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RESEARCH REPORT



Is Clovis Technology Unique to Clovis?

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ABSTRACT

Clovis technology is argued to possess distinctive attributes that make a stone tool assemblage recognizable as Clovis, even absent its hallmark fluted projectile points, or radiometric ages that place the assemblage in the late Pleistocene. Excavations at Goodson Shelter in Oklahoma yielded artifacts bearing unmistakable attributes of Clovis biface and blade technology, such as fluted bifaces, overface flaking, and prismatic blades, all from a clearly-delineated, unmixed stratigraphic layer securely dated to the mid-Holocene. This indicates that those technological attributes are not unique to Clovis, and cannot be used by themselves to identify Clovis age material. To illustrate the consequences of this result, we review biface and blade caches assigned to Clovis by their technology alone. Although many could be Clovis in age, they are not demonstrably so. Overall, our findings emphasize the importance of looking at suites of evidence, chronological, technological and otherwise, in assigning assemblages to the Clovis period.

KEYWORDS

Clovis; lithic technology; convergence

1. Introduction

It has recently been argued there is a “distinct combination of technological behaviors” that are diagnostic of the Clovis culture, such that “once defined it becomes possible to track it through space and time wherever and whenever it occurs” (Bradley, Collins, and Hemmings 2010, 177; see also Bradley and Collins 2014, 250–251; Collins 2005; Huckell 2014; and references therein). By diagnostic, we mean “unique to the Clovis culture.”

Several specific technological attributes have been identified as critical to that recognition process, foremost among them is the use (argued to be intentional and controlled) of overshot flaking, which as Bamforth (2014, 51) observes is “fast becoming the gold standard for identifying Clovis biface reduction.” But there are other elements as well, including raw material selectivity; distinctive patterns of flake and blade platform preparation, thinning and flaking; characteristic biface size and morphology, including the presence of end-thinning; and the size, curvature and reduction strategies of blades (Bradley, Collins, and Hemmings 2010; Bradley and Collins 2014; see also Beck and Jones 2014; Bamforth 2014; Hill, Loebel, and May 2014; Huckell 2014). With those features, it is suggested that “experienced investigators can confidently recognize a Clovis assemblage on the basis of just a few specimens, sometimes on debitage alone” (Collins and Lohse 2004, 181), even in the absence

of its distinctive fluted projectile points, or of absolute dates that place it in Clovis times.¹

That premise has been essential to the identification of the majority of the reported Clovis caches (Table 1): 15 of the 24 caches (62.5%) widely considered to be Clovis in age and affiliation lack Clovis fluted projectile points, and are identified as Clovis principally by their technological and morphological attributes (e.g., Bamforth 2014; Bement 2014; Collins 1999; Condon et al. 2014; Green 1963; Hill, Loebel, and May 2014; Huckell 2014; Kilby 2008; Muñiz 2014; Osborn 2016).² This is not to suggest those identifications are incorrect. It does indicate, however, the interpretive weight being placed on technological attributes inferred to be Clovis, and if those attributes are not specific to Clovis technology it will have consequences for our understanding of caching behavior.

For example, one of the most striking aspects of Clovis caches is that they far outnumber those from immediate post-Clovis times (Collins 1999; Meltzer 2002, 2009; also Kilby and Huckell 2014b). The post-Clovis drop off in the frequency of caches is so sharp that the discovery of a Late Paleoindian cache is considered “provocative” (Holliday, Johnson, and Miller 2017, 85). Caches have likewise played an important role in discussions of Clovis mobility, provisioning and land use; technological organization; knapping skill and specialization; and

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Table 1 List of Clovis caches (from Huckell and Kilby 2014, table 1; with the addition of the Baller cache, reported by Osborn 2016).

Cache	Clovis points?	Reference
Anadarko	No	Hammatt (1970); also Kilby (2008)
Anzick	Yes	Wilke, Flenniken, and Osbun 1991
Baller	No	Osborn (2016)
Beach	No	Huckell (2014)
Busse	No	Kilby (2008)
Carlisle	No	Hill, Loebel, and May (2014)
Crook County	Yes	Tankersley (1998); also Kilby (2008)
CW	No	Muñiz (2014)
de Graffenreid	Yes	Collins, Lohse, and Shoberg (2007)
Dickenson	No	Condon et al. (2014)
Drake	Yes	Stanford and Jodry (1988); also Kilby (2008)
East Wenatchee	Yes	Gramly (1993)
Fenn	Yes	Frison and Bradley (1999)
Franeý	No	Grange (1964); also Kilby (2008)
Green	No	Green (1963); also Kilby (2008)
Hogeye (Bastrop)	Yes	Waters and Jennings (2015)
JS	No	Bement (2014)
Keven Davis	No	Collins (1999)
Mahaffy	No	Bamforth 2014
Rummells-Maske	Yes	Morrow and Morrow (2002)
Pelland	No	Kilby (2008)
Sailor-Helton	No	Mallouf (1994); also Kilby (2008)
Simon	Yes	Butler (1963, 1965)
Watts	No	Kilby (2008)

what they may reveal about larger questions of demography, territoriality and colonization (Bamforth 2014; Beck and Jones 2014; Bradley and Collins 2014; Huckell and Kilby 2014; Kilby 2008, 2014; Kilby and Huckell 2014b; Lohse, Collins, and Bradley 2014; Meltzer 2002, 2009). More broadly, it is asserted that caches reveal a thorough knowledge of a stone poor landscape and thus enabled highly mobile Clovis hunters to solve the logistical incongruence between the sources of their stone and the places of their big-game prey. It is not an unreasonable assertion, but it begs the question – never addressed – of why cache use essentially vanishes in immediate post-Clovis times among highly mobile late Paleoindian hunters who were using the same widely scattered sources of stone and pursuing big-game on the same stone poor landscape.

Obviously, if some or all of those 15 caches identified as Clovis based on technological attributes are not Clovis in age or affiliation, then the post-Clovis decline in cache use is not as steep as it seems, and in turn the apparent prevalence of Clovis caches – and perhaps their role in Clovis technological organization – will have to be reconsidered. Unless, that is, there are aspects of biface and blade production that are technologically and/or morphologically unique to or at least diagnostic of Clovis. We previously ascribed to that view (Cooper and Meltzer 2009; Eren and Desjardine 2015; Eren, Vanderlaan, and Holland 2011; Eren and Redmond 2011; Meltzer and Cooper 2006). However, our recent excavations at Goodson Shelter in northeast Oklahoma (Figure 1)

produced artifacts that bear unmistakable attributes of Clovis biface and blade technology, but proved to be from a clearly-delineated, unmixed stratigraphic unit that is securely dated to the Middle Holocene.

In this paper we summarize our investigations at Goodson Shelter, focusing on its stratigraphic history, the artifact assemblage we initially suspected might be Clovis in age and affiliation, and the radiocarbon and luminescence dating that indicates its actual age. We subsequently consider the implications of our results for assigning otherwise-undiagnostic biface and blade caches to the Clovis culture.

We will not address here the question of whether technological attributes such as overshot flaking are “typical” or even representative of Clovis (but see Eren et al. 2013, 2014; Muñiz 2014; O’Brien, Buchanan, and Eren 2018; Sellet 2015), preferring to keep the focus on whether those attributes are diagnostic of Clovis. We would, however, acknowledge Bamforth’s observation made in regard to Clovis blades, but one that can be more generally applied to other elements of their toolkit: “if there was a canon of Clovis blade production, individual Clovis stoneworkers interpreted it freely” (Bamforth 2014, 50). Just how freely those interpretations varied is a matter that warrants consideration.

2. Is there Clovis in Goodson Shelter?

Our investigations at Goodson Shelter (Figure 2) were prompted by a collector’s discovery of a Late Paleoindian Dalton projectile point in an unnamed narrow stream valley near a small sandstone rockshelter. At present, the shelter is ~30 m wide, ~6 m deep at its center, with a ceiling ~3.4 m above the floor; in the past, the floor was as much as 2 m lower. Both the ceiling and floor slope toward the rear of the shelter. The hillside above and behind the shelter rises in elevation ~8 m over a horizontal distance of ~50 m. Below and ~12 m east of the shelter dripline is the south–north-flowing stream, one of headwaters tributaries of Pryor Creek (which in turn feeds into the Verdigris river).

The shelter formed as a result of the stream cutting into the western side of the valley wall. The lowest unconsolidated deposit atop the shelter bedrock, Stratum 1, is a relatively clean, thin (~18–28 cm thick) layer of red sandy clay loam (10YR4/4 and 2.5YR4/6) that rests on and amidst a layer of rounded, subangular stream cobbles 10–20 cm in maximum length (Figure 3). The cobbles form a clast-supported fabric with a red sandy matrix, and mark the channel bed load from the time the stream flowed unimpeded through the shelter. After the deposition of Stratum 1, the stream shifted eastward towards its present position.

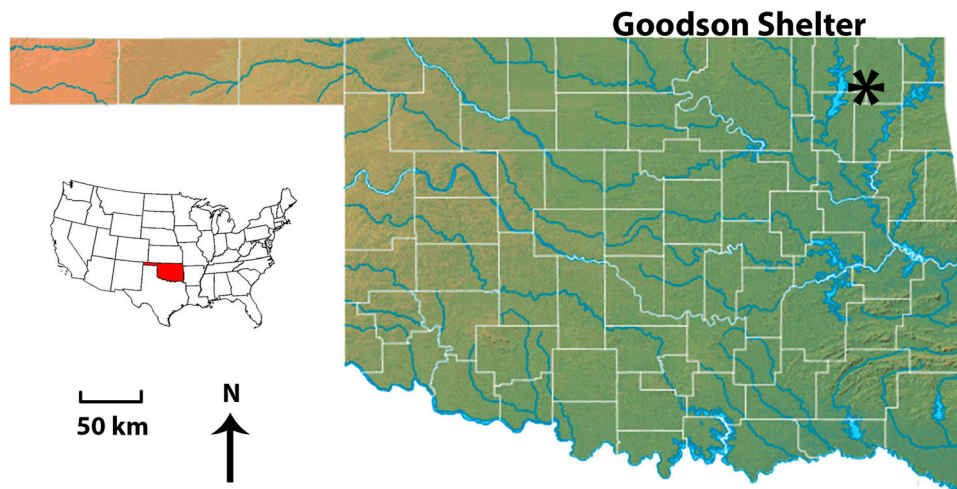


Figure 1 Location of Goodson Shelter.

Once the stream had abandoned the shelter, it began to fill with sediment, principally colluvial material from the hillslope behind the shelter. The bulk of the overlying section – Stratum 3 – is comprised of a ~1.8–2 m thick, very dark gray (10YR 3/1) sandy clay loam (Stratum 3), which has abundant roots and charcoal. The presence of rock clasts, including large blocks of roof fall and innumerable small (< 5 cm) sandstone fragments, indicate a secondary contribution of in situ weathering and erosion from the shelter ceiling and walls.

In between Stratum 1 and Stratum 3 is a transitional zone (Stratum 2) of dusky red sandy clay loam. This unit, ~30 cm in thickness, appears to be the result of bioturbation (principally by worms and insects) at the base

of Stratum 3, which brought material up from Stratum 1. The largest blocks of *éboulis* in the section are in Stratum 2 and the base of Stratum 3, and form a discontinuous but substantial stone cap over Stratum 1.

Excavations in Goodson Shelter over several seasons (2013–2015) exposed ~2 m of deposits,³ which proved extraordinarily rich in artifacts, especially projectile points: over 600 were recovered from just 30 m³ of deposits. The great majority of the points was recovered from Stratum 3, and include notched and stemmed Archaic and Woodland types. Although these were found somewhat mixed throughout Stratum 3, a back-plot of projectile points of different ages showed a general temporal trend through time.



Figure 2 Goodson Shelter in 2014 (by DJM, Image 3884).



Figure 3 Photograph of the south wall (N 1007 grid line) of the Goodson Shelter excavations in 2015, looking south. The front of the shelter is to the left in this image, the interior, rear wall of the shelter is to the right (note the downward slope of the surface). The image shows the fully excavated profiles of units N 1007 E 999 and N 1007 E 998 (N 1007 E 997 is the partially excavated block visible to the right). At the base of the profile is the distinct, relatively clean red sandy clay loam of Stratum 1. The large blocks of *éboulis* above Stratum 1 are in Stratum 2 and the base of Stratum 3 (Goodson Project Image 2015, 4044).

In sharp contrast, resting atop and in the upper centimeters of Stratum 1 was a very different and distinctive artifact assemblage. These specimens included fluted bifaces, one with a diving flute failure (Figures 4 and 5); curved blades and other evidence of prismatic blade production such as blade cores, core tablets, and small blade-lets (Figures 6–8); large early stage biface cores (e.g., Figure 9(e)); and large bifacial overface (*sensu* Smallwood 2010) thinning flakes and overshot flakes possessing both pronounced dorsal flake scars and some combination of ground, faceted, isolated, reduced, projected, and/or released platforms (e.g., Figure 9(a,b)) (Table 2). These characteristics are all considered markers of Clovis lithic technology (Bradley, Collins, and Hemmings 2010; Bradley and Collins 2014; Collins 2005). Also uncovered in Stratum 1 were “classic” Clovis-like unifacial “tools on flakes” (Collins 2005) such as trianguloid end scrapers and spurs (Figure 9(c,d,f)) (Table 2).

The specimens from Stratum 1 appeared to have been made exclusively of a high quality, cream-colored Keokuk chert, obtainable only from a source ~85 km distant. This too was in contrast to the specimens of later age and higher strata, which had been manufactured from a variety of stone types, including materials located at outcrops much closer to the site.

Finally, several of the blades refit (i.e., sequential blade removals), indicating there had been *in situ* blade production. There was no evidence of significant

disturbance within the Stratum 1 red sand where the blades were recovered, suggesting they were in primary archaeological context. The Stratum 1 artifacts appeared to have been deposited on (and by bioturbation worked into) what was then the dry and newly exposed shelter floor, created when the tributary stream shifted to the east. The alluvial portion of the shelter’s history thus predates its human occupation.

No finished Clovis fluted projectile points were recovered in Stratum 1 or in or around Goodson Shelter. Even so, we inferred from the above observations that this was a Clovis assemblage. Others, beyond the Goodson Shelter excavation team, to whom we showed these artifacts agreed when we publically presented our initial impressions at the 2015 Society for American Archaeology conference (Andrews et al. 2015).

The purported Clovis assemblage in Stratum 1, and the more recent artifacts in Stratum 2 and Stratum 3, were not separated by any obvious erosional unconformity, only the roof fall activity that postdated the deposition of Stratum 1. But as the artifacts in Stratum 2 and Stratum 3 appeared to sort vertically by age, and given the apparent temporal and stratigraphic integrity of Stratum 1, we inferred there was a *cultural unconformity* at Goodson Shelter, between a Pleistocene-age deposit at the base (Stratum 1) containing Clovis-age material, and middle to late Holocene deposits (Strata 2 and 3) containing Archaic to Woodland age materials above.

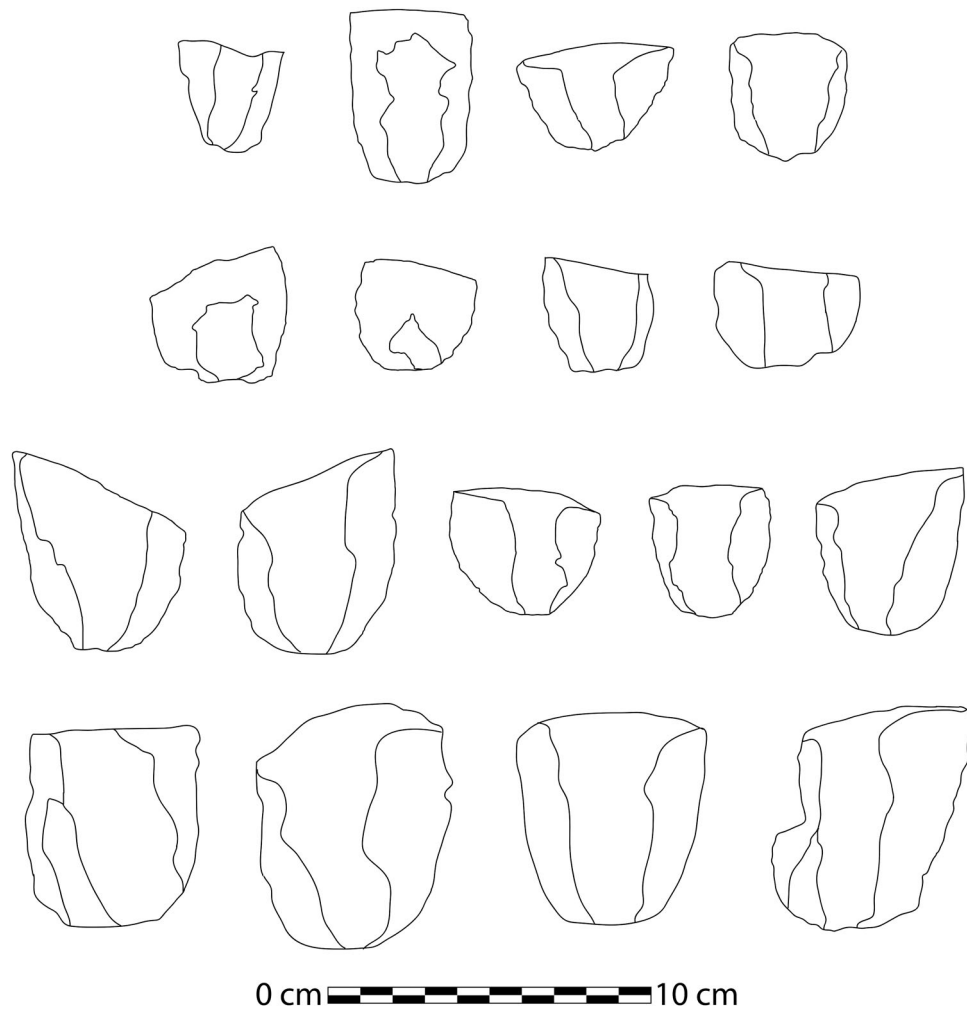


Figure 4 Examples of bifacially flaked fluted rounded bases from Clovis contexts and from Goodson Shelter. Top row, left to right: Murray Springs (Huckell 2007, 202, figure 8.10), El Bajío (Sanchez et al. 2015, 247, figure 2), Little River Complex (Yahnig 2009, 96, figure 25), Little River Complex (Yahnig 2009, 156, figure 77). Second row, left to right: Goodson, Paleo Crossing (CMNH Specimen Accession #1752A-02-00-00-01), Thunderbird (Carr et al. 2013, 200, figure 8.20d), Thunderbird (Carr et al. 2013, 200, figure 8.20a). Third row, left to right: Welling/Nellie Heights (Kent State University Archaeology Collections), Gault (Bradley, Collins, and Hemmings 2010, 72, figure 3.24), Goodson, West Athens Hill (Funk 2004, 58, figure 39-12), Carson-Conn-Short (Smallwood 2012, 698, figure 2c). Bottom row, left to right: Gault (Bradley, Collins, and Hemmings 2010, 72, figure 3.24), Gault (Waters, Pevny, and Carlson 2011, 94, figure 48e), Lincoln Hills/Ready (Morrow 1995, 180, figure 2), Welling/Nellie Heights (Kent State University Collections).

Fortifying that inference, a cluster of four Archaic points was found at the same depth as the supposed Clovis assemblage. Yet, these were not *in situ* within Stratum 1, but instead found in an erosional channel along the rear wall of the shelter incised by water runoff from the hillslope and bedrock walls, and which was filled with dark Stratum 2 sediments. The artifacts within that feature (Feature 2014-1) were easily separable in the field from those in the red sediment of Stratum 1.

To ensure our “Clovis” diagnosis was correct, we examined published assemblages from Clovis sites, including residential and kill sites, as well as caches. In addition, we examined the Kincaid site artifacts directly, the only Clovis assemblage currently known from a

rockshelter and hence comparable in that respect to Goodson (Figure 10). As can be seen in Table 2 and Figures 4–9, the material from Goodson is indistinguishable from many Clovis sites. All assemblages share attributes such as fluting plunging failures on bifaces with rounded bases; fluting snap failures on bifaces with straight base; bifaces with early stage flutes; large biface cores with prominent flake scars; blades and blade core fragments; and overface flakes with prepared platforms. Importantly, not all Clovis attributes are always present on all artifacts from all sites we examined. As Bradley (2009, 370) observes, “few, if any, individual Clovis sites have produced the entire known range of flaked stone tools” (which led him to incorporate in his

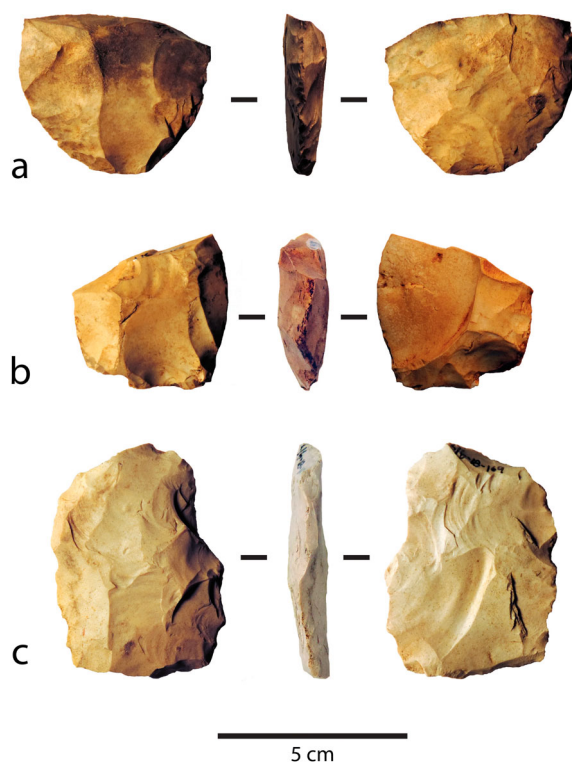


Figure 5 Images of fluted bifaces from Goodson Shelter. The fluted rounded bases (a, b) are depicted in Figure 3; also depicted here is a complete, early-to-middle stage fluted biface (c). See also Table 1 for descriptions and Clovis Doppelgängers.

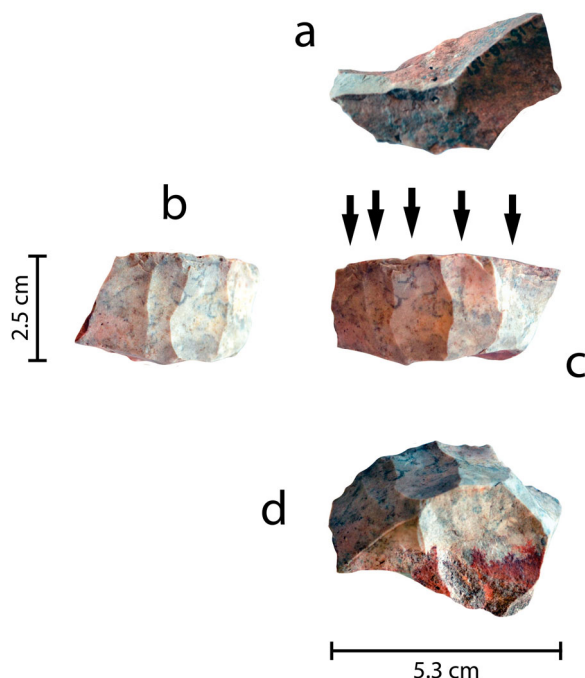


Figure 6 Multiple views of a prismatic blade core tablet from Goodson Shelter: top/platform (a); profile view (b); plan view with arrows indicating blade removals (c); bottom view. See also Table 1 for descriptions and Clovis Doppelgängers.

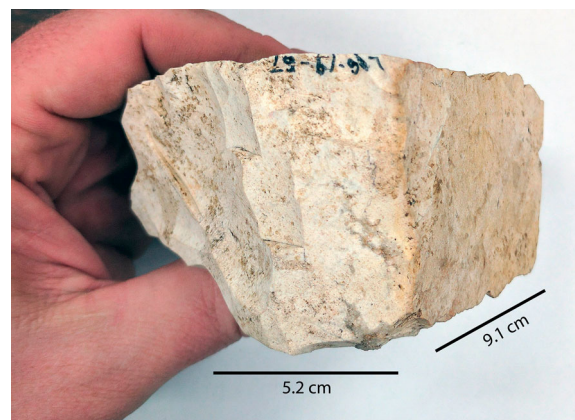


Figure 7 An early stage blade prismatic blade core from Goodson Shelter. See also Table 1 for descriptions and Clovis Doppelgängers.

discussion of Clovis technology “the assemblages from a number of Clovis sites”). The Goodson specimens possessed all of these attributes.

3. Dating the Goodson Shelter assemblage

To fortify the case for the Clovis affinity of the materials in Stratum 1, we undertook several rounds of radiometric dating. An initial set of radiocarbon samples of charcoal associated with the apparent Clovis bifaces from Stratum 1 yielded ages of 4530 ± 30 and 4740 ± 30 radiocarbon years ago (^{14}C yr BP) (Beta-347601 and Beta-347602, respectively). A charcoal sample associated with an Archaic point found in Stratum 2 returned an age of 4180 ± 30 ^{14}C yr BP (Beta-347600). Subsequent dating of charcoal from Feature 2014-1 returned only a slightly later age, 4020 ± 30 ^{14}C yr BP (Beta-412027). These results were problematic, suggesting that Stratum 1 and Stratum 2 were roughly contemporaneous, and that both dated to the mid-Holocene.

Given the evidence for insect bioturbation in the shelter and with it the possibility of movement of charcoal particles, the ages for Stratum 1 were initially dismissed. However, continued excavations and additional radiocarbon dating proved that doing so was ultimately indefensible. Archaic-age projectile points were subsequently found made of Keokuk chert, thereby eliminating the lithic raw material distinctiveness of the supposed Clovis material. Moreover, those points were recovered *in situ* within Stratum 1 – and not (as with the specimens in Feature 2014-1) from an intrusive pit filled with sediments of later age.

Finally, additional dating of charcoal from Stratum 1 returned ages of 4540 ± 30 and 4580 ± 30 ^{14}C yr BP (Beta-412029 and Beta-412028, respectively). The older of the samples came from below a large roof fall block,

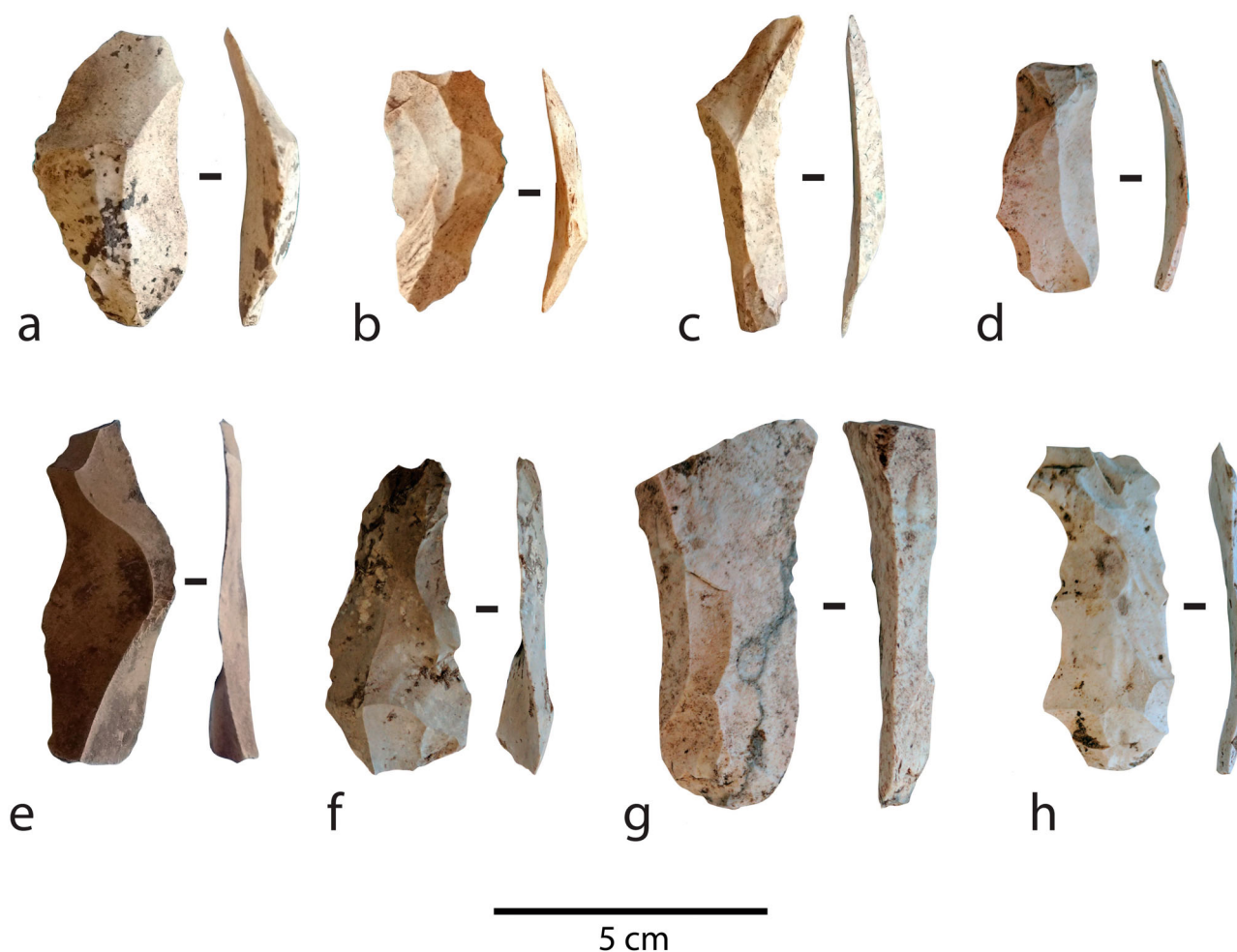


Figure 8 Curved prismatic blades from Goodson Shelter. See also [Table 1](#) for descriptions and Clovis Doppelgängers.

limiting the possibility of downward movement of charcoal. Altogether, three of the four radiocarbon ages from Stratum 1 (Beta-347601, Beta-412028, and Beta-412029) are statistically contemporaneous (as determined by chi-square test), and yield an average age of 4550 ± 20 ^{14}C yr BP, with a 2σ range of 5066–5315 calendar years ago (cal yr BP) (IntCal13).

As an additional, and methodologically independent test of whether the Stratum 1 deposits are mid-Holocene in age, two samples were collected from that unit for single-grain optically stimulated luminescence (OSL) age determination. The samples returned ages (at $\pm 2\sigma$) of 6440 ± 800 (USU-2047) and 5910 ± 690 (USU-2048) yr BP. The younger of the two OSL ages overlaps the 2σ range of the calibrated average radiocarbon age for Stratum 1. Accordingly, we conclude that a mid-Holocene age for Stratum 1 cannot be rejected.

These results demonstrate that the Stratum 1 artifacts with apparent Clovis technological attributes are not Clovis in age. Nor can it be suggested, given the horizontal and vertical integrity of the site, that these artifacts

were washed in; for that matter, they cannot have been lagged onto that floor and subsequently buried by fluvial action, since that would have meant that the “Clovis” artifacts overlay a 4500-year-old surface, and yet there is no evidence of a stratigraphic reversal.

The continued absence of finished, diagnostic Clovis fluted projectile points, the presence of Archaic projectile points made of lithic raw material thought to be exclusive to the supposed Clovis artifacts, and the presence of absolute dates indicating no deposits older than the mid-Holocene are present in the shelter together suggests there was no Clovis presence at Goodson Shelter.

4. How secure are Clovis assignments based solely on technology?

These results, in turn, indicate that technological attributes by themselves may not be sufficient to identify Clovis materials, at least in the absence of independent chronological evidence. Two questions follow from this. First, how secure is the cultural affiliation of

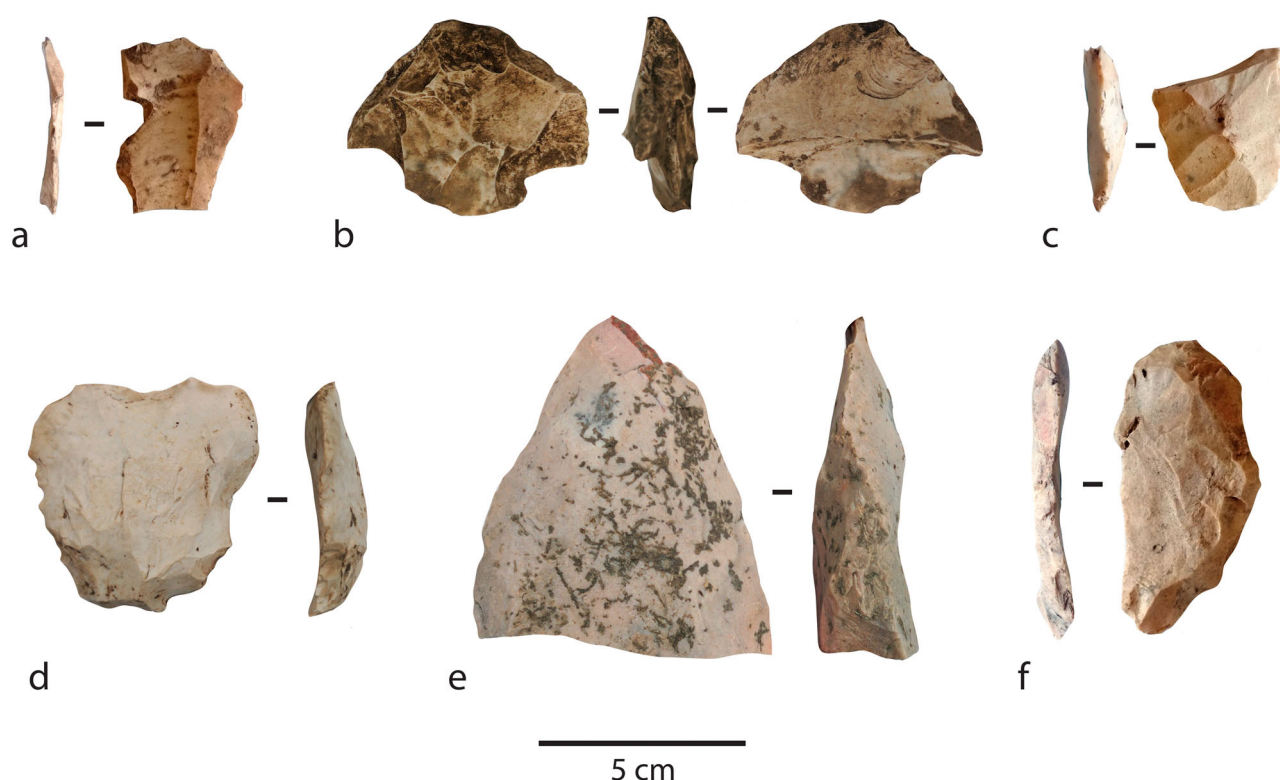


Figure 9 Artifacts from Goodson Shelter: bifacial thinning flake (a); overshot flake (b); unifacial tools (c, d, f); and a large biface (e). See also [Table 1](#) for descriptions and Clovis Doppelgängers.

assemblages assigned as Clovis based on technology alone? Second, how can we explain the presence of “Clovis” technology in post-Clovis assemblages at sites such as Goodson Shelter? We consider each of these in turn.

4.1. Assigning Clovis affinity from technological attributes: Biface and blade caches

For reasons earlier noted, we use caches to illustrate the complications and potentially-problematic consequences of identifying artifacts as Clovis from their technological attributes. Of course, the Goodson assemblage is not a cache. However, we assume the technological strategies used in biface and blade manufacture are the same for artifacts that end up in caches and those that end up in camp sites, as presumably the intended end-function of the artifacts is the same. This assumption is supported by the work of Buchanan et al. (2012), who morphometrically compared Clovis points from caches with Clovis points recovered from kill and camp sites. They found that cached points were the same shape as, but generally larger than, points from kill/camp sites, and that cached points and points from kill/camp sites followed the same allometric trajectory. These results supported the hypothesis that cached points served the same function as points from kill/camp sites, namely, as arm hunting weapons. We can, therefore, compare technological and manufacturing traits between caches and other types of assemblages.

Assigning a cultural affiliation to caches can be particularly difficult for several reasons. First, the majority of the supposed Clovis caches lack finished, diagnostic

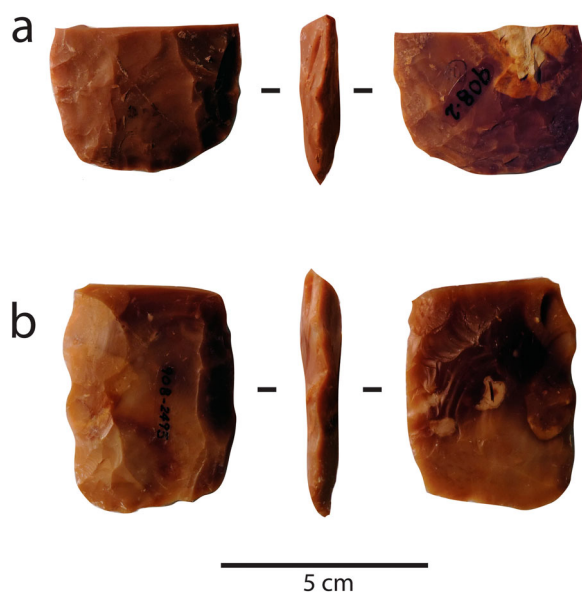


Figure 10 Two examples of bifacially flaked fluted rounded bases from Kincaid Rockshelter, Texas: 908-2 (a); 908-249 (b). Compare with [Figures 3](#) and [4](#).

Table 2 Goodson Shelter specimen numbers, artifact descriptions, and Clovis Doppelgängers for artifacts depicted in Figures 4–8.

Figure	Goodson Shelter specimen number	Description	Clovis Doppelgänger Example(s)
5a	L16-20-50	Proximal fragment of a fluted biface	See references in figure 3 caption
5b	L16-18-178	Proximal fragment of a fluted biface	See references in figure 3 caption
5c	L16-18-169	Early stage biface with flute, full face and diagonal flake scars	Bradley, Collins, and Hemmings (2010, figure 3.16); Collins (1999, figure 3.3c)
6	L16-18-151	Prismatic blade core distal fragment	Bradley, Collins, and Hemmings (2010, figures 2.21a, 2.21b, 2.9 g); Collins (1999, figure 3.7d); Waters, Pevny, and Carlson (2011, figure 34)
7	L16-19-67	Possible early stage blade core	Bradley, Collins, and Hemmings (2010, figures 7.11, 7.12)
8a	M16-17-99	Curved non-cortical blade-like flake	Waters, Pevny, and Carlson (2011, figure 33f)
8b	L16-18-130	Curved prismatic blade	Bradley, Collins, and Hemmings (2010, figure 2.7d); Waters, Pevny, and Carlson (2011, figure 33a)
8c	L16-17-100	Curved prismatic blade	Waters, Pevny, and Carlson (2011, figure 36c)
8d	L16-16-84	Proximal fragment of curved prismatic blade	Bradley, Collins, and Hemmings (2010, figures 2.4, 4.1)
8e	L16-19-51	Prismatic blade	Bradley, Collins, and Hemmings (2010, figure 2.25b)
8f	M16-18-259	Prismatic blade	Bradley, Collins, and Hemmings (2010, figures 2.4, 4.1)
8g	L16-24-39	Prismatic blade partial overshot	Waters, Pevny, and Carlson (2011, figures 30d, 33c, 54b, 54d)
8h	L16-24-154	Curved crested blade	Bradley, Collins, and Hemmings (2010, figure 2.3d, 2.19d); Waters, Pevny, and Carlson (2011, figure 31d)
9a	L16-20-48	Distal fragment of a full-face bifacial thinning flake with full face scars on dorsal face	Waters, Pevny, and Carlson (2011, 64c)
9b	L16-15-161	Distal fragment of overshot flake	Waters, Pevny, and Carlson (2011, figure 64j)
9c	L16-17-175	Proximal fragment of a unifacial tool, possibly a trianguloid end scraper	Huckell (2007, figure 8.10k)
9d	L16-24-144	Large end scraper	Sanders (1990, figure 51d, 51e)
9e	M16-16-158	Distal fragment of bifacial core with full-face flake scars	Sanders (1990, figure 19c)
9f	L16-17-174	End scraper on a blade-like flake	Waters, Pevny, and Carlson (2011, figure 64h)

Clovis projectile points.⁴ This is understandable if the caches were intended to refurbish a tool kit (Kilby 2008): they might have been “packaged” as prepared blanks or early stage bifaces that could have been easily transported to the cache spot, and once reclaimed readily modified into a range of possible tool types depending on need. This makes assigning a cultural affiliation to caches more of a challenge than with assemblages in kill and camp sites, which routinely include the end products of the manufacturing process, such as finished projectile points abandoned because of wear or breakage (Huckell and Kilby 2014, 6–7; Kilby and Huckell 2014a, 217).

Second, very few of the 15 caches identified as Clovis but lacking diagnostic specimens were found *in situ* and/or recovered by archaeologists. Most, in fact, come from collectors, who found them on the surface or as a result of earth-moving activity. Testing of the spot where a cache was found, if it took place at all, often occurred long after the initial discovery, and invariably with meager results (Kilby 2008). Hence, the original depositional and stratigraphic context of these caches is usually unknown, and materials for radiometric dating are unavailable, rendering it impossible to resolve their age (Kilby and Huckell 2014a, 221).

Finally, there is the fact that bifaces and blades are part of a generalized technological strategy shared, as Muñiz observes, “by many precontact cultures through time” (Muñiz 2014, 117; also Roper 1999). Given the finite range of forms these might take, the limited technologies to achieve those forms, and thus the strong

likelihood of convergence (Eren, Buchanan, and O’Brien 2018), bifaces and blades can be similar across broad stretches of time and space, and their form and attributes, as a result, can be indeterminate. It is not surprising that we observed many of the attributes identified as Clovis on the mid-Holocene age artifacts at Goodson Shelter.

It is important to stress, however, that the challenge of assigning a Clovis affiliation to a cache by its technology and morphology is generally recognized (e.g., Huckell 2014; Muñiz 2014), and efforts are made to bolster the case with independent evidence of the age or context of the cache (e.g., Hill, Loebel, and May 2014). Yet, even the best of those efforts ultimately rely on technology and morphology. Consider the following examples from the literature, of both biface- and blade-dominated caches (a systematic examination of all the caches identified as Clovis by their technology and morphology is beyond the scope of this paper).

The Carlisle biface and flake cache was recovered during 1968 salvage excavations at a late prehistoric Oneota village in south-central Iowa. The cache was initially exposed by heavy equipment, then excavated by archaeologists, making it one of the few to have been seen close to its primary context (the overlying deposits had been earlier removed). The cache was comprised of 43 specimens, the majority bifaces ($n = 25$), the remainder large and small flakes ($n = 12$ and 6, respectively), found lying flat and tightly clustered in an ellipse $\sim 40 \times 70$ cm (Hill, Loebel, and May 2014, 80–83).

Although lacking finished fluted points, Hill and colleagues assign the cache to the Clovis complex on geoarchaeological and technological grounds (Hill, Loebel, and May 2014, 85).

In regard to the former, it is impossible to return to the find spot, long since destroyed. Photographs and a stratigraphic section (at a spot ~150 m from the find) made in 1968 were used by Hill and colleagues to approximate the original stratigraphic position of the find. In 2009, they cut several backhoe trenches in a pasture ~500 m distant, and by matching the sediment color in the trenches with one of the 1968 images, they surmised the cache was recovered from a local expression of the Gunder Member of the DeForest Formation (Baker et al. 2002).

In two of those trenches they obtained six OSL ages on sediments, which ranged from 16,700 to 7900 yr BP (Hill, Loebel, and May 2014, 88–89). Comparing the OSL ages with previously obtained radiocarbon ages on the same unit from Money Creek, a locality several hundred kilometers distant in southeast Minnesota (Baker et al. 2002), suggested the age of the cache fell between 11,280 and 9985 ^{14}C yr BP (Hill, Loebel, and May 2014, 89).⁵ Although their efforts to determine the age of the cache made full use of the meager information available, the cache cannot be considered dated. Even granting it was recovered from Gunder Member sediments, that unit ranges in thickness from 3 to 4 m, and in age from 11,450 to 5090 ^{14}C yr BP (Baker et al. 2002, 107); the position of the cache within that vertical and temporal span is simply not known.

The cache was also found near several other features containing ceramics, but Hill and colleagues observe that the bifaces and flakes in the cache are anomalous by Oneota standards (Hill, Loebel, and May 2014, 84; but see Padilla and Ritterbush 2005), and instead “display distinctive characteristics that are diagnostic of the reduction sequences employed by Clovis knappers” (Hill, Loebel, and May 2014, 79). A number of the bifaces in the cache have overshot flakes ($n = 15$) and are end thinned ($n = 6$), the frequency of the former being roughly comparable to that seen in bifaces from the Fenn and Simon caches (Hill, Loebel, and May 2014, 94).

Although Hill, Loebel, and May (2014) consider overshot flaking of bifaces “the single most distinctive characteristic” of Clovis technology, as do others (Bradley, Collins, and Hemmings 2010), that feature is not unique to Clovis, but appears in a variety of later Paleoindian and non-Paleoindian contexts (Bamforth 2014; Bradley 2009; Eren et al. 2013, 2014; Huckell 2014; Muñiz 2014; Sellet 2015). Furthermore, arguments that rely on its frequency in an assemblage are moot, since no modal tendency has been demonstrated for the

production of overshot flakes in Clovis (Huckell 2014) nor, more importantly, has one been demonstrated for post-Clovis assemblages.

In fact, there are post-Clovis assemblages with greater frequencies of overshot flakes than seen in Clovis assemblages (e.g., the Late Prehistoric Easterday II cache (Muñiz 2014; cf. Huckell 2014, 151)). Under the circumstances, we perhaps already have an answer to the question of whether “intentional overshot flaking is *uniquely* diagnostic of Clovis” (Huckell 2014, 151, emphasis in original).

That the Carlisle cache specimens were compared to known Clovis caches is not unreasonable, nor uncommon: artifacts and their attributes suspected to be Clovis are regularly evaluated relative to material of known Clovis affiliation (e.g., Bement 2014; Collins 1999; Condon et al. 2014; Huckell 2014; Osborn 2016). But just as important as demonstrating that artifacts in a cache compare favorably to Clovis is showing they *differ* from those in post-Clovis assemblages. The importance of that two-part assessment is acknowledged (Kilby and Huckell 2014b, 221), though rarely undertaken (but see Muñiz (2014)). It is particularly necessary when the cache includes, as in the case of the Beach cache, a wide range of biface sizes and shapes, more than half of which if found alone “most likely wouldn’t be called Clovis” (Huckell 2014, 135).

As with biface-dominated caches, the antiquity and cultural affiliation of blade caches can be as susceptible to misinterpretation. In a few instances, the assignments of blade caches to Clovis are compelling: the Green cache, for example, though not found *in situ*, was well-argued by Green to have come from Clovis age deposits at Blackwater Locality 1 (Green 1963). The Dickenson cache, also from Blackwater Locality 1 and likewise not found *in situ*, has less secure provenience and stratigraphic position (and may even have been derived from a secondary deposit). It is nonetheless very similar in form and metrics to the Green cache, and “Operating under the current paradigms that would have blade technology almost singularly linked to the Clovis culture,” has been posited as Clovis in age (Condon et al. 2014, 36–37).

But how “singularly” is blade technology linked to Clovis? Bradley and colleagues acknowledge there is “considerable variability” in Clovis blades, and that they “range widely” in size and shape (Bradley, Collins, and Hemmings 2010, 53–54). Just how much they vary, and the consequences of that for identifying Clovis blades, is evident in the results of discriminant function analyses (DFA). This analytical technique, as applied here, uses attributes of known Clovis blades versus known post-Clovis age blades to create statistical

“definitions” (discriminant functions) using variables that most strongly distinguish blades from different periods, then uses those definitions as the basis for classifying blades of unknown age from other caches (Meltzer and Cooper 2006).

Obviously, if the other blade caches are known (e.g., Pavo Real) or suspected (e.g., Dickenson, Keven Davis) to be Clovis in age, then they should be assigned by the DFA to the Clovis group. Conversely, if Clovis blades (like Clovis bifaces) are variable and time-*insensitive*, there will be errors in identifying specimens as Clovis, while assemblages from post-Clovis sites such as Goodson will be “mistaken” for Clovis.

We conducted such an analysis using the blades ($n = 81$) from the Gault site (data from Bradley, Collins, and Hemmings 2010, table 2.4) and the Green blades ($n = 6$) (data from Condon et al. 2014, table 3.3) to create the statistical definitions of Clovis blades, and the Archaic-age specimens from the Gibson cache from west Texas serve as the post-Clovis proxy (data from Tunnell 1978). The morphometric variables used are those in Collins (1999); the discriminant functions derived in the analysis were applied to a sample of 348 blades from 20 Clovis and post-Clovis sites. The data, analysis and results are detailed in the Supplemental Material (SI). We summarize that discussion here by noting that there is considerable morphometric

variability in known Clovis blades, so much so that when the Gault blades are used as the proxy, ~65% of the middle Holocene-age blades from Goodson are classified as Clovis, while ones thought (or suspected) to be Clovis – such as the Dickenson blades and those from Pavo Real – group with the Archaic blades at equal and even greater frequency (Table 3). When the morphometrically more homogenous, and smaller sample of blades from the Green cache are used as the Clovis proxy, the Goodson blades are correctly grouped with the Archaic blades from Gibson. However, correct assignment of the Dickenson, Gault, and Pavo Real blades to Clovis occurs no more than ~65% of the time (Table 3). In broad terms, whether the Gault or Green blades are used as the Clovis proxy, the result is the same: blades from non-Clovis sites – including Goodson – are often statistically assigned to the Clovis group based on attributes said to be distinctive of Clovis, and blades from Clovis sites are not always statistically “recognized” as Clovis but are assigned to post-Clovis form (see also Tables S3–S6). In effect, the variables routinely used to identify Clovis blades are not definitive. Just as with bifaces, one can have only limited confidence in a Clovis-assignment of a blade cache where there is no independent evidence of its antiquity or affiliation, and where it is argued *to be Clovis*, but without showing that *it is not post-Clovis*.

Table 3 Results of the DFA of Clovis blades, (3a) using the Gault site blades as a proxy for Clovis blades, and (3b) using the Blackwater Locality 1 “Green” blades as the proxy for Clovis.

(a) Using the Gault site blades as the proxy for Clovis. Variables used in the creation of the discriminant function in order of entry: platform width, maximum width, and maximum length (see also Table S3 and Table S5).

Site	Clovis	Archaic	Sum	Percent correct	
Gault	72	9	81	88.9%	Post-hoc classification of the specimens used to separate the groups.
Gibson	0	45	45	100.0%	
5GN149	10	31	41	?	As classified using the discriminant functions derived from separating the Gault and Gibson caches. Percent correct is based on presumed group, whether Clovis or Archaic (read another way, 64.7% of the middle Holocene Goodson blades are assigned to the Clovis group).
Brookeen	15	14	29	?	
Dickenson	3	2	5	60.0%	
Goodson	11	6	17	35.3%	
Green	6	0	6	100.0%	
Keven Davis	8	0	8	100.0%	
Pavo Real	10	4	14	71.4%	
Yellow Hawk	1	1	2	50%	

(b) Using the Blackwater Locality 1 “Green” blades as the proxy for Clovis. Variables used in the creation of the discriminant function, in order of entry: maximum length, maximum width, curvature and platform width (see also Table S4 and Table S6).

Site	Clovis	Archaic	Sum	Percent correct	
Green	6	0	6	100.0%	Post-hoc classification of the specimens used to separate the groups.
Gibson	0	45	45	100.0%	
5GN149	2	18	20	?	As classified using the discriminant functions derived from separating the Gault and Gibson caches. Percent correct is based on presumed group, whether Clovis or Archaic. Here, the Goodson blades are almost all correctly identified as Archaic.
Dickenson	3	2	5	60.0%	
Goodson	1	16	17	94.1%	
Gault	53	28	81	65.4%	
Keven Davis	8	0	8	100.0%	
Pavo Real	6	7	13	46.2%	

See Supplemental Materials for details.

The presence of overshot flakes and a failed fluted preform in the JS cache, for example, is argued to lend “credence to the Clovis attribution of this cache” (Bement 2014, 64). Yet, were we to compare the JS cache with the material from Goodson Shelter (a comparison that, in fairness, Bement was unable to do), with its six fluted bifaces that are middle Holocene in age, along with many other similarities between its specimens and the JS cache (as a comparison of Bement 2014, figures 5.3 and 5.4, with Figures 4–9 above show), we could just as likely conclude the JS cache dates to the middle Holocene.

Ultimately, for the JS cache, as well as any other biface or blade cache lacking independent chronological control, we cannot demonstrate its age or affinity. This conclusion brings up a larger observation, made by Sellet (2015) in his re-evaluation of the Sheaman site and its potential Clovis affinity (of which he is skeptical), who suggests we should “question the validity of a normative approach that treats technological behavior as cultural makers.” Further, that “the reduction of idiosyncratic tools such as [...] highly redundant manufacturing processes like the occurrence of overshot flakes in biface manufacture to particular mental templates is unlikely to provide the answers we seek about Paleoindian adaptations or migrations” (Sellet 2015, 86; also, Muñiz 2014).

Finally, while the assignment of a Clovis cultural affiliation to caches is often more of a challenge than it is for outcrop, kill, and camp sites, where the latter lack unequivocal finished Clovis points the challenge of cultural assignment is no less difficult (Jackson 1998; Sellet 2015).⁶ Just as with caches, it is important to compare assemblages from outcrop, camp, or kill sites with both Clovis *and* well-described and well-dated post-Clovis assemblages, to ensure a proper cultural affiliation assignment in the absence of independent age control.

5. Are Clovis technological features restricted to Clovis?

Post-Clovis age stone tools include attributes that we routinely ascribe to Clovis (see also Muñiz 2014; Sellet 2015). Clovis technology may very well overlap with technologies found in Archaic and later cultures to different degrees. But just how much it may overlap is not known.

There have been multiple, nuanced, detailed studies made of Clovis and, more broadly, Paleoindian technology (e.g., Bradley, Collins, and Hemmings 2010; Collins 1999; Sanders 1990; Waters, Pevny, and Carlson 2011; Waters and Jennings 2015). To our knowledge, that is not the case of post-Paleoindian technology. A substantial and significant volume on the Archaic of the midcontinent (Emerson, McElrath, and Fortier 2009), for

example, touches only briefly on matters of stone tool production technology. The same can be said for volumes on the Woodland period (Brose 1976; Emerson, McElrath, and Fortier 2000; Genheimer 2000). Other works discussing post-Clovis cultures in North America (e.g., Anderson and Sassaman 1996; Bousman and Vierra 2012; Carr, Bradbury, and Price 2012; Daniel 1998; Graf and Schmitt 2007; Jackson and Hinshilwood 2004; Jeffries 2008; Knell and Muñiz 2013), likewise lack extensive, detailed analyses of stone tool production and technology analogous to those conducted on Clovis assemblages.

The relative inattention to post-Clovis technology is perhaps attributable to several factors, either singly or in combination: there is a broader range of stylistic variability in Archaic and Woodland projectile points, and this has perhaps led to a greater focus on artifact typology than technology; there is also a greater range and abundance of artifact classes in Archaic and Woodland assemblages – such as chipped and ground stone, ceramics, bone tools, and so on – diffusing analytical attention across many areas and away from a focus on chipped stone tool technology; finally, there is in Paleoindian studies considerable interest in understanding its possible origins in the Old World Upper Paleolithic, which given its historical attention to technology and in the absence of shared diagnostic tool types, has led to a focus in North America on Clovis technology.

The absence of detailed knowledge of post-Clovis stone tool production technologies reinforces the importance not only of independent age assessments (or diagnostic finished Clovis fluted points) to determine Clovis affinities, but also, in the absence of these, the development of objective, quantitative determinations of Clovis versus post-Clovis technological variability (e.g., using tools such as geometric morphometrics, calculations of flake scar density, flake type frequency, etc. (Eren, Buchanan, and O’Brien 2015)). These will be necessary to demonstrate which attributes (if any) belong only to Clovis, and whether on an individual attribute basis or at the assemblage level, and which attributes tend more frequently to appear in Clovis versus post-Clovis assemblages at a statistically significant level (Lycett 2015, 2017; Lycett and von Cramon-Taubadel 2015).

6. Conclusions

This study raises additional issues that are beyond the scope of this paper, but warrant further investigation. For example, are we seeing a case of technological convergence at Goodson Shelter, or is there a currently undocumented historical connection between Clovis and the Late Archaic technologies of northeastern Oklahoma (Buchanan, Eren, and O’Brien 2018; Jennings and

Smallwood 2018; Lycett 2009, 2011; Smallwood et al. 2018; O'Brien, Buchanan, and Eren 2018; Wang et al. 2012)? If we are seeing a case of technological convergence, it would be apt to ask what sort of constraints are driving that convergence: whether developmental, functional, or some combination of both (McGhee 1999, 2011). If developmental constraints are behind the patterns we have documented, then perhaps Late Archaic knappers re-discovered flaking techniques that led to Clovis-like forms. If functional constraints are instead driving the archaeological patterns, then perhaps Clovis and Late Archaic peoples faced similar resource procurement or processing challenges. Finally, we note that it is interesting that we see virtually the entire "Clovis package" at Goodson (minus finished Clovis points, of course), which is something not often documented at actual Clovis sites. Provisionally, we wonder whether this situation may be due to differences between Clovis and Late Archaic in terms of mobility or site residence time (Bettinger 1991; Eren et al. 2012; Schiffer 1975; Surovell 2009).

These issues aside, it has long been a tenet of Clovis studies that their technology is distinctive and in many respects unique (e.g., Bradley, Collins, and Hemmings 2010; Bradley and Collins 2014; Collins 1999, 2005; Collins and Lohse 2004; Huckell 2014; Morrow 2015; Stanford 1991; Stanford and Bradley 2012; Tankersley 2004). This is expressed most explicitly by Bradley, Collins, and Hemmings (2010, 3), who argue that Clovis is "a distinct technological complex that is discernable, has unique characteristics and is identifiable archaeologically."

As we have shown, that technological complex is discernable and identifiable archaeologically, but it is not necessarily unique to Clovis. The similarity in Clovis and post-Clovis technological features may be the result of convergence either because of the limitations imposed by fracture mechanics or similar adaptive responses, or is a reflection of a shared historical technological tradition. Investigations into post-Clovis technologies will help resolve which of these factors (if not both) account for the similarity between Clovis and later technological processes. Regardless, for now, this result emphasizes the importance of looking at suites of evidence, technological and otherwise, in assigning assemblages to Clovis, and avoiding, or tempering, such assignments in the absence of such evidence.

Notes

1. Granting the caveat there is morphological and technological variation and diversity in Clovis points, as well as disagreements regarding the precise span of the Clovis period (e.g., Hamilton and Buchanan 2007, 2009;

Buchanan, O'Brien, and Collard 2014, 2017; Eren and Buchanan 2016; Eren and Desjardine 2015; Morrow and Morrow 1999; Prasciunas and Surovell 2015; O'Brien et al. 2015; O'Brien, Buchanan, and Eren 2016; Smallwood 2010, 2012; Smallwood and Jennings 2015; Smith, Smallwood, and DeWitt 2015; Waters and Stafford 2007).

2. The other nine caches – Anzick, Crook County, de Graffenreid, Drake, East Wenatchee, Fenn, Hoge, Rummells-Maske and Simon – all have finished, diagnostic Clovis projectile points or age control indicating a Clovis age (Huckell and Kilby 2014a; Kilby 2008, 2014).
3. Details of the work at Goodson Shelter are in a forthcoming report on the site.
4. Like Bamforth (2014, 50), we are skeptical about the diagnostic potential of other formal tools, such as spurred end scrapers.
5. To render the OSL ages in radiocarbon years, Hill and colleagues 'reverse-calibrated' the OSL ages using the IntCal04 calibration curve. This is a problematic procedure, not least because it assumes that calibrated ages are single points in time (they are not), and loses the inherent statistical uncertainty estimates that accompany radiocarbon ages, whether calibrated or not.
6. The affiliation of these sites is described by Jackson (1998) as "Gainey," a Great Lakes and Midcontinent Clovis-like variant, rather than "Clovis" itself. There is currently no empirical, quantitative, technological, or chronological justification for the Gainey moniker (e.g., Buchanan, O'Brien, and Collard 2014; Eren and Redmond 2011; Eren, Vanderlaan, and Holland 2011), and we have addressed this issue elsewhere (Eren and Desjardine 2015). As such, we will use the term "Clovis" in our discussion here.

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