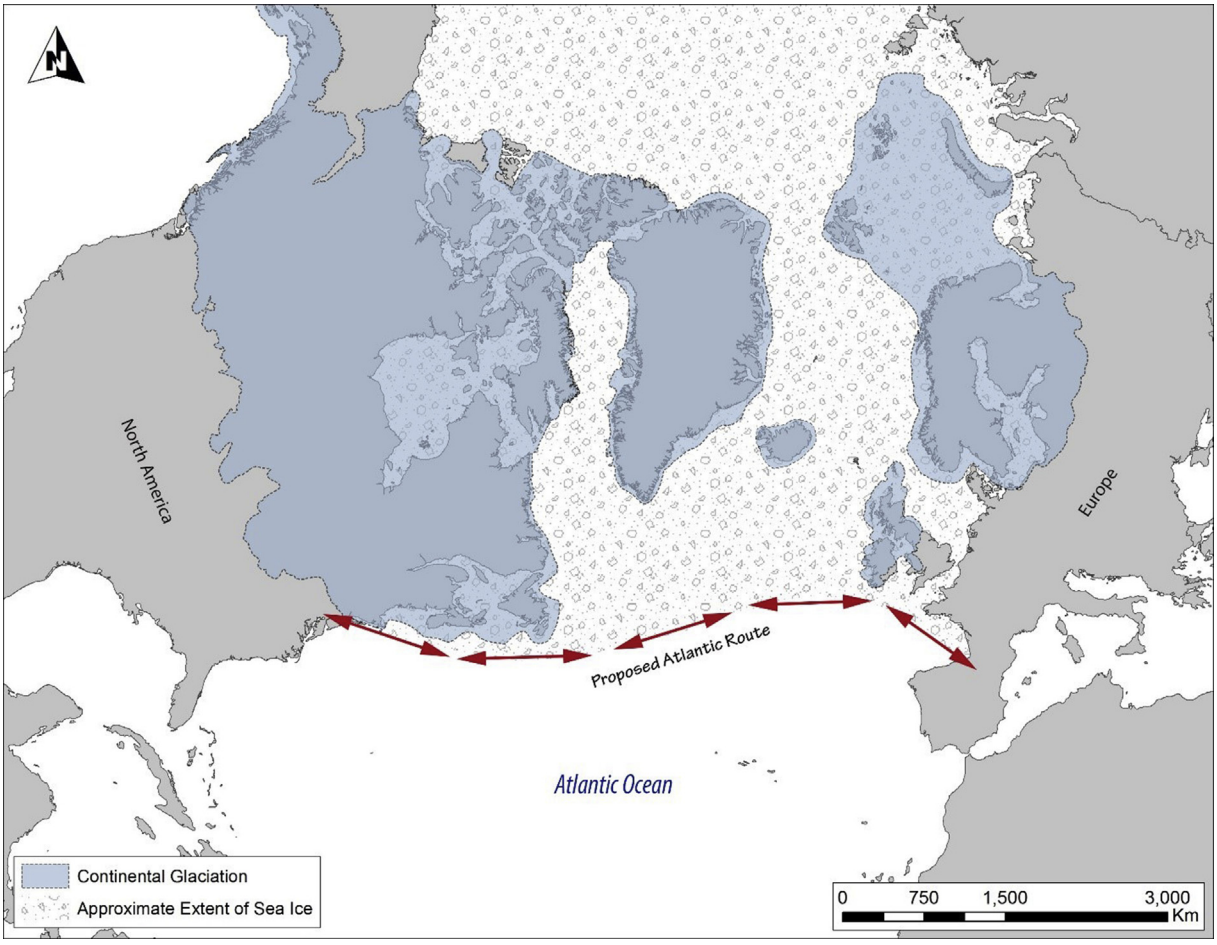

Fig. 1. The proposed Paleolithic Atlantic route to the New World (after Bradley and Stanford, 2006). Last Glacial Maximum data for Eurasia projects glaciation margins around 20 ka (Hughes et al., 2016); North America data projects glaciation margins around 17 ka (Isacks, 2016); map projection: Lambert conformal conic.

manufacturing technology, and the two cultures share many unique behaviors. Indeed, the degree of similarity is astounding." (Bradley and Stanford, 2006:465).

The reactions of many professional archaeologists in both North America and Europe have ranged from skeptical to dismissive (e.g., Eren et al., 2013; Goebel, 2004; Kornfeld and Tabarev, 2009; Meltzer, 2002, 2004; O'Brien et al., 2014a; b; Straus, 2000a; Straus et al., 2005). Lawrence Straus, to whom this volume is dedicated, has been a consistent critic of the Solutrean hypothesis and points out that in addition to the large temporal gap between the two cultures, there is no evidence for seal hunting, deep sea fishing, or even boats at Solutrean sites. Further, oceanic research indicates that the biologically productive corridor along the sea ice is likely overstated by Stanford and Bradley, and may not have existed at all (Westley and Dix, 2008). Straus has succinctly summed up the problem in pointing out that in order to entertain a Solutrean origin for Clovis one must thoroughly account for the 5000 years and 5000 km that separate them (Straus, 2000a, p. 224).

Stanford and Bradley (2012) have taken steps to account for these temporal and spatial disparities. The authors point to a suite of pre-Clovis sites in eastern North America (specifically Meadowcroft, PA, Cactus Hill, VA, and Page-Ladson, FL) as "missing links" (Bradley and Stanford, 2004, p. 472) that exhibit attributes of both Solutrean and Clovis, and to a series of localities with artifacts around Chesapeake Bay (Miles Point and Oyster Bay in particular, along with the "Cinmar biface" – a bipointed artifact reportedly dredged up along with proboscidean remains by a scallop dredge) that appear to date earlier than 20,000 years old. The significance of these missing links also has met with considerable criticism, including the observation that spatio-temporal gradients in radiocarbon dates for Clovis sites (Hamilton and Buchanan, 2007; Collard et al., 2010) are not consistent with a Mid-Atlantic origin for Clovis (O'Brien et al., 2014a); the pre-Clovis sites are not universally accepted as legitimate (Straus et al., 2005), the Chesapeake Bay localities are unexcavated and their context and dating is questionable (O'Brien et al., 2014a; b), and details surrounding the discovery and context of the Cinmar biface are unclear and in some cases contradictory (O'Brien et al., 2014b; Eren et al., 2015). A further problem is that the pre-Clovis assemblages that are proposed to fill the temporal gap between Solutrean and Clovis do not actually look very much like either (Straus et al., 2005; also O'Brien et al., 2014a). Stanford and Bradley (2012, also Bradley and Stanford, 2006) appeal to overshot flaking to clinch the technological connection among them; however, despite their assertions, systematic overshot flaking does not appear to be present in any of the putative pre-Clovis assemblages (O'Brien et al., 2014a; Eren et al., 2013). An apparent trend in the criticism of the Solutrean hypothesis is that Stanford and Bradley overstate the similarities between Solutrean and Clovis, and understate the dissimilarities between Solutrean and Clovis and between them and the "missing links."

Looking beyond archaeological sites and artifacts, it stands to reason that the biological signature of colonizing population from Europe should be evident in the genetics of prehistoric Americans. Initially, Stanford and Bradley (2002, also Brown et al., 1998) argued that haplogroup X, one of five mtDNA founding lineages in the New World, is found primarily in Europe and among some groups of Native Americans, and thus can best be explained in reference to the Solutrean hypothesis. However, haplogroup X also has been identified in the Altai region of Southern Siberia and subsequent genetic research suggests this is the more likely source for that lineage among indigenous Americans (e.g., Derenko et al., 2001; Raff and Bolnick, 2015). Further, the results of recent genetic analyses from Anzick, MT (an infant burial associated with a cache of Clovis artifacts [Rasmussen et al., 2014]) and from Hoyo Negro, QR, MX (a teenage female roughly contemporary with Clovis [Chatters et al., 2014]) do not detect European ancestry in either individual. Biological data provide little or no support for the Solutrean hypothesis (Goebel et al., 2008), and it is noted that discussion of genetics in *Across Atlantic Ice* is relatively (and seemingly intentionally) minimal (Surovell, 2014:308).

The evidential basis for the Solutrean hypothesis as outlined by Stanford and Bradley is largely one of archaeological materials and their interpretations. The backbone of their argument is a series of technological and behavioral correlations that they argue reflect a direct ancestral relationship between the older Solutrean culture and the younger Clovis culture. In *Across Atlantic Ice*, the authors divide their argument into quantitative and qualitative comparisons. Their quantitative comparison consists of a dynamic systems analysis and cluster analysis, which are critically addressed elsewhere in a published debate (O'Brien et al., 2014a; b; Stanford and Bradley, 2014).

The bulk of explicit comparison in the volume, however, is qualitative and admittedly relies on "more subjective assessments" of artifact form and raw material preferences, but also "of less tangible evidence, such as artistic expression and behaviors like caching large bifaces" (Stanford and Bradley, 2012:162). Caching is by no means a keystone of their argument, but it does represent a behavioral attribute that they consistently reference as evidence for a direct historical connection. It is an attribute that thus far has not been addressed in detail in these debates, and one for which there are relatively abundant data (at least with regard to Clovis). The remainder of this paper focuses on comparing caching behavior represented in a series of Clovis caches to that represented in the Solutrean Volgu cache, toward assessing the validity of this particular proposed behavioral connection. While it is acknowledged that acceptance or refutation of the Solutrean hypothesis does not hinge on caching, it is hoped that this comparative analysis will contribute to both the overall evaluation of its strength and a better understanding of caching behavior among both Clovis and Solutrean populations.

3. The role of caching in the Solutrean Hypothesis

Caching is referenced as supportive evidence in each of the scholarly publications that lay out the logic and evidence underlying the Solutrean hypothesis (Stanford and Bradley 2002, 2012; Bradley and Stanford, 2004). The authors note in earlier publications that "caches of over-sized bifaces, that can be argued were not intended to be used, are another trait shared between Clovis and Solutrean" (Stanford and Bradley, 2002:261; also Bradley and Stanford, 2004:467). The significance of caching is given more weight in *Across Atlantic Ice* as a behavior *uniquely* shared by the two cultures, and it is asserted that "caching is rare to nonexistent in other Old World Paleolithic cultures (Stanford and Bradley, 2012:134). Later in the book the authors specify that "Extra-large, extremely well made bifaces have been found buried in groups, sometimes with other kinds of artifacts and frequently with concentrations of red ocher. This caching of extraordinary artifacts has been found in only two more-than-13,000-year-old archaeological cultures: Solutrean and Clovis" (Stanford and Bradley, 2012, p. 177). It is worth noting that neither "other kinds of artifacts" nor red ocher are associated with a known Solutrean cache.

An explicit model is not provided by the proponents of the Solutrean hypothesis for the roles of caching in Solutrean and Clovis cultures, the processes by which the behavior may have been maintained during the proposed oceanic migration, or what changes might be expected as Solutreans adapted this behavior to the their new environmental and social conditions on the North American continent. Their consistent reference to this purportedly unique behavioral similarity, however, implies that in their view the significance of caching, like other technological and behavioral characteristics they invoke, is that it is so similar in detail and in function that it is best explained as the result of Solutrean caching being a direct historical antecedent of Clovis caching. Given this understanding of their argument, we should expect that Clovis caching, while perhaps undergoing some degree of evolution over time (and across space as populations colonize new areas), should retain fundamental similarities to Solutrean caching as a result of its historical relationship. The essential similarities on which the

Fig. 2. The Simon Clovis cache from the U.S. state of Idaho. The Simon cache consists of bifaces in a wide range of reduction states, from initial production from a large flank blank (lower left) to finished formal tools (upper left). Simon is identified by the author as a Clovis ritual cache.

comparison is founded are extraordinary bifaces (extra-large and extremely well-made) grouped together in caches that are not intended for retrieval. We should minimally expect these similarities to hold up under close examination of Volgu and Clovis caches.

3.1. Clovis and Solutrean caches

Caching is increasingly recognized as a regular strategy in the behavioral repertoire of Clovis groups in the continental interior of North America. At least 25 caches of stone and osseous tools, and occasional other items, from the Clovis period have been identified from the Mississippi River to west of the Rocky Mountains, and from the edge of Pleistocene ice margins in Minnesota to the prairies of southern Texas (Kilby and Huckell, 2013, Fig. 3). These cache assemblages range from as few as 5 to well over 100 individual items that appear to have been intentionally deposited at particular places on the landscape. Clovis caches show considerable variation in content, exhibiting obvious variation in number of items cached, diversity of artifact forms, and lithic raw material diversity (Fig. 2). While no single function appears to characterize all Clovis caches (Kilby, 2008, 2011, 2014, 2015; Kilby and Huckell, 2013), the majority appear to have been strategically placed to provide artificial supply depots for highly nomadic peoples navigating Ice Age landscapes. At least one (Anzick, MT) is associated with a human burial, and a small number of others may incorporate ritual or ideological significance in addition to or instead of utilitarian function.

Solutrean caches do not appear to be as ubiquitous, and although Stanford and Bradley (2002, 2012; also Bradley and Stanford, 2004) refer to Solutrean *caches* (plural) throughout their work, they specifically identify only one cache: *Volgu* from central France (Fig. 3; Fig. 4). Their justification for referring to caching as a recurring phenomenon in the Solutrean includes having heard of additional caches not recorded in the literature available to them (Stanford and Bradley, 2012, p. 134). My review of the literature resulted in only one other possibility (Montaut [Mascaraux 1890, Mascaraux, 1912]), a lesser known archaeological assemblage for which identification as a cache is tentative at best. Volgu is the only example of a Solutrean cache that can be identified with any confidence. In 2015 I analyzed the Volgu cache of artifacts in detail for the purposes of comparing it to technological and contextual aspects of Clovis caches. The goals were to characterize Volgu according to attributes determined to be useful in investigating variation in caches in North America (Kilby, 2008), and to determine whether or not Solutrean caching and Clovis caching meet expectations for equivalent and historically related behaviors.

4. The Solutrean cache of Volgu

Volgu consists of at least 15 bifacial stone tools found in the late 19th century in Saône-et-Loire near the confluence of the Arroux and Loire Rivers, about 60 km (37 miles) west of the type site for the Solutrean culture, *Le Solutre* (Chabas, 1874; Cabrol, 1940; Smith, 1966; Aubry et al., 2003). The cache was discovered while digging a canal (*Rigole de* L'*Arroux*) from Digoin to Gueugnon about 0.3 km (0.2 miles) west of the current channel of the Arroux (and within its modern floodplain) and 5.8 km (3.6 miles) northeast of its current confluence with the Loire River (Cabrol, 1940; Peyrouse et al., 2014). Only detected when they were struck by a pickaxe, several pieces were broken in discovery. Chabas (1874), an engineer working on the canal, originally reported 12 artifacts buried side by side on edge, and aligned roughly North-South about 1 m deep in sandy clay alluvium. The workers recovered no datable material in association with the Volgu assemblage, thus their assignment to the Solutrean is based on artifact morphology and technology. Thirty years later, it was reported that as many as 17 artifacts had been discovered, with four disappearing before authorities were notified (Bonnet, 1904). Other reports (Cabrol, 1940) indicate an even greater number may have been found (Aubry et al., 2009). Currently, 15 are known to exist (13 in the Musee Denon in Chalon-sur-Saone, one in the Musee d'Archeologie Nationale in Saint-

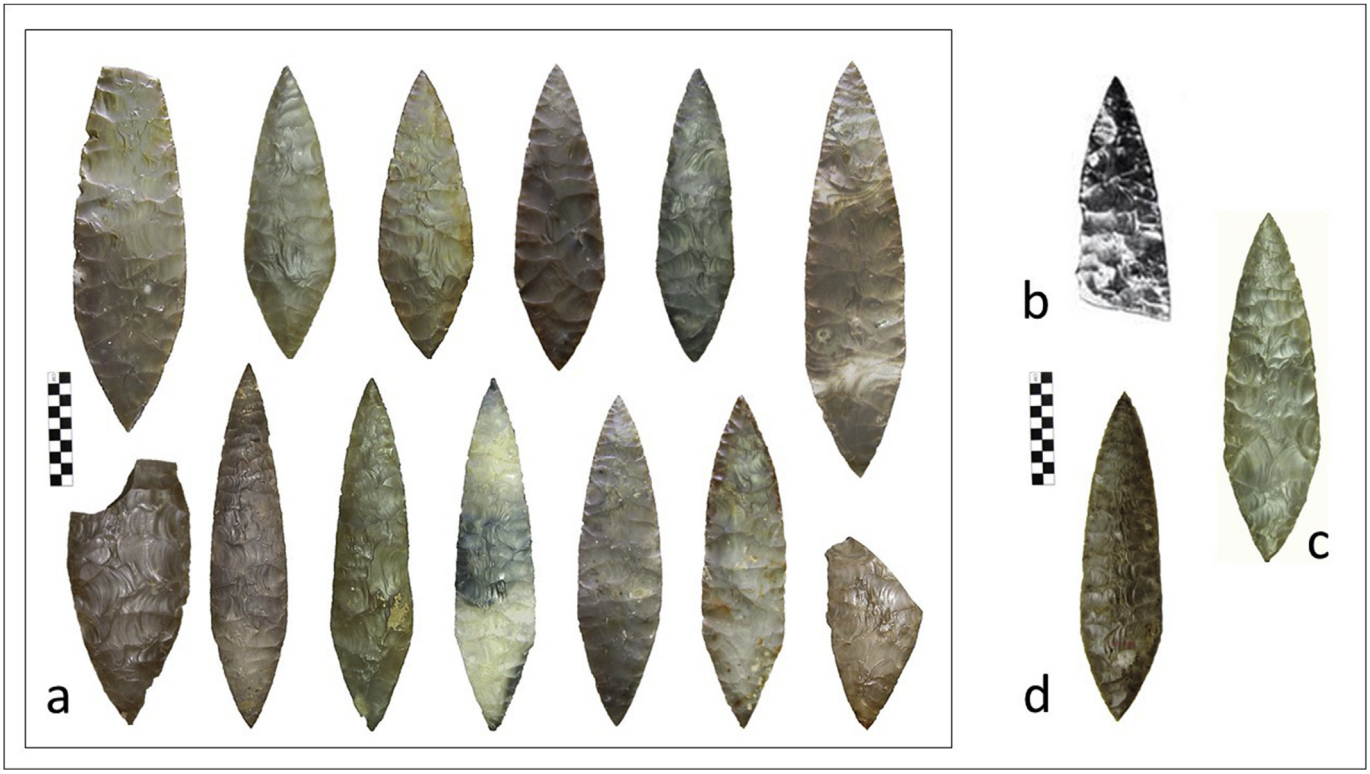

Fig. 3. Extant artifacts from Volgu, France; (a) Musee Denon, Salon-sur-Saone, France; (b) Jost (1927; Aubry et al. 2009); (c) Musee d'Archeologie Nationale in Saint-Germaine-en-Laye, France; and (d) The British Museum in London, England.

Germain-en-Laye in France, and one in the British Museum in London, England). Another artifact is rumored to exist in a private collection in Switzerland, and fragments thought to refit to Artifact 12 at the Musee Denon are said to exist in a private collection in Germany (Jean-Paul Thevenot, personal communication 2014). Yet another, sold to the Musee Guimet d'Histoire Naturelle de Lyon (Lyon, France) in 1897, was found through petrographic analysis to be an imposter made from chert of Mesoamerican origin (Masson, 1984). Like Clovis caches (Kilby and Huckell, 2014), Volgu has a long and complicated history, and its completeness may always be in doubt.

The 15 extant artifacts of Volgu are exquisitely made laurel leaf bifacial points that combine unusually large overall size with unusual thinness (Table 1). The origin of the lithic raw material is imperfectly known, but has been tentatively identified as four varieties of flint from the Turonien chalk sources near Gien, France about 150 km (90 Miles) away (Aubry et al., 2009). As no datable material was recovered in association with the Volgu assemblage, their assignment to the Solutrean is based on artifact morphology and technology. Typical Solutrean laurel leaf bifaces appear to have functioned as points and/or knives and range from 3 to 10 cm in length (Cook, 2013). Complete laurel leaf bifaces from Volgu range from 23.4 to 34.3 cm in length, and yet range from only 0.6–1.2 cm in thickness (which, as demonstrated below, is exceptionally thin). They are manufactured by careful removal of consistently wide, thin flakes by percussion. Experimental replication by Jacques Pelegrin indicates that as much as 5 h is required to manufacture each piece due to the careful planning and platform preparation required to achieve thinness without breaking the piece (Piel-Desruisseaux, 2002).

Certainly, the degree of skill and craft evident in the bifacial reduction technology from the Volgu assemblage is comparable to that of many bifaces from Clovis caches. Flake scars on bifaces from both contexts reflect wide thin flakes successfully removed as a result of carefully chosen and prepared platforms. Broad diving flakes that converge along the longitudinal centerline are attributes shared by Volgu and many Clovis bifaces. Though it is worth noting that systematic overshot flaking is not found among the laurel leaves of Volgu, these attributes reflect the importance of bifaces in both contexts and perhaps similar methodological approaches to bifacial reduction.

5. Volgu assemblage attributes, with comparisons to Clovis caches

The use of the term cache in archaeology goes beyond the strict concept of temporary storage, and with regard to lithic artifact assemblages has been generally used to refer to any collection of items that appears to have been intentionally set aside rather than discarded, lost, or abandoned (Collins, 1999; Huckell and Kilby, 2014; Kilby, 2008; Kilby and Huckell, 2013). Caches are identified in the archaeological record as assemblages that are tightly clustered in space, that do not correspond to other site types associated with that cultural-temporal period (i.e., camps, kills, workshops), do not contain the residue of manufacture or maintenance, and that do not reflect any activities other than their own deposition (Kilby, 2008:1; Kilby and Huckell, 2014, pp. 220). The find at Volgu is consistent with these criteria, and thus can be considered a cache in the same general sense as caches from the Clovis period in North America.

The variability among assemblages identified as Clovis caches suggests that they did not all serve the same function for those who deposited them. In previous research (Kilby, 2008), I attempted to determine the function(s) of Clovis caches through observations on several different assemblage attributes including remnant utility, artifact diversity, lithic raw material diversity, evidence of use, associated materials, and landscape context. Based on these observations, along with expectations derived from ethnographic and archaeological literature, it was determined that Clovis caches could be divided into two general functional groups: *utilitarian caches* (including insurance, passive gear, and load exchange functions) and *ritual caches* (including afterlife and possibly votive caches). Observations on this same suite of attributes for Volgu facilitate both comparison with Clovis caches and

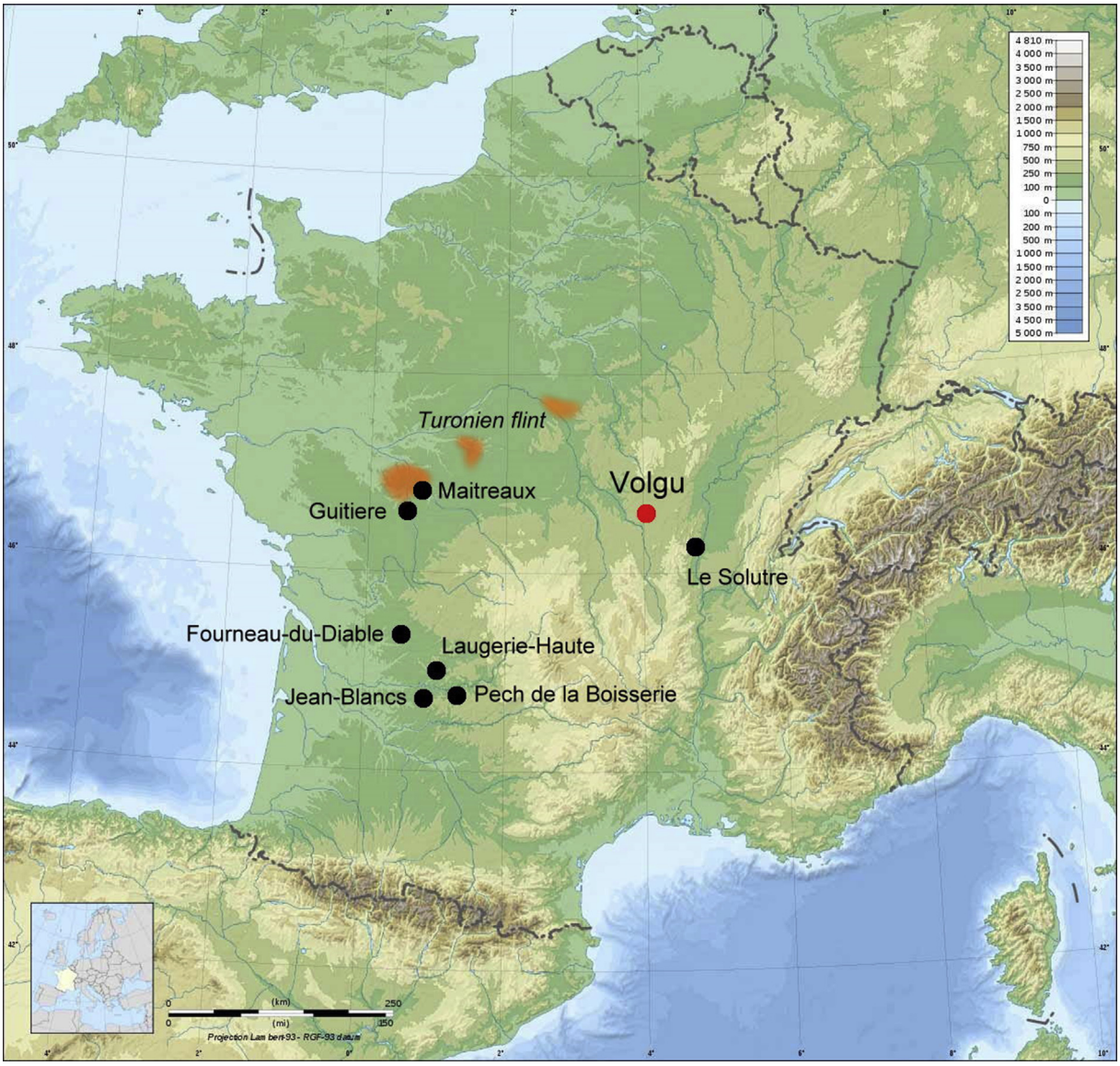

Fig. 4. Sites mentioned in text; orange areas represent known geological sources of Turonien flint (after Aubry et al., 2009). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

making progress toward hypothesizing a function for the Solutrean cache.

5.1. Remnant utility

Remnant utility refers to the remaining usefulness of individual items in a cache assemblage. Due to the reductive nature of lithic technology, remnant utility is generally a matter of relative size. Utility can be operationalized as a measurement of the size of cached artifacts relative to the size of artifacts from that same artifact class that were discarded at kill or camp sites. Items from Clovis caches tend to have high remnant utility, suggesting that their usefulness as tools was an important consideration in caching them. High remnant utility often gives bifaces and projectile points from Clovis caches the appearance of being elaborate or "oversized" forms. However, morphometric analysis of projectile points (Buchanan et al., 2012) and reconstructive analysis of bifaces (Kilby, 2008, pp. 225–230; Kilby and Huckell, 2014) indicate that large cached items are at relatively early stages of reduction, but are otherwise a part of the regular Clovis lithic reduction continuum.

Like bifaces from Clovis caches, the laurel leaf bifaces from Volgu are unusually large compared to morphologically similar artifacts from other sites. Fig. 5 presents a size comparison of the complete laurel leaves from Volgu to those from other Solutrean sites surrounding the Massif Central of France, including Fourneau-du-Diable, Jean Blancs, Le Solutre, Laugerie-Haute, and Pech-de-la-Boissière (Fig. 4; measurements acquired from collections at The British Museum and from Smith [1966]). The shortest complete laurel leaf from Volgu is longer than any specimen from the other sites, and only two specimens (one from Fourneau-du-Diable and one from Pech-de-la-Boissière) fall within the range of widths for the Volgu specimens. The linearity of the scatter reflects the degree to which length-width ratios are consistent across scales.

The pattern in Fig. 5 might support a scenario in which Volgu laurel leaves represent early stages of a continuum of reduction leading to the specimens discarded at other sites, if not for their thickness. In Fig. 6, relative or proportional thickness of complete specimens from all sites is displayed by plotting an index of thickness against an index of length (both are standardized by dividing by width). Given their size, the specimens from Volgu are exceptionally thin (Fig. 7). Adjusted for scale, the thickest specimen from Volgu is thinner than any specimens from other sites. If the Volgu laurel leaves represent early stages of reduction, they would be expected to fall in the upper or central area of the plot.

Table 1
Summary data for Volgu Artifacts.

Catalog		Artifact	Dimensions					Use Wear/Breakage			Lithic Raw Material	
Location	Catalog No.	Type	Condition	Wt (g)	L (mm)	W (mm)	Th (mm)	Chips	Breaks	Use/Hafting	Description	Identification
Musee d'Archaeologie Nationale	32224	Laurel leaf	Complete	224.00	283.38	77.44	11.51	Y	N	N	brownish grey flint	Turonian flint
The British Museum	582a	Laurel leaf	Complete	163.80	282.94	67.31	6.00	N	N	N	brownish grey flint	Turonian flint
Musee Denon	2011.0.12.1	Laurel leaf	Proximal	295.19	295.94	88.39	9.82	Y	Y	N	brownish grey flint	Turonian flint
Musee Denon	2011.0.12.2	Laurel leaf	Complete	243.58	342.70	81.34	7.42	Y	N	N	brownish grey flint	Turonian flint
Musee Denon	2011.0.12.3	Laurel leaf	Complete	121.10	260.47	64.68	7.00	Y	N	N	brownish grey flint	Turonian flint
Musee Denon	2011.0.12.4	Laurel leaf	Complete	181.42	267.12	67.88	9.56	Y	N	N	brownish grey flint	Turonian flint
Musee Denon	2011.0.12.5	Laurel leaf	Complete	144.02	240.52	64.65	10.03	Y	N	N	dark brownish grey flint	Turonian flint
Musee Denon	2011.0.12.6	Laurel leaf	Complete	177.21	252.24	74.89	9.36	Y	N	N	brownish grey flint	Turonian flint
Musee Denon	2011.0.12.7	Laurel leaf	Complete	152.75	233.64	77.34	9.60	Y	N	N	brownish grey flint	Turonian flint
Musee Denon	2011.0.12.8	Laurel leaf	Complete	144.63	236.49	73.97	9.65	Y	N	N	brownish grey flint	Turonian flint
Musee Denon	2011.0.12.9	Laurel leaf	Complete	128.39	273.00	64.52	8.22	Y	N	N	greyish brown flint	Turonian flint
Musee Denon	2011.0.12.10	Laurel leaf	Complete	131.19	272.67	62.57	8.50	Y	N	N	grey and black flint	Turonian flint?
Musee Denon	2011.0.12.11	Laurel leaf	Complete	129.36	282.91	59.06	8.43	Y	N	N	brownish grey flint	Turonian flint
Musee Denon	2011.0.12.12	Laurel leaf	Proximal	189.39	204.09	95.00	8.53	Y	Y	N	brownish grey flint	Turonian flint
Musee Denon	2011.0.12.13	Laurel leaf	Proximal	106.05	158.63	78.33	7.61	Y	Y	N	brownish grey flint	Turonian flint

The fact that they cluster at the lower area of the plot suggests that, unlike points and bifaces from Clovis caches, Volgu laurel leaves do not represent early stages of a normal reduction continuum; they are not only different in scale, they are different in kind. Pelegrin (in Piel-Desruisseaux, 2002) notes that the pieces have been reduced to such a degree that no further thinning flakes can be detached, thus rendering them non-functional as cores, and of very limited use as knives. That the Volgu artifacts do not appear to be intended for use is a point on which Stanford and Bradley (2012) and I agree. It can be concluded that, despite the large overall size of the specimens from Volgu, *they actually have no remnant utility* as defined above – they could not be further reduced proportionally, and use or resharpening would likely result in breakage.

Taken in combination, the observations that the Volgu specimens have no practical remnant utility, cannot be further reduced without catastrophic damage, and are too thin to be functional as cutting instruments or projectiles effectively rules out a utilitarian function (such as tool storage) for Volgu as a cache. Thus, the remainder of this analysis compares attributes of Volgu with those from Clovis assemblages that have been identified as ritual caches (c.f. Kilby, 2008). Specifically, these are the Anzick, East Wenatchee, Fenn, and Simon caches.

5.2. Artifact and raw material diversity

Volgu consists of a single class of artifact: laurel leaf bifaces. Likewise, it appears that they are all manufactured from a single geographic source of flint that occurs in the chalky Turonien limestone of the middle Loire Valley. Aubry et al. (2009) identify the raw material as coming from the easternmost outcrop of Turonien flint. This outcrop is closest to the find location for Volgu, lying about 150 km (90 miles) directly downstream in the same drainage system. Relative to average transport distances for raw materials deposited in Clovis ritual caches that range from 80 to 1100 km (50–680 miles), the transport distance for Volgu is rather short.

Clovis caches vary considerably with regard to both artifact diversity and raw material diversity; however, Clovis ritual caches are consistently diverse with regard to both. Ritual caches exhibit the highest values for raw material diversity among Clovis caches in general (Kilby, 2008, pp. 172), with as many as 14 different lithic raw materials represented in single cache (Simon). Likewise, high degrees of artifact diversity characterize the majority of Clovis ritual caches. Only the Simon cache, which includes bifaces (in various stages of reduction) and finished projectile points, is characterized as having low artifact diversity (Kilby, 2008, pp. 130). Consisting of only a single artifact type, Volgu stands in contrast to Clovis ritual caches, and for that matter, to all Clovis caches with the exception of two blade caches (Green and Pelland) with regard to artifact diversity.

5.3. Evidence of use

None of the Volgu specimens exhibit evidence of wear or damage resulting from use or from hafting; the sporadic distribution of edge damage on some specimens is reportedly the result of poor display and curation over the years (Jean-Paul Thevenot, personal communication). The lack of evidence for use, hafting, or maintenance on the items in Volgu renders it unlike Clovis ritual caches, which all consist of a combination of items that have undergone some use and maintenance and items that appear to have been newly manufactured (Kilby, 2008, pp. 140–143). Among Clovis ritual caches, evidence for use or maintenance is particularly common on projectile points and blades (tools presumably used as projectiles or knives). Projectile points from Fenn and East Wenatchee show evidence of once having been hafted.

5.4. Context and associations

Evaluating landscape context and potential landmarks that may

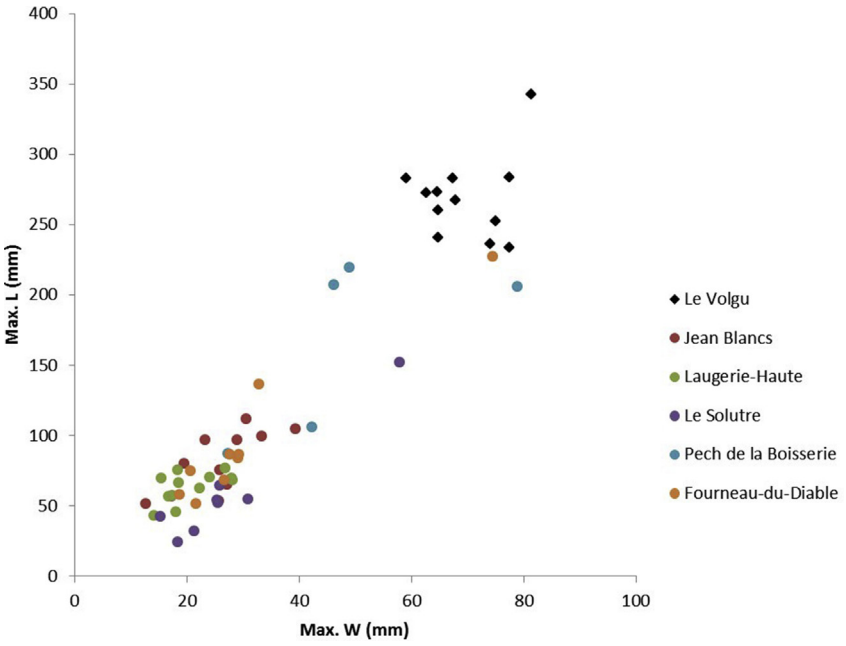

Fig. 5. Size comparison of laurel leaves from Volgu and five Solutrean sites from the area surrounding the Massif Central, France.

have been associated with Pleistocene caches is difficult due to geomorphic and ecological changes that can occur during the course of ten to twenty thousand years. Stream courses and spring locations may change, trees or other potential landmarks may decompose or be moved by geologic forces. With this in mind, it is not surprising that clear landmarks have not been associated with the majority of caches. Among Clovis ritual caches, Anzick is associated with a rock shelter and Simon is associated with a fossil spring. East Wenatchee is not associated with any conspicuous landscape feature, and the original find location of Fenn is not known. Volgu also does not appear to have been associated with any conspicuous landmark, but at the landscape scale it is located in a saddle connecting two major river valleys (the Saone/Rhone and Loire) and in close proximity to the headwaters of a third (the Seine).

Earthy hematite, or red ocher, is consistently associated with Clovis ritual caches as well as a number of utilitarian caches. The Anzick cache and associated child burial were recovered from a lens of ocher-stained sediments. Fenn and East Wenatchee both exhibit streaks and stains of red ocher on the surfaces of artifacts, and Simon was reportedly liberally slathered with red ocher when found. No red ocher has been identified in association with Volgu, despite the implication in Stanford and Bradley's (2012:177) statement, and despite common usage of red ocher in Solutrean art (e.g., Tymula, 2005).

6. Discussion

Artifacts from many caches are noticeably larger than their counterparts from other site types. Those from Volgu are no exception;

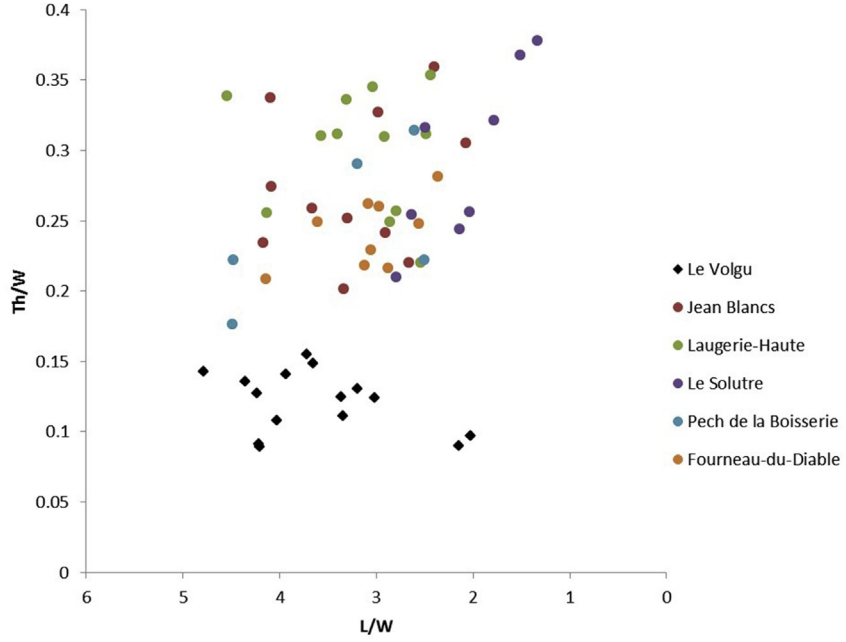

Fig. 6. Relative (proportional) thickness of laurel leaves from Volgu and five Solutrean sites from the area surrounding the Massif Central, France.

Fig. 7. Face and side views of a Volgu biface (Catalog Number 2011-0-12-11 from the Musée Vivant Denon) illustrate the extreme thinness of laurel leaf bifaces in the Volgu cache.

however, they differ from large artifacts from Clovis caches in a critical way. Even the largest specimens from Clovis caches fit into a morphological continuum with other Clovis artifacts of the same artifact class. For example, the largest bifaces from Clovis caches appear to be utilitarian bifacial cores at early stages of reduction. Minimum core dimensions reconstructed from overshot and refitted flakes at kills and campsites demonstrate that these large bifaces were routinely transported and maintained as a source for flakes (Kilby, 2008, 2011; Kilby and Huckell, 2013). Similarly, morphometric comparison of Clovis points from non-cache contexts with Clovis points from caches (including those from the Drake cache, which consists entirely of projectile points and is thus comparable to some interpretations of the Volgu assemblage) indicates that they fit into a single range of variation that reflects reduction over the course of the use lives of the tools (Buchanan et al., 2012). In other words, the large artifacts from Clovis caches reflect everyday technology, and only appear to be "extra-large" or "oversized" because they are at early stages in their use lives. From the perspective of a Clovis toolmaker, they were likely more ordinary than extraordinary.

Unlike bifaces and points from Clovis caches, there is no evidence of the use of laurel leaves of similar morphology to those from Volgu as bifacial cores, knives, or points on kill or camp sites. Although there is some evidence for manufacturing unusually large laurel leaves at workshops (e.g., Laugerie Haute [Peyrony in Smith, 1966), La Guitière near Les Maitreaux [Aubry et al., 2003 in Cook (2013)]), the relative thinness of Volgu laurel leaves renders them effectively useless for practical tasks, and sets them apart from the morphological continuum of which utilized laurel leaves are a part. Thus, while Clovis caches (even ritual Clovis caches) consist of potentially useful tools, Volgu does not appear to represent any sort of functional toolset. The combination of extreme size and extreme thinness in the Volgu artifacts suggests that they are indeed extraordinary. They might be considered not as Solutrean laurel leaves so much as *monuments to* Solutrean laurel leaves. As such, the cache appears to fit the general expectations for a votive cache – a form of ritual cache made as an offering or dedication. The maker or makers of the items in the Volgu cache may have been motivated by showing off their technological prowess, or by participating in some symbolic gesture related to landscape, prey, or perhaps something more esoteric. The limited information on the discovery context makes it impossible to rule out having once been associated with a burial. The location of Volgu near the common origin of three major river valleys is intriguing, and suggests that landscape may have played a role in the creation and placement of the cache (cf. Tabarev et al., 2013).

Ruling out a utilitarian function for Volgu renders it incomparable to the majority of Clovis caches, thus this examination turned to specifically comparing Volgu to Clovis ritual caches. The results (Table 2) indicate that despite the superficial similarity of all being assemblages of large artifacts intentionally deposited in a tight concentration, the only known Solutrean cache has very little in common with Clovis ritual caches. Indeed the assemblages are so consistently different from one another with regard to each attribute examined that they do not appear to represent the same behavioral tradition.

6.1. Temporal and geographic patterning in Clovis caching

It might be argued that the differences between Volgu and Clovis caches are the result of gradual change through time and across space. Perhaps Volgu-like ritual caching was coopted for a more practical purpose and the behavior evolved to include utilitarian caching (and all the attribute changes that entailed) as populations spread westward. If there were evolutionary changes in caching as Solutrean culture transitioned to pre-Clovis and then to Clovis, we should expect to see clinal change in caching behavior from early to late in time and from east to west in space. Moreover, if caching is a homologous rather than analogous trait within these cultures, the practice should be expected to proceed uninterrupted across this transition; in other words, we should also expect to find it present among the "missing links" and across the continent. These expectations, however, are not met by temporal or geographic patterns in the available data. Due to the small number of dates available we currently cannot determine if caching is an early or late Clovis phenomenon (Kilby and Huckell, 2013), let alone whether or not there is an east-west gradient in the age of caches or kinds of caches. The only Clovis ritual cache with associated radiocarbon dates (Anzick, MT) appears to be late rather than early relative to other dates for Clovis (Stafford, 1994), which is at odds with the scenario presented

Table 2
Comparison of Volgu and Clovis ritual cache Attributes.

Attribute	CLOVIS				SOLUTREAN
	Anzick	East Wenatchee	Fenn	Simon	Volgu
Remnant Utility	High	High	High	High	Low
Raw Material Diversity	Medium	High	High	High	Low
Artifact Diversity	High	High	High	Low	Low
Use wear	High	High	Low	Low	None
Landmarks	Yes	No	No	Yes	No
Red Ocher	Yes	Yes	Yes	Yes	No

above. Regardless, the lack of any known pre-Clovis caches suggests there is a substantial intervening period (much longer than the known duration of Clovis) for which there is no evidence for caching at all, thus disrupting any direct historical connection.

The Solutrean hypothesis is no better served by the geographic range of Clovis caching. All known Clovis caches are from west of the Mississippi River (Kilby and Huckell, 2013). None are known from Eastern North America (Lassen, 2010) where the hypothesis predicts the antecedent behavior should be found (though there are fluted point caches in the Great Lakes region, they appear to post-date Clovis [Kilby and Huckell, 2013, pp. 266–267]). The Clovis ritual caches that compare most favorably with Volgu are limited in range to the Northern Rockies and far northwestern North America and only serve to further distance them from the part of the continent hypothesized to have had the most direct connection to Solutrean colonizers. If ritual caches are the firmest basis for connecting Solutrean and Clovis caching behavior, their locations increase the temporal and spatial dilemma highlighted by Straus (2000a) to 5000 years and 8000 km.

6.2. Caching behavior in the Middle and Upper Paleolithic

A remaining consideration is Stanford and Bradley's statements indicating that caching is significant not just because it is found in both Solutrean and Clovis contexts, but (at least during the during the time period in question) that these are also the only contexts in which it occurs. In *Across Atlantic Ice* it is asserted that caching is "rare to non-existent" in other Old World Paleolithic cultures (Stanford and Bradley, 2012, p. 134), and more specifically that caches of extraordinary artifacts older than 13,000 years have *only* been found in Solutrean and Clovis (p. 177, emphasis mine). Although "extraordinary" is a qualitative term that is difficult to employ objectively, it is worth noting that several caches are reported from the Magdalenian (17,000–12,000 BP) of Western Europe (Peresani, 2006, 2009), some of which include large early-stage artifacts of nonlocal material (Bouvier and Duport, 1968), which are thus "extra-large" in the same sense as those in Clovis caches.

While the archaeological discovery of caches can be considered rare in comparison to other kinds of sites (after all, successful utilitarian caches would have been retrieved prehistorically), material caching was practiced and is practiced by a wide range of hunter-gatherer groups (Binford, 1979; Brown et al., 1998; Schlanger, 1981; Kilby, 2008; Peresani, 2009). Lithic artifact caches were present in Europe by the Middle Paleolithic, and caching appears to have increased in frequency during the late glacial and post-glacial periods (Peresani, 2009). This pattern arguably extends well beyond Europe. Features interpreted as caches for food and raw material (lithic and osseous) are reported from the Upper Paleolithic of the Central Russian Plain (Solfer, 1985, pp. 253–258), northern Mongolia (Tabarev et al., 2013), and Japan (Kanomata, 2010). Stanford and Bradley (2012, p. 78, p. 177) themselves describe caches of artifacts including large bifaces, microblades, and lanceolate points from both Western and Eastern Beringia (they see no relation between these and Clovis caching). An increase in the frequency of caching behavior in the Late Pleistocene is arguably a pattern throughout the Northern Hemisphere, perhaps related to growing human populations and resource stress in middle and upper latitudes. While Solutrean and Clovis caching may both be manifestations of this phenomenon, it does not necessarily reflect (nor provide strong evidence for) an ancestor/descendant relationship between them.

7. Conclusions

The results of this examination of the Volgu artifacts and site context are consistent with Stanford and Bradley's (2012, p. 133) description of the assemblage as a ritual deposit of non-utilitarian artifacts that was probably not meant to be retrieved; however, this sets it apart from the majority of known Clovis caches in both content and function. Though a subset of Clovis caches is interpreted to have been ritual in nature, these differ from Volgu in each of the attributes examined here. It is concluded that the attributes of Volgu and the Clovis caches are not similar enough to warrant appealing to a direct historical connection to explain them. On the contrary, Clovis and Solutrean caching behaviors stand in contrast to one another in that caching appears to have been an institutionalized part of Clovis throughout a significant portion of its range (though it's conspicuously absent in Mid-Atlantic North America), while Volgu, despite being discovered nearly a century before the first Clovis caches, remains a singular anomaly in the archaeological record of Solutrean. It is further concluded that there is no apparent geographic or temporal continuity in the practice of caching with which to connect the dots between Volgu and Clovis caches, and that the practice of caching is not unique to the two cultures in question as is presented in the Solutrean hypothesis. The more parsimonious explanation for the existence of the Solutrean and Clovis caches is that they represent analogous, somewhat convergent behaviors among otherwise disparate Late Pleistocene hunter-gatherers. If there is support to be found for a Solutrean origin for North American populations (and it increasingly appears there is not) it is not found among caches or caching behavior.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.quaint.2018.06.019.

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