ABSTRACT

Title of Thesis: AN ARCHAEOLOGICAL INVESTIGATION OF CLOVIS BLADE TECHNOLOGY AT THUNDERBIRD (44WR11), A PALEOLITHIC STRATIFIED SITE OF THE FLINT RUN COMPLEX, WARREN COUNTY, VA

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The presence of Paleoindians in the Eastern United States at the end of the Pleistocene has been a focus of scientific examination for more than a century, resulting in the discovery of numerous sites. These sites, occupied more than ten millennia ago, are extremely rare, and even more so in an undisturbed context. The Flint Run Complex in Northern Virginia contains not one, but several Late Pleistocene and Holocene open-air stratified Paleoindian sites. Thunderbird (44WR11) is the main site within the complex with evidence of human occupation in the region at around 9,990 BP. Numerous tools were recovered which fit the Clovis technocomplex and extensive analysis has been performed on bifacial technology at the site. Additionally, the identification of blades at Thunderbird would support previous assertions that the site was an important refugia on a migratory pattern where scheduled resource exploitation and toolkit refurbishments took place as part of seasonal rounds. How does the analysis of lithic blade production at the Thunderbird site (44WR11) refine our understanding of localized seasonal migration and exploitation of local resources among Paleoindian people of the Shenandoah River Valley. Confirmation of blades and their use would indicate a more robust exploitation of the region's natural resources and reinforce previous assessments of the importance of Thunderbird

as a sedentary seasonal base camp. Through the examination of 324 lithic artifacts from the site, this study seeks to identify the presence of a concerted blade manufacturing technology where it was believed one did not exist, and better understand the behaviors tied to those tools. Blades are a known part of the Clovis toolkit and have been found at sites across the United States. The identification of blades at Thunderbird will provide an expanded understating of the Clovis toolkit, the spread of blade technology, and of Paleoindian lifeways in the Middle Atlantic region.

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WARREN COUNTY, VA

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Forward

Every artifact provides insight only after finding its place in history, just as research contributes to knowledge by building upon what is already known. This study began with a prehistoric stone blade, or rather several, and a question about their origin. In 2022 I was fortunate to become involved in a private archaeological investigation in the Shenandoah River Valley of Northern Virginia supported by Dr. Robert Richards of Jasper Ridge LLC and endorsed by the Archaeological Society of Virginia. It was the first such undertaking in decades in the Flint Run Complex, with a focus on Paleoindian history in the region. The area is rich in archaeological sites dated as far back at the terminal Pleistocene. The site in question lies on a ridge overlooking the valley and has evidence of thousands of years of occupation. Recorded as 44WR506, Jasper Ridge encompasses two acres and sits adjacent to an extensively used jasper quarry. It has produced more than 50,000 catalogued artifacts to date. However, its disturbed stratigraphy and significant collecting has made dating of the site inconclusive and at times frustrating. In the process of cataloging the many lithic artifacts, primarily comprised of local jasper, the quantity of blades and blade-like flakes became apparent. The presence of these blades and blade-like flakes, like those found in other Clovis contexts, began to raise questions about a possible Early Archaic or even Clovis age blade industry at the site. We soon realized we would need to look at other collections for comparative insight to better understand the artifacts at Jasper Ridge. Fortunately, less than a mile from Jasper Ridge is the Thunderbird site, (44WR11).

This well preserved Late Pleistocene site underwent excavation for more than a decade and produced solid evidence of Clovis habitation from undisturbed stratified levels more than three feet below datum. The years of research that came out of Thunderbird would go on to establish settlement patterns and ecological understanding for the region and shed light on Paleoindian lifeways across the Mid-Atlantic. By the 1980s Thunderbird lost its notoriety, and the collections made their way to the archives of the Smithsonian where researchers occasionally visited them. Despite being locked away, the work at Jasper Ridge afforded an opportunity to access the collection of more than 100,000 artifacts. But mention of blades was absent from all literature related to Thunderbird, except for explicit statements that true blades did not exist at the site.

A complete examination of the collection was a considerable time commitment, and one that had no guarantee of paying dividends. Would Thunderbird hold the answers to Jasper Ridge, and could it provide the necessary baseline to understand the distinct blade technology being employed there? More importantly, were the same people inhabiting Thunderbird also using Japer Ridge as an alternate camp as part of their seasonal rounds? One thing remained certain: evidence of a Clovis blade industry would only be found in the deepest levels of the Thunderbird collection. In this regard, the research done at Thunderbird more than 40 years ago continues to support a broader knowledge of history in the region as a legacy collection.

It is beneficial to anyone who reads this to understand my mindset when tackling these broad and complex questions. Each researcher views a problem differently and leverages their unique life experiences and academic background to shape the approach to their hypothesis. I am new to archelogy, but I am not new to research. I have spent decades studying and working with communication theory, specifically related to how it shapes human behavior. The communication theories underlying behavior have great parallels with archaeology, which I believe at its core seeks to unravel behavior through the examination of artifacts. Communication theories, such as the theory of planned behavior (Sussman and Guifford 2019) and diffusion of innovation (Rogers

2003), leverage the complex combination of internal and external factors to explain behavioral outputs, as well as explain how behavior changes in response to inputs. These theories share parallels to those found in processual and cognitive archaeology and their examination of systemic processes. From weather to culture, everything plays a role in shaping behavior, and I believe the output, or artifact, can tell us what types of factors influenced its creation. I view every artifact as a behavioral output, shaped in subtle ways by the world around its creator. Blades are no exception. Their techniques of manufacture allude to diffusion of innovation between peoples, their existence in a particular location implies the type of work done there, use-wear demonstrates how they were used, and their discard tells another piece of the story. Given my view on behavior, I am fully aware that knowing blades exist at a site is only the beginning of a larger initiative to understand what influenced their creation in the first place.

Nowhere in North America is the dispersion of Paleoindian artifacts greater than in the Eastern United States, ranging from New England to the Southeast. Research has documented many sites with varying degrees of success, creating compartmentalized reports of great detail. But we have reached a stage in Paleoindian research where we can begin to share and view information about artifacts from these sites on a much larger scale. Comparative analysis of artifacts can tell a much bigger story about mobility, material use and transport, social structures, and occupation periods. Finding a blade is just the beginning of the story. The existence of a blade industry in the Shenandoah River Valley is a necessary addition to a much bigger narrative focused on Paleoindians in the East during the Terminal Pleistocene. It is my hope that this research provides another subtle addition to the understanding of the role blades played in the lives of these people, and thereby a broader understanding of the physical and social environment they existed in.

Dedication

To the 8-year-old version of myself, who stared endlessly into collection cases at the Peabody Museum at Yale, dreaming of lost treasure, adventures, and a really nice hat.

Acknowledgements

My gratitude goes to my archaeological mentors, Dr. Mike Johnson, Patrick O'Neill and Yvonne French, who have been with me since I decided to commit to the cause of understating human origins, and who have provided a constant flow of wisdom and encouragement. My thanks go to Dr. Bob Richards for allowing access to Jasper Ridge, and for sharing his knowledge of lithic technology. Also, thanks go to Jim Krakker at the Smithsonian Museum Support Center for enabling access to the Thunderbird collection. I only got lost in the archives once. And I would be coming up short if I didn't mention the outstanding support of the Archaeological Society of Virginia, and the Northern Virginia Chapter of the ASV for setting the stage for my entry into archaeology. Finally, my deepest appreciation for my family who watched patiently as I sacrificed years of weekends and weekday nights to a quest for knowledge that is insatiable and at times compulsive.

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Chapter 1

1.1 The Blade - An Essential Companion Throughout Human History

Research at sites around the world (Apel and Knutsson 2006, Otsuka 2017, Takakura 2020,), to include those in North America (Carr et al. 2010, Collins 1999, Eren and Redmond 2011, Roux et al. 2024, Sain 2012; 2016) has demonstrated the importance of blades and blade technology in the toolkit of Paleoindians. These highly mobile people relied on complex seasonal migratory patterns supported by a refined lithic toolkit which supported a range of behaviors. The identification of blades at Thunderbird would support previous models that the site was an important refugia on a migratory pattern where scheduled resource exploitation and toolkit refurbishments took place as part of seasonal rounds. How, when, and where people decided to manufacture certain types of tools is directly related to the migratory patterns of those people, which is also highly influenced by environmental stressors (Sain 2012:15-16). How does the analysis of lithic blade production at the Thunderbird site (44WR11) refine our understanding of localized seasonal migration and exploitation of local resources among Paleoindian people of the Shenandoah River Valley.

Of the few Paleoindian sites in North America, even fewer have intact stratified levels, making Thunderbird a genuine snapshot in time (Gardner, 1974). Numerous excavations at Thunderbird identified a wide variety of lithic tools, as well as post holes outlining structures which place artifacts in context of a stratified Late Pleistocene habitation (Gardner, 1974; 1983; 1994). The low number of finished tools found compared to the amount of waste from production would indicate it was where toolkits were refitted before these small hunter gatherer bands moved on to other locations (Gardner 1974). The presence of any blades at Thunderbird would suggest a complex toolkit like other locations in the East. Since blades were frequently produced and transported from one location to another for future use (Boldurian & Hoffman 2009), the presence of blade cores without blades is noteworthy as it would suggest cache behavior for anticipated migration. Thunderbird has been the subject of numerous studies and research papers, several of which focused on the common biface technology of the Clovis period (Boyer 1974, Callahan 1979). Blades on the other hand are unique in their function, only being found at certain sites, and in varying forms. Blades are recognized as a prominent tool in Upper Paleolithic tool kits around the world. Yet their presence in research has been underrepresented. This is due in part to blades being lumped in with debitage (Sain 2012). This has led to an increasing reexamination of North American sites for blades especially in the East, such as Shoop (Cox 1986), Shawnee Minisink (Iceland 2013), Adams (Hagg and Jones 2022), Topper (Sain 2012), Carson-Conn-Short (Jones 2018), and Cumberland (Gramly 2013).

It is widely accepted that people of the Clovis Era, to include those in Virginia were highly skilled in their ability to create distinctive stone tools from high quality toolstone. The most notable is the Clovis fluted point which is a product of bifacial reduction and takes on the appearance of a rigid and durable tool (Figure 1). And while these complex lithics are a wonder of craftsmanship, this was not the only tool in the toolkit of early people. Likely their daily lives involved a variety of organic and stone tools necessary to survive the harsh environment at the end Pleistocene. Functional utility was key and tools were often multipurpose by design to accomplish a variety of tasks. Research has demonstrated that a key tool within the Clovis toolkit was the blade for its masterful design and utility (Collins 1999, Boldurian & Hoffman 2009), which at first glance does not look durable enough to be significant when comparted side by side with bifacially knapped tools (Figure 2). Despite their delicate appearance the physical structure of blades makes them incredibly durable and versatile tools which made them the “tools of choice” for delicate tasks like slicing and shaving of soft materials, and heavy work like shaping bone and wood (Boldurian & Hoffman 2009:169). Clovis blade technology is unique in that the desired output is a specific tool type with distinct characteristics not created by chance. Blades by their design serve a vastly different purpose than that of large, carefully curated points used for repeated heavy use or for taking large game. What could be called the Paleolithic version of paring knives would have complemented the larger cleavers of their day. Knowing the types of tools used by Paleoindians in a specific region and time opens a window, however small, to their daily lives.

Figure 1. (Left) Fluted Clovis point from Thunderbird. (Right) Double crested blade from Thunderbird. The Clovis point was created with hundreds of carefully planned flake removals. The crested blade on the other hand was created after other blades were removed laterally from the left and right, followed by a single strike to remove the blade as seen above. Both are created with clear intention with very different outputs. Photos by the author.

1.2 Origins and Ice

The Shenandoah River Valley in Northern Virginia was a vastly different 13,000 years ago. The landscape was possibly covered by boreal woodland with open grasslands and bog-like marshes (Carbone 1974). This was home to mammoth, bison, giant sloth, and saber tooth tigers. Braided rivers, forests and marshland gave refuge to a multitude of species long extinct (Gardner 1974). The small bands of people inhabiting this landscape used the world around them to create the tools necessary to survive and left behind only shadowy traces which produce more questions than answers. With organic remnants all but gone, scientists rely on stone tools and their byproducts of manufacture to tease out some small understanding of this early chapter of human history in North America. Paleoindian research is contentious, and findings claiming to have unraveled a piece of the enigmatic story must be absolute and irrefutable because of the weight they carry. No origin story is something to be taken lightly. However, there are things we do know about these people, largely tied to their tools and their distribution across the landscape.

1.3 A Story Written in Stone

Humans have been reducing stones to an increasing level of complexity for hundreds of thousands of years, and the shaping of stone by our distant cousins' dates back nearly 2,000,000 years. If read properly and with skill, stone can peel back the millennia and give us subtle insights into daily activities. The study of lithic technology shows us the progress of these people, their abilities, and movements across landscapes (Crabtree 1974). The process of flintknapping demonstrates the foresight of early people to induce and control the fracture of stone to create tools which progressed in complexity and technical skill through the ages, based on the "systematic knowledge of forming stone into useful cutting, chopping and other functional impairments… Flintknapping was not a haphazard art, but rather, a carefully planned process of making stone tools to suit a specific functional purpose," (Crabtree 1972:2). The core of this research is based on pure intentionalism; the concept that an individual's intentions and conceptualization of something have a direct role in its creation. Therefore, it could be said that lithic analysis is the validating and deciphering of the intentions of prehistoric knappers.

As a scientific process lithic analysis has its roots in physics and effects of applied force on various materials. Different materials have different properties which produce noticeably different attributes. These attributes are predictable and repeatable, providing great insight to a trained analyst. One way analysts do this is by dividing the process into specific stages, such as preliminary modification, blank, preform and final implement (Bradley 1975). Being able to read the attributes of one type of material is akin to speaking one language, but recognizing similarities to others is like translating across many. It could take a present-day lithic analyst a lifetime to become well versed in the physical attributes and variations of many different material types. But early people were also lithic analysis, well versed in the workings of stone. Evidence from Virginia demonstrates that Clovis people were multi lithists (Johnson 1989). At the core of this study are the lithic attributes of jasper and the technological process of creating blades and bifacial tools.

Blades have been noted for their optimization of cutting edge, and as a foundation for creating curated tools. Many definitions exist for blades (Collins 1999, Sorensen 2006, Sain 2012), however a blade in its simplest form is a flake, intentionally removed for its lateral cutting edge, and which is often longer than it is wide upon removal. However, the definition of a blade remains fluid, and under increased scrutiny and debate. Unfortunately, blades have taken a backseat to more diagnostic and refined lithics like the Clovis point, which was used as a temporal marker when early archaeologists saw more value in establishing chronology through artifacts than what those artifacts could reveal about ancient human behavior. Further exasperating the issue is the fact that Paleoindian tools are rare, often found far from their point of manufacture and discarded when worn, misshapen though curation, and no longer of value to the user. Blades are no exception. Blades, because of their less-than-formal nature and ill-defined definition can be easily misconstrued and overlooked. This research will examine artifacts previously considered as waste due to overly stringent typologies, and different archaeological priorities at the time of initial collection. In short, previous researchers may have been biased toward "finished" tools with formal complexity, thereby completely overlooking the value of more simplified and expedient tools which likely played a key role in the everyday life of Paleoindian people in Virginia and elsewhere.

1.4 Overview

This study highlights the importance of Paleoindian research to the history of North America and calls out the blade for its specific role in that journey. To understand the context of blades it is first important to know more about the Paleolithic world of the Middle Atlantic and Susquehanna River Drainage ancestral to the Chesapeake Bay as it existed 13,000 years ago. Chapter two presents an overview of the unique geography of Virginia and how it rapidly changed at the end of the Pleistocene but fortunately preserved evidence of Paleoindian settlements. The heated quest to unravel the Paleo-American story is addressed, with major historic milestones explained, leading up to the discovery of Thunderbird and the Flint Run Complex in Northern Virginia.

Chapter three discusses the theories that have been used to investigate Paleolithic sites in the Eastern United States, starting with some of the first major investigations to note blades and making comparisons to artifacts of the Old-World Upper Paleolithic. These discoveries and debates have led to refined theories focused on the role of blades, and more importantly active discussion on what blades are and how narrow typologies and biases can limit research and understanding.

Chapter four outlines the techniques and methods used to carry out this study after addressing the development and progression of relevant theory, a less restrictive definition of blades, and common methodologies for analysis. Over the course of several months the necessary data was collected from the solitude of the Smithsonian collection repository. Many of the methods for analysis are drawn from best practices of other researchers, while some were created through trial and error to create an original analysis of lithics recovered from Clovis-period contexts at the Thunderbird Site. Ultimately a sizable dataset of more than 300 artifacts were analyzed in the context of trying to better understand blades and blade like flakes.

The tabulation of data is presented largely in raw format in Chapter five and highlights the value of the data in answering some of the key questions of this study. In total more than 18,000 measurements as datapoints were available for comparison. This required the narrowing and careful organization of datasets into those that are meaningful to blade research.

The analysis presented in Chapter six finds unique attributes in both the quantitative and qualitative analysis of the collection, not only raising questions about the role of blades at Thunderbird but highlighting the value of answers yet to be found in legacy collections. By selecting several key artifacts from the analysis, multiple lines of evidence are presented on the role of blades at Thunderbird within the Clovis context.

Like many research projects, the facts uncovered created more questions than answers and illuminated future research opportunities. In Chapter seven, a holistic look back on the research for its broad implications is paired with recommendations for additional research. The opportunities in blade research are numerous, with multiple collections, like Thunderbird, never cataloged and just waiting for analysis. That is provided someone has an immense amount of patience, a good soundtrack, and an affinity for rocks.

Chapter 2

2.1 Virginia - A Paleolithic Hotspot in a Cold World

Virginia has a unique set of physiographic provinces due to its long and complex geologic history that complements Paleoindian research. The state contains five distinct physiographic regions. On the easternmost side of the state, bordering the Atlantic Ocean, is the mostly flat Coastal Plain. Further west the low and unobtrusive elevation of the Coastal Plain gives way to the rolling hills of the Piedmont which steadily increase westward until they meet the Blue Ridge mountains. To the west of the Blue Ridge Mountains is the Valley and Ridge region which is notable for its repeating ridges and valleys increasing from east to west. Finally, to the far southwest of the state is the Appalachian Plateau comprised of rugged, heavily dissected hills. These regions and their drainages are of notable importance when we consider models developed by researchers, who connected Paleolithic movement, resources, and settlement patterns to the landforms which acted as corridors and barriers to movement. But the Virginia of the late Paleolithic, more than 10,000 years ago during the Late Pleistocene looked very different than it does today.

2.2 Paleoindian Timeline and Climate

It is believed that the greatest expansion of humans in North America took place during the Middle Paleoindian period between 13,450-12,900 cal. BP (Anderson, 2001:154). This was a time of climate warming at the end of the Pleistocene. Clovis technology is a key marker of this spread. Around 11,500 BP during the Late Glacial period the Shenandoah Valley had many microhabitats which varied by geography. Uplands were likely covered in alpine tundra, coniferous forests on slopes, mixed forests on the foothills and valleys and deciduous forests in the valleys (Carbone 1976 as cited in Carr et al 2013:163). By 11,000 BP groups employing fluted points were in the Shenandoah region (Carr et al. 2013). But this time of significant warming was followed by a sharp reversal around 10,900 BP which occurred abruptly within 40 to 100 years and returned to a cold and dry glacial like climate known as the Inter-Allerod period Younger-Dryas (Isarin and Bohncke 1999 as cited in Carr et al. 2013:162). This event was catastrophic and likely caused the extinction of megafauna in Eastern North America such as mammoth, camel, and giant sloth (Anderson, 2001:152). This drastic impact on the environment may have also killed off early humans who had adapted to these resources for survival. As explained by Edwards and Merrill (1977) as cited in Egghart (2020), during this period of glaciation and cooling so much water was locked in ice that sea levels were as much as 130 meters lower than present day. Much of the Northern Hemisphere was pressed beneath massive ice sheets 3,500 to 4,000 meters thick. It's fortunate for archaeologists that Virginia escaped the scouring effects of these massive glaciers, however the region would not escape significant change driven by sea level rise when the sudden cooling reversed once again at the end of the Younger-Dryas (Egghart, 2020).

So drastic was this change that sea levels rose by several hundred feet. This resulted in movement of the Atlantic coastline westward as water inundated the gently sloping portions of the continental shelf. Estimates place this change at 510 horizontal meters inundated for every 0.30 m rise in sea level (Milliman and Emory 1968 as cited in Egghart 2020). What this means for Virginia's early Paleoindian coastal sites is that many are now submerged and have been for millennia. Prior to this inundation Paleoindians could have ranged an additional 70 miles east of the current coastline, as shown in Figure 2. The Cinmar site is reported to have been found approximately 40 nautical miles off the Virginia coast where a biface and mastodon remains were recovered by a scallop trawler (Stanford and Bradley 2012), however this find remains under scrutiny (Eren, Boulanger, and O'Brien 2015). This does not negate the fact that the Virginia coastline was much further out than it is today. But Paleoindians were not confined to these not submerged coastal regions. Sea level rise had a mixed impact, most severe in the larger floodplains that had been scoured deeply during spring melts in the mountains (Johnson 2012). Sites such as Cactus Hill, Blueberry hill and Rubis-Pearsall, the first two containing pre-Clovis components, are all in the present day inner Coastal Plain and avoided the erosive effects of full glaciation as they sit on smaller rivers (Johnson 2012).

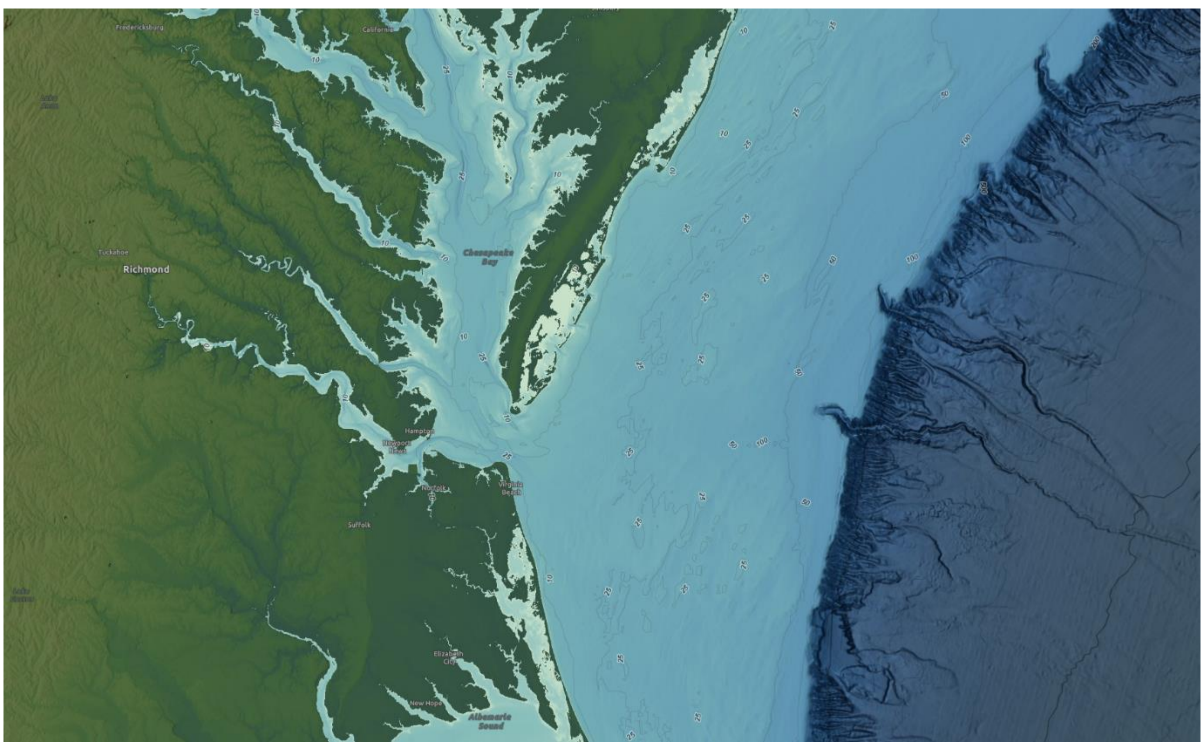

Figure 2. The extent of the Virginia coastline at the end of the Late Pleistocene would have extended approximately 70 miles from today's coastline where the current depth is approximately 100 meters, as shown in light blue. Map produced by the author using the National Oceanographic and Atmospheric Administration, Bathymetric Data Viewer, 2024.

Following the Younger Dryas, around 10,000 BP, temperatures rose markedly into the Archaic Period, ushering in the spread of warm-adapted flora and fauna (Egghart 2020:24). But this may not have been a constant process across all regions. By 9000 BP the Wisconsin Glacier remained as far south as Lake Superior and Ontario. The cooling effect from the corresponding periglacial lakes in the north would have had a profound impact on winter climate in the East. The residual effect of this being the persistence of cold adapted microenvironments in the Plateau, Ridge and Valley and Blue Ridge regions where alpine grasses and spruce parkland remained well into the later warming period (Mike Johnson, personal communication July 2024).

Virginia's reprieve for the crushing ice and partial inundation of its eastern coastline means that very old prehistoric deposits, although rare, do exist in Virginia. These Paleoindian sites are limited to a few regions, notably the Coastal Plain, the Northern Shenandoah Valley, and the Valley and Ridge physiographic region in Southwest Virginia (Boyd 2020:39). As noted by Boyd (2020:39) as of 2020, the State of Virginia database listed only 88 Paleoindian sites in Virginia, but there are 240 in total with Paleoindian components; the majority lacking provenience. However, those that have been found are of great importance.

2.3 Searching for the American Paleolithic

Extensive research has been conducted on Paleoindian cultures of the Mid-Atlantic, with notable focus being placed on the sourcing of lithic materials and the production of bifacial tools, such as the well-known lanceolate fluted Clovis point. The quest for evidence of an American Paleolithic in the East dates back to the 1850s, as excavations in Europe spurred a hunt on the part of American scientists for artifacts of similar antiquity in America (Meltzer, 2015). However, artifacts did not present themselves as readily as they did in European caves and rock shelters, forcing scientists to leverage findings of limited credibility. The controversy surrounding these questionable artifacts raged for decades before the quest for a Paleolithic presence in America was written off in the early 20th century (Meltzer, 2015:4). However, in 1927 the find of a fluted point *in situ* with extinct bison bones in Folsom, New Mexico changed that belief and rekindled the study of Paleoindian sites in the United States. Following the find at Folsom, discoveries of fluted points in the Eastern Woodlands began to shed light on the possibility of a separate and distinct group of Late Pleistocene people in North America. Although few and far between, the presence of fluted points in the East spurred analysis of the lithics found at these Eastern sites. By the 1950s several sites had been located which allowed for collective comparative analysis. One early analysis was performed by Witthoft (1952) who examined the collections from Paleoindian sites in North Carolina, Virginia, and Pennsylvania. Through that analysis we begin to see terms of interest to this thesis such as triangular and trapezoidal cross section, "flake knife fragments", and polyhedral core begin to emerge in writings, all of which are indicative of blade technology being present in the East. Witthoft's (1952) study focused on a small site, surface collected in the 1930s on a farm in Eastern Pennsylvania. The Shoop Site as it became known produced 48 fluted points, and a variety of formal tools on flakes. Through his analysis we learn that the flakes and corresponding flake scars begin to paint a unique picture of the methods used at the site to form and reshape tools. Interestingly, he noted a high percentage of long, flat flakes terminating in hinge fractures. He noted that flakes at the site and resharpening scars were more "conspicuous in blade-making and tool shaping" (Witthoft, 1952:474).

The fluted point blanks found at Shoop show a triple channel flake pattern, whereby two longitudinal flakes are taken prior to removal of the central channel flake (Witthoft, 1952, 481).

This is of particular relevance when trying to understand blade technology in the East, as Witthoft explains, “In so preparing the blank for the removal of the central channel flake, the flint knapper was applying core and blade technique to a bifaced tool (Witthoft, 1952, 483).” Witthoft’s analysis of the flakes and tools at Shoop concluded that the chert industry at the site “is a remarkably clear-cut blade industry, of a pattern which is totally new for the Eastern Woodlands and perhaps for the whole United States and Canada” (Witthoft, 1952: 475). He elaborated, “Typical scrapers represent a blade tradition otherwise unknown in the Northeast but very familiar in many Old-World cultures” (Witthoft, 1952:478). Depleted cores found at the site further strengthen this argument, as do pointed prismatic spalls which Witthoft (1952:476) believed were the by-product of “flake knife manufacture.” Witthoft pointed out that cores found at Shoop were so expended that they could no longer produce bladelets. This work led Witthoft to look at the Williamson site in Virginia and the Hardaway site in North Carolina and conclude they were all part of the same complex (Witthoft, 1952:466). “The people who came at Shoop were the carriers of a blade industry which is best illustrated by scraper forms; in America, their blade technique was extended to the basal thinning of projectile points (Witthoft, 1952:493). What is most interesting about this claim by Witthoft is that the flutes on Clovis points are facilitated by an understating of blade technology. “The way of life and the technology of the Shoop site were probably not too different from that of the upper paleolithic of the Old World” (Witthoft, 1952, 494). But like many conclusions in archaeology, this too was quickly challenged by later researchers who did not feel Witthoft’s assessment fit the typology of a true blade and core technology (Krieger 1954; Wilmsen 1970; Cox 1986). Witthoft’s theories have bene neither proven nor disproven despite the controversy, and a definitive answer would be best served by further comparative studies (Cox,1986). Herein lies the issue with blades. The definition of a blade can vary widely as can the interpretation. This shows the need for comparative study and a further pool of research regarding blade technology in the East.

At the time of his analysis in 1952, Witthoft noted that only one Eastern site with a fluted component had been excavated, and even then, it was not stratigraphically isolated from a Late Archaic component. Now, as then, stratigraphy is a key component of temporal understanding. In these early days of looking for Paleoindian sites in the East, Witthoft alluded that other sites with a fluted component may be found in high mountainous country. Today we know this to be true. As summarized by Boyd (2020:34-35), investigations into Paleoindians in Virginia began in the 1930s primarily through fluted point surveys and the earliest Paleoindian artifacts in Virginia come from the Cactus Hill site (44SX202) and have been dated to approximately 15,000 years ago (Boyd 2020). In fact, nowhere in the Americas are the number of Paleoindian sites higher than in Eastern North America (Figure 3), yet few published reports exist, and most documentation is reserved to special publications or hard to find dissertations and master's theses (Gingerich, 2013). One such site of critical importance to this research, which, like Shoop did not achieve more than local notoriety, is the Thunderbird site (44WR11) which is part of the Flint Run Complex. The site lies an hour and a half west of Washington D.C. along the South fork of the Shenandoah River (Figure 4). Fully aware of the importance of Thunderbird, and understanding the publication vacuum surrounding its data, Gingerich noted that the "need for more work within the Thunderbird assemblage has long been apparent, as well as the need to

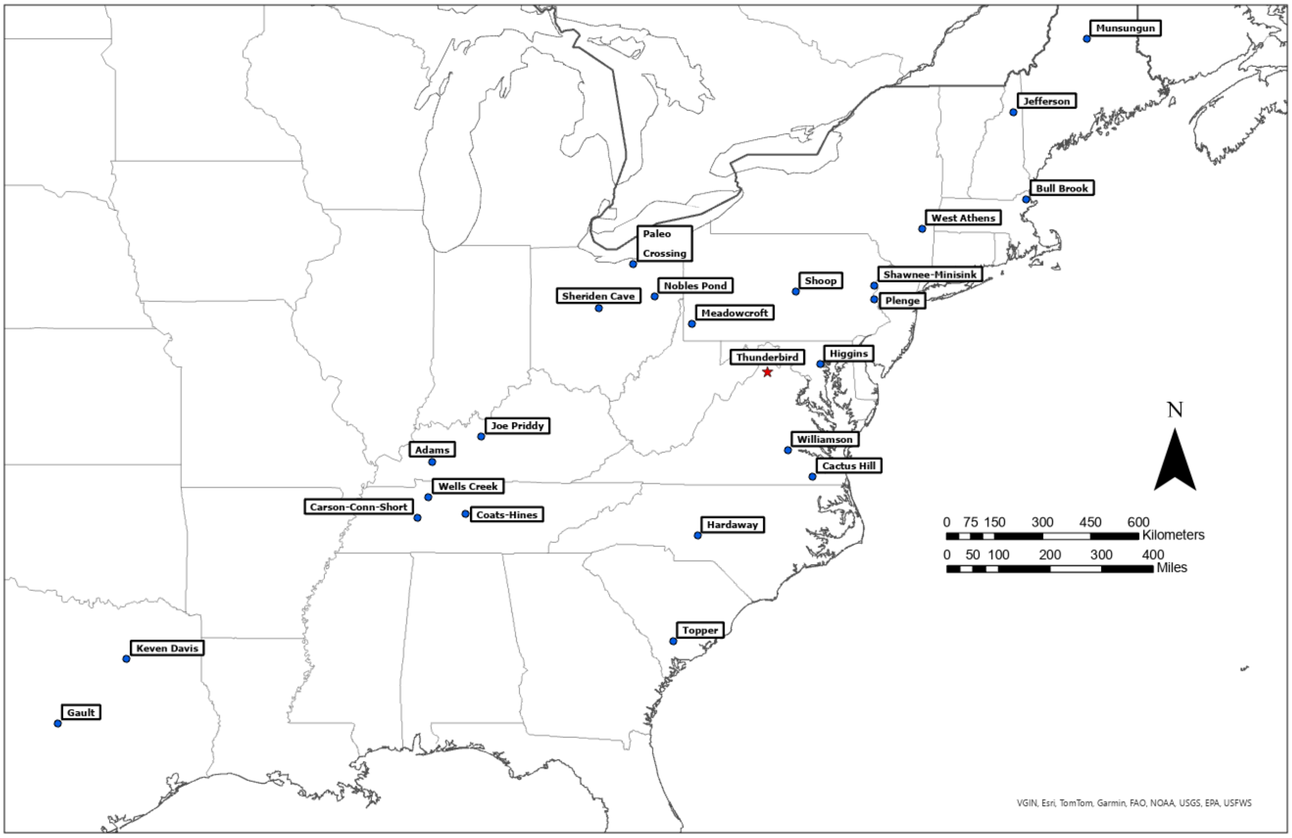

Figure 3. Selected Paleoindian sites in the East mentioned in early and current research. Thunderbird is centrally located between several of these prominent Eastern sites. Map created by author using ArcGIS basemaps.

further refine the models generated from the work at Flint Run" (Gingerich, 2013:3). To Gingerich's point, to date there have been three master's theses (McNamara 1980; Melton 1978; Rubenstein 1980) and one PhD (Verrey 1986) with a focus on Thunderbird (Carr et al. 2013:174). Moreso, Carr et al. (2013) notes that in no documents is there a collective analysis, nor an all-encompassing list of cataloged artifacts. This is not to say the work at Thunderbird was not done well, but rather that it established a sound foundation of knowledge for which to build more refined understating of Paleoindian lifeways.

Figure 4. The Thunderbird site lies approximately 80 miles west of Washington, D.C. It is part of the Flint Run Paleoindian Complex located in the Shenandoah River Valley of the Blue Ridge Mountains. Map created by the author using ArcGIS basemaps.

2.4 A Paleoindian Complex in Virginia

It is not possible to talk about Paleoindians in Virginia without mentioning Dr. William Gardner of The Catholic University of America. As noted by Carr et al. 2013, Gardner and his multidisciplinary team began excavations at Thunderbird in 1971 and continued to conduct research for more than 15 years. Initial investigations at Thunderbird were focused on surface collections, but the realization that there were intact stratified despots drove further investigation. Prior to this work there were no known stratified Paleoindian sites discovered in the East (Carr et al 2012) Gardner's work at the Flint Run Complex in Northern Virginia would become a primary source of understanding Paleoindian occupation in the region (Boyd 2020:35). Gardner used the data from Flint Run to rethink local, regional, and pan-regional Paleoindian lifeways (Carr et al 2012). This was a dynamic time in archaeological theory. Gardner placed an emphasis on cultural ecology and environmental reconstruction resulting in a more detailed understanding of the world in which Paleoindians existed (Carr et al 2012:157). Previous archaeological theories, which I discuss later in greater detail, not only approached archaeology differently, but are likely to be blamed for the absence of documented blades through their stringent adherence to typology and normative views.

There are more than 20 sites within the Flint Run Paleoindian complex, Thunderbird being just one. What makes Thunderbird notable is that it “contains practically all known components of the Flint Run Complex in a sealed stratified context” (Carr et al. 2013:171). As noted by Gardner (1974:2), so diverse were the sites that they represented a full span of pre-contact history covering the Ridge and Valley province. In addition to Paleoindian artifacts within the deepest levels, the site encompasses cultural and natural features such as stockaded villages, hunting and fishing camps, as well as buried flood plains, swamps, and extinct streams from many cultural periods. The amount of foundational research and model building conducted at Thunderbird and the surrounding sites is of great benefit to anyone studying nuanced aspects of early occupations in the Mid-Atlantic region. The area of continuous Paleoindian occupation was estimated at 3,600 by 200 feet. By 1973 excavations at Thunderbird had opened 20 ten-foot squares, a lesser number of 5-foot squares, to a maximum depth of 3.5 feet to the identified living floor. Not only was the site meticulously investigated archaeologically (Gardner, 1974), but the entire region was studied from geologic (Segovia, 1974; Foss, 1974), ecologic, and climatologic (Carbone, 1974) perspectives. As summarized by Carr et al. (2013:156) the Flint Run Complex was defined based on years of work by Gardner at several sites in the northern Shenandoah Valley of Virginia. The complex is primarily comprised of six sites near one another, and in close proximity to sources of cryptocrystalline toolstone (Carr et al. 2013:157).

Thunderbird is only one of two sites in the complex with stratified Paleoindian components (Carr et al., 2013:202). Gardner's work opened the door for the hypothesis that the Paleoindian lifeways were in fact not based on highly mobile big-game hunting as previous models had suggested, but rather extended occupation of sites (Carr et al. 2013:156). Gardner notes that "lithic parsimony and tool kit curation are necessary requisites for any system which insists on maintaining a raw material preference unless that system is virtually sedentary and/or surrounded by large quantities of the preferred material" (Gardner, 1983:51). This means that we should expect to find a wide variety of tools at sites, including those constructed using blade and blade like reduction methods. A wide variety of lithic and non-lithic tools would have been required to accomplish the daily tasks of surviving during the late-Pleistocene. This typical Paleoindian toolkit would have included "scrapers, with or without gravers, wedges, unifacial flakes with varying kinds and degrees of edge modification, expediently and briefly used flakes, and other types of tools which defy description other than crude such as banging, smashing, chopping and hacking tools" Gardner (1994:19) Gardner's (1974) lithic assessment of the site names several tool forms to include fluted, corner notched, and side notched points, prepared unifacial tools, wedge or bifacial tools, utilized flakes, and associated tools to produce those previously noted. He concluded that "all tools were made from either flakes or cores. Deliberately manufactured blades were absent" (Gardner, 1974:5). "Completely lacking in the Shenandoah Valley sites are true blade cores and burins. Flakes conforming to blade length-width ratios do occur but are so rare as to be considered accidental" Gardner (1994:19). A breakdown of artifacts by Carr et al. (2013:193) from the Fifty site (44WR50), also within the Flint Run Complex, shows a generalized tool kit, more than half of which was comprised primarily of utilized and retouched flakes, with just over 1% being classified as projectile points.

Thunderbird was noted for its high quantity of debitage, or waste material, and a low percentage of expended tools. Most tools recovered appear to have broken during various stages of manufacture and were therefore discarded. The technology of Paleoindians is especially characterized by a preference for high quality cryptocrystalline tool stone in the manufacture of tools suited for bifacial reduction strategies, repeated rejuvenation and repurposing adapted to settlement mobility (Goodyear 1979; Carr et al. 2012.) These "sources of cryptocrystalline lithics were viewed as an essential organizing principle in settlement patterns within territories that were relatively small to moderate in size. There appears to be evidence that Thunderbird had extended occupation, not the highly mobile characteristics typically placed on Paleoindian sites" (Carr et al 2012). During the Paleoindian occupation at Thunderbird, high quality jasper was the stone of choice, making imported stone remnants scarce on the site (Gardner, 1974). Jasper is a high silica content isocratic material extremely suitable for tool manufacture. So prevalent was jasper that its disappearance in the stratigraphic record serves as a terminus for the abandonment of the Flint Run Complex by Paleoindian people (Gardner, 1974). While jasper was a preferred material by Paleoindians, it was used through later time periods due to its high workability as a high grade toolstone. But the abandonment of Thunderbird likely coincides with a change in climate between 9-8000 BP when a warm and dry period resulted in periodic flooding and seasonal food variation (Gardner 1974). This also causes a reduction in the water table which causes a decrease in surface water making the location less attractive for habitation (Carr et al 2012:165). Climate change in the late Pleistocene and Early Holocene effectively left once resource rich areas "high and dry" (Gardner, 1994:27).

The revisiting of previously excavated sites like Thunderbird, and summary examinations of Paleoindian research, has provided a platform for which to launch focused and pertinent

Paleoindian research in the East. Some notable synthesis of this subject includes Gardner's (1994) overview of Paleoindian research in Virginia. In this research Gardner details the many issues with typology and periods and uses examples of morphologic change and similarities to make the point that periods overlap, regional site contents vary, and above all else our understanding does and should change as new information is presented. Gingerich's (2013) summary of Paleoindian research over the past several decades shows the broad and expanding examination of Paleolithic sites in the East. Through this synthesis he develops a holistic picture of studies in the East to expose opportunities for continued research into Paleoindians in Eastern North America. "Crucial to our understanding of the spread of populations and Paleoindian material culture is the recognition and understanding of sites that may represent the earliest occupations in eastern North America" Gingerich 2013:5).

It should also be noted that the type of tools found at sites is essential to deciphering them. Analysis of tool kits, like those at the Fifty site, and Thunderbird do not differentiate or note blades, despite a variety of blades being highlighted by Bradley et al. (2010:10) as integral to Clovis life. Bradley et al. (2010:12) note that blades represent a far more efficient technology when compared to biface manufacture. Despite this, archaeologists have devoted little attention toward Clovis blade technology and have frequently failed to capture the existence of blades in site records and analysis (Bradley et al. 2010:14); Collins (1999; Sain 2012). To counter this trend, this research explicitly examines the Thunderbird site for the presence of blade-like technology to determine if it played a role at that location during the Late Pleistocene.

Chapter 3

3.1 Driving Theories and Models in Paleoindian Research

For more than 50 years researchers have been examining the sites that make up the Flint Run Complex. The predominant guiding theories underlying these investigations have used the processual theories of Lewis Binford as foundations for teasing out cultural, social, and economic behaviors. This approach makes sense as Lewis Binford sought to step beyond the simple classification of artifacts and culture by the cultural-historical archaeological theorists, to fulfill a need for archaeologists to contribute to the understanding of cultures from an anthropological perspective. Binford's systemic approach in the evaluation of artifacts was concerned with all the subsystems within the broader cultural system, as there is a systematic relationship between people and the environment, with culture being the item that brings them together. If this theory remains true, individuals, regardless of location will have similar adaptations to their environment, as well as hindrances (Binford, 1962:218). Based on this idea we should see similarities in technologies, such as blade manufacture at Thunderbird, among groups facing similar circumstances shaped by their immediate environment (Binford, 1962:218).

Recent research has effectively used processual models to test hypothesis related to Paleoindians, namely that of Gardner (Boyd 2020:35). The work of Gardner (1974, 1983, 1994) is a prime example of applying the processual theoretical framework of Binford in formulating a model for the Paleoindian settlement patterns in the Mid-Atlantic region. As noted by Carr et al. (2013:156), Gardner's work established a new settlement pattern model in the region. In this Gardner (1974, 1983) identifies six site types. These are quarry, reduction stations, base camp maintenance stations, hunting sites, and isolated fluted point finds. Under the processual theory these sites are part of a system. The types of lithic artifacts found vary depending on the site type and provided the evidence necessary to deduce what type of site the artifacts are related to. Gardner also created the model of "lithic determinism" which he used to explain Paleoindian settlement patterns (Boyd, 2020:35). This model states that given their preference for high quality toolstone, groups would center settlements around quarries capable of providing this material, while smaller camps for other purposes, hunting, foraging, etc., would be established at distance from the main camp. In this context the lithic source determines the central location of the basecamp, versus a group that ranges to collect resources. The concept of lithic determinism is key to the evaluation of the role of blades in this thesis.

As researchers continue to refine conclusions on the influence of environmental factors, we can better explain the behavior of Paleoindians, among others. A unique aspect of behavior is the output of artifacts. To further refine the applicability of individual artifacts to the larger cultural system, Binford pointed out that in the sea of thousands of artifacts, we must have the wherewithal to be able to identify those of relevance to the social, technological, and ideological sub-systems of the total cultural system. At Thunderbird, where tens of thousands of artifacts were recovered, this rings true. Similarly, we cannot look at differences between these items for an explanation of material culture, as items alone cannot expose intangible social constructs. Gardner (1994:33) believed "that sites like Thunderbird or Williamson served a social as well as a technological function." Binford adds, these artifact assemblages must be paired with their contextual elements to create a picture of the extinct cultural system in its totality (Binford 1962:219). He suggests culture be "viewed as a system composed of subsystem, and it is suggested that differences and similarities between different classes of archaeological remains reflect different subsystems and hence may be expected to vary independently of each other in the normal operation of the system" (Binford,1965:203). Binford noted that those archaeologists using normative methods are essentially acting as cultural-historians or paleo-psychologists, or merely typologists, neither of which they are trained to perform (Binford, 1965:204). But while Binford criticized normative processes, his quest for systemic understanding has received equal criticism, for its dry application of analysis through the lens of arbitrary conditions (Schmidt and Kehoe 2019: 21-22). As a refinement to Binford's systemic processes Schmidt and Kehoe (2019) stress that there is a human element focused on knowledge transmission that has long been ignored by anthropologists brought up under scientific methods laced with colonialism.

Schmidt and Kehoe (2019: 21-22) discuss the benefits of ethnographic interaction saying, "archaeologists and archaeology as a discipline benefit from an interchange with local and descendant communities through which their deep experience and historical knowledge broaden our base for inference to the best explanations" (Schmidt and Kehoe, 2019:2). Despite the criticisms, Binford's Processual approach tops the creation of multiple avenues in Paleoindian research, with a focus on cultural systems, rather than technologies. Having the theoretical foundation to look at sites as more than collections of artifacts in a cultural timeline has changed how these Paleoindian sites are treated and examined. But while processual theory satisfies some requirements, the cognitive theory that developed in the post-processual movement also has notable applications to the analysis of past cultures and gets at the issue Schmidt and Kehoe (2019) point out regarding Binford's reluctance to get into the mind of those he was studying. Abramiuk (2012) notes that all humans interpret the world around them, and archaeologists are doing the same type of interpretive process when examining the archaeological record, rather than using an agreed upon set of standards or methodology. Abramiuk adds that cognitive-processual archaeologists argue that even if numerous interpretations do carry seeds of truth, such as that found in normative and processual theories, method rooted in comparison and generalization is still needed to help determine the more truthful interpretations (Abramiuk 2012:14). “Cognitive archaeology should accommodate not only archaeological data, but any form of accessible data in pursuit of understanding the mind in the past” (Abramiuk 2012). Cognitive archaeology does not consist of a single approach, rather it is a discipline using multiple approaches. (Currie and Killin 2019, 263-279) note that human cognition and things are intimately linked and that much can be gleaned about mental and cultural lives from material objects. Relative to this thesis’s focus on lithic technologies, Currie and Kiln (2019:268) note that knapping, the process of manipulating stone for tool production, takes significant cognitive ability. Aspects include forward planning, capacity, good working memory, focus and impulse control, impressive manual dexterity, and task specialization. Sellet (1993, 106-112) elaborates on this idea of tasks by stressing that blade manufacture is a process, not an accident. And while there may be accidental blade-like flakes, the intentional creation of true blades as a specific technology requires a process.

This process, or *chaine opératoire*, has long been highlighted by researchers as a means of understanding the blade production process (Collins 1999, Sorensen 2006). This highly cognitive approach to lithic analysis and study looks at knapping as “a succession of mental operations and technical gestures, in order to satisfy a need (immediate or not), according to a preexisting project” (Sellet 1993:106). With very similar outcomes to processual methods, *chaine opératoire* originated in ethnology, the other in processual archaeology (Sellet 1993:107). *Chaine opératoire* addresses five subsystems. Raw material procurement, reductions sequences, use, maintenance and discard (Sellet 1993:108-110), all of which are highly relevant when conducting lithic analysis or experimental processes. This is because not only are diagnostics important, but perhaps more so are the distinct byproducts of their creation. "The *chaine opératoire* also integrates a conceptual level and, thus, cannot be understood without reference to the technical knowledge of a group" (Sellet 1993: 106). While both the systemic and cognitive approaches provide insight into behavior, the advent of computer aided spatial analysis has added a new level of refinement to models supporting Paleoindian studies.

The space between spaces and the interplay of artifact positioning has been a key part of archaeological analysis for decades. Today, models of spatial analysis are taking previous systemic models, like those of Binford, and applying computer aided statistical analysis to create nuanced pictures of human behavior. Studies which once focused on site structure are now able to delve deeper into the behaviors likely to have created features at those sites. As noted by Clark (2022:8), behavior cannot always be explained by the "configuration of space". Of relevance to this study, Clark (2022) points out how the location of formal tools is no longer the focus, but rather the distributional patterns of artifact types, which when examined together and for their distinct attributes can have more meaningful outcomes for understanding how a site was used. At the Topper site (38AL23) in South Carolina, we see the implementation of spatial analysis as a modified model for behavioral study. Like Thunderbird, Topper is a stratified Clovis occupation with natural variations from terrace, hillside escarpments, and uplands. Smallwood et al (2023) apply spatial analysis to compare the distribution and variation of artifact types across the zones of the site to explore intrasite variation. Similarly, Gingerich (2022) reexamined the Shawnee-Minisink site (36MR43) in Pennsylvania, which represents another undisturbed and stratified Clovis occupation. The spatial examination of artifact mass, raw material types, artifact density and refitting distances has the potential to increase our understating mobile forages as well as sedentary groups at similar sites worldwide (Gingerich 2022). Studies like these demonstrate how models have evolved to account for intrasite variation and the spatial position of artifacts and what it can tell us about past human behavior.

The process of examining and interpreting artifacts share similarities to the periods in which analyses were conducted. When normative archaeologists examined blades, the confines of statistical analysis and typology created a clear picture of what blades were. Processual processes made blades part of system but did little to refine what encompassed blades. Now that we have reached a period encompassing many theories and models the definition of blades is beginning to expand to include valuable statistics, systemic processes, as well as environmental and cognitive influences on their creation and use. Like the blades of the Old World or Mesoamerica, Clovis blades have their own vein of research, and while widely varying at times, the role of blades in the Paleoindian toolkit is increasingly being examined next to some of the more prominent tool forms of the time.

3.2 Defining Blades

While the principle diagnostic artifact for Clovis classification is the lanceolate, fluted Clovis point, other objects are also synonymous with Clovis culture such as ivory points, large prismatic blades, and polyhedral blade cores (Collins, 1999:35). Endscrapers have also been diagnostic of Clovis in Pennsylvania (Whitthoft 1952; McNett, McMillan and Marshall 1977). Blades are a well-known technology, especially in Old World contexts, and have received their own level of examination concurrent with more widely recognized biface and fluted point technology. In Collins (1999) we see a concerted effort to examine the specific characteristics of Clovis blades and blade like flakes, not to confine them, but to statistically examine them for variation. But a huge hurdle exists on how to define blades. There has been little agreement among archaeologists on how to define blades, and a wide variation of definitions of what makes a blade a blade. Several definitions have been proposed over the decades, notably that of Bordes (1961) as cited by Collins (1999) which defines blades simply as “any detached piece that is twice as long as it is wide” (Collins 1999). But there are also “true blades” which Bordes 1967; Bordes and Crabtree 1967, as cited by Collins (1999), elaborate as involving technique of production, not just length to width ratio. By refining definitions based on technique it has constricted what can be interpreted as a true blade and subjected all but the clearest of examples to classification as elongated flakes produced by chance (Collins, 1999). We see a clear demarcation between true blades and flakes by Crabtree (1982:16), who defined blades as:

> Specialized flake with parallel or sub-parallel lateral edges; the length is equal to, or more than, twice the width. Cross sections are plano convex, triangulate, subtriangulate, rectangular, trapezoidal. Some have more than two crests or ridges. Associated with prepared cone and blade technique; not a random flake.

In comparison, Crabtree (1982:36) defines flakes as:

> Any piece of stone removed from a larger mass by the application force, either intentional, accidentally, or by nature. A portion of isotropic material having a platform and bulb of force at the proximal end. The flake may be of any size or dimension, depending on which technique was used for detachment.

The definitions of blades have been more of a hindrance than a help, possibly eliminating blades from site catalogs for decades. To this point, Collins (1999) noted that the reporting of blades from Clovis contexts has likely been inadequate.

Regarding the more objective positivist classifications of lithics that have occurred over the decades, Sorensen (2006:280) notes that “nothing seems more subjective than to force lithic assemblages into some subjective chosen metrical categories. The lithic analyst misses the opportunity to recognize different technologies, to specify blade concepts and cultural groups or to interpret social interactions through technology." Sorensen (2006) proposes rethinking the definition of lithic blades, from the perspective of technological use variation. Sorenson (2006: 278) notes that blades are often classified as distinct groups situated between tools and waste in the traditional artifact hierarchy. In his Old World research, he examined Paleolithic and Mesolithic blades and found that items once classified as waste were in fact blades. For this reason the examination of new sites for blades and revisiting previously excavated sites for the presence of blade technology is relevant and warranted, especially on sites where heavy collecting is believed to have stripped the surface of easily identifiable Clovis points. A growing focus on blade manufacture, relationships to source material, and regional variation is evident in research focused on the Southeast (Boulderain and Hoffman 2009, Bradley et al. 2010, Collins 1999, Eren and Redmond 2011, Goodyear, 2006, Gramly 2013, Hagg and Jones 2022, Hagg et al. 2014, Sain and Goodyear 2016, Sain 2016: 2012, Tune et al. 2022). Sain & Goodyear note that "continued efforts to systematically assemble and share data on Paleoindian artifacts have generated new insight into patterns of land use, demographic trends, and raw material utilization for the Paleoindian period" (Sain & Goodyear, 2016: 128). Case in point is the experimental work related specifically to blade technology by Sorensen (2006) on Maglemosian blade technology in the Old World, whereby he postulates broader definitions of blades, thereby removing some of the confining typological standards and methodology. Sorensen's examination is very much a culmination of decades of theory building and refinement, with data collection elements of normative, systemic constructs of processual, and cognitive examinations of process. In his experimental research Sorensen identifies not one type of blade, but four traditions or groups (Sorensen, 2006:287). Typology aside, each has its own set of distinct replicable traits that facilitate dating of blades, type of cores, and tools used. From this Sorensen presents a new definition of blades:

> "A blade is a serially produced removal made with the intention of being a tool or preform for a tool. Blades in the same industry are produced by the same technique, method and mental representations and are characterized by a similar morphology and that same set of diagnostic attributes" (Sorensen, 2006:289)

From a behavioral standpoint this makes sense as all outputs are a result of behavior, and there are countless variations that shape behavior - environmental factors being key. On those grounds blades should also be variable. Sorenson (2006) goes on to outline two benefits of this defining approach; focus can be placed on prehistoric human behavior, and archaeology's traditional ways of approaching culture can give way to examining behavior though traditions defined by technological applications of the time.

When we examine blades found at one geographic location through this lens as Sorensen describes it, we can localize behavior by not immediately lumping all artifacts sharing a common typology into the same technocomplex. Clovis blades as described by Collins (1999) are very much defining of a culture, but finding blades with varying morphology in the East does not imply Clovis blade culture was not present. Merely, we see the same culture applying varied technology to meet environmental and situational needs as explained by Sorensen (2006). By examining the artifacts from a technological approach of how they were applied to the immediate environment, we can understand the tools needed and used by a distinct group. These functional attributes define why blades are a key part for the Clovis toolkit. Blades could be produced and easily transported and future use. Blades could be used as created for their incredibly sharp cutting edge or modified to create a wide variety of tools such as scrapers, burins or as preforms for points. Their function as burins is noteworthy as it extends an individual's ability to manipulate features of the surrounding environment to create more complex tools which help them accomplish a particular task. This makes these types of tools essential for complex tasks and demonstrates higher order thinking on the part of the user. This goes well beyond blades being views solely for their sharp edge and immediate use as a cutting implement as it. This variation can speak volumes about the environmental factors affecting a people at a given time. It was Witthoft (1952) who said that a definitive blade technology existed in the East, like that of the Old World, and by the definition of true blade as defined by Collins (1999), this statement was accurate. However, if we remove the confines of typology and look at the function of blades, combined with Witthoft's observations, why would a blade technology by a looser definition not exist at Thunderbird as blades serve the same function regardless of geographic region, and independent from the function of biface technology. The contents of a toolkit are not created to match a predetermined idea of what it should contain. Rather, it contains what is needed to meet the needs and expected tasks to come. And as people change locations those tasks may also change, making the Paleoindian toolkit a constantly evolving system effected by everything from season to geography. We must examine each toolkit in relation to its location and consider tools not only for their presence but also their absence and decipher what that means about the activities being taken at that time and place.

Experimental archaeology has played a vital role in understanding the variability of toolkits in both form and function. Undoubtedly, the creation of lithics through experimental processes by archaeologists, or 13,000 years ago by Paleoindians in Northern Virginia, is a group processes rooted in the sharing of knowledge. Callahan (1979) applied experimental archaeology to investigate lithic variability in the early stages of reduction in the creation of Virginia fluted points. He noted that "experimental replication and techno functional activity are indispensable aids to the lithic analyst in defining variability" (Callahan 1978:172). Callahan believed that there was significant variability in Virginia Clovis fluted points, and that several types can be isolated and defined. If this is the case for points, should we not consider variability when examining the creation of blades? For this reason, variability must be considered when developing and executing methodologies of examination, study, and comparison.

3.3 Blades as a Key Component of Paleoindian lifeways

While blades may not be at the forefront of the broader examination of Paleoindian lifeways, the many detailed excavations at sites across the East have amassed significant data and conclusions about chronology, subsistence, and tools that can support future study in the region. Numerous blade focused studies have been conducted in the past decade such as, (Hagg & Jones, 2022; Hagg et al. 2014; Tune et al. 2022; Sain 2012; Sain and Goodyear 2016), with many old sites being revisited from a new perspective. These types of studies are beginning to create a clearer picture, and more importantly a new dataset, specifically related to Paleoindian blade technology in the East. Blades have been noted in Clovis contexts throughout the East. "Most sites are quarry-related reduction or temporary camp locales, where lithic extraction and tool manufacture were significant activities. Assemblages are dominated by locally available raw material, as sites are generally located adjacent to or near river drainages" (Sain 2012).

These studies also highlight effective methodologies for conducting these types of blade centric research projects. Many site collections are housed at the Smithsonian, where these legacy collections are providing valuable datasets decades after the fieldwork that produced them. In many cases these legacy collections contain larger samples, which help place in context the limited data collected in more recent excavations (Joyce, 2022:28). This also affords researchers an opportunity for intensive analysis while addressing the ethical considerations of excavations and the challenges of creating and housing new collections (Joyce, 2020). Significant excavations at the Flint Run Complex ended in the 1980s, but the value contained in their well-documented collections is immeasurable. Considering the availability of data, and the challenges of new excavations, this thesis is tapping into the legacy collections housed at the Smithsonian while building upon decades of thoughtful modeling and research methodologies from many schools of thought.

Chapter 4

4.1 Research Methods and Methodology

By its nature lithic analysis is both a quantitative and qualitative process dedicated to the examination of artifacts, not the behavior that created them, as Binford (1989:3) noted. However, what the study of artifacts allows us to do is infer the actions that caused their creation, i.e., the behavior. In the case of Thunderbird, the goal should be to understand what took place there and why. “If the goal of science is to know something about the past that is dependent upon inference, then one must develop a reliable methodology that permits reliable inferences to the phenomena of interest” (Binford 1989:4). To this point, how others have chosen to define and examine blades provides significant guidance in the methods of lithic analysis. As shown in Chapter 3 there is not only great variability in how lithics are measured, but ongoing disagreement of how to define their attributes. Regardless, it is important that the methods of collection meet the goals of respective research, while remaining cognizant of proven best practices. This research uses some of the most common variables to ensure effective and meaningful data collection and make data comparable to that of previous research. The examination of blades within the Thunderbird collection leans heavily on the attribute analysis methods and variables explored and refined by Collins (1999), Sain (2012), Sain & Goodyear (2016), and Pargeter et al. (2023). The goal of many of these studies was to identify the analytical processes most likely to return consistent results when analyzing blades. Consistency in data is essential to analysis, which can span hundreds or thousands of artifacts from a site, and require comparison to other site collections regionally, nationally or across continents. Two approaches were used to examine artifacts withing the Thunderbird collection for the presence of blades and blade-like flakes. The first was a qualitative assessment requiring a visual inspection based on the experience of the lithic analyst and comparison to blades documented in previous studies. The second method was quantitative and used both common measurements as well as those specific to this study.

4.2 Collection, Location, and Condition

The Thunderbird collection is located at the Smithsonian Museum Support Center (MSC) in Suitland, Maryland and is comprised of thousands of lithics, soil, and other organic samples. The collection is not publicly accessible and is available upon request to those who provide research-based justification. Access to the Thunderbird materials was approved by Torbin Rick, Smithsonian curator for Virginia archaeology collections. The repatriation policy for the Smithsonian National Museum of Natural History is set out in the National Museum of the American Indian Act of 1989, and the Smithsonian Museums are excluded from the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA). Consultation under NAGPRA was not required for access to the collection (James Krakker, personal communication July 26, 2024). Documents related to the site are kept in the Smithsonian Archive separate from the collection. It is estimated that more than 100,000 artifacts were mapped during the 15 years of excavation (R. Verrey, personal communication, as cited by Carr et al. 2013). When the collection was accessioned “a preliminary, but incomplete count of selected artifacts and diagnostic flakes from the Paleoindian and Early Archaic levels were compiled by Smithsonian staff” as shown in Table 1 (Carr et al. 2013:174).

Table 1. Preliminary Counts on Artifacts from the Paleoindian-Early Archaic Levels at Thunderbird (Carr et al. 2013:174).

Artifact	Count
Bifaces	449
Cores	98
Scrapers	120
Hammerstones	79
End thinning flakes	35
Unifacial absence	209
Overshot flakes	35

McNamara (1980) created the most complete rough classification which included artifacts like cores, utilized and unutilized flakes, prepared tools, unprepared tools, and unclassified items for a total of 98,965 artifacts from Areas 1B and 4 as well as 40 features. Evidence of previous examinations was apparent as items were sorted, boxed and or bagged, but there was no obvious indication of why catalogued. Many artifacts were meticulously labeled with unit and artifact number.

Each MSC Unit is comprised of a metal cabinet with a right and left door, and a varying number of drawers on each side (Figure 5). The MRC term "unit" does not relate to the same term used in archaeology to identify and area of excavation. For the purposes of this study MU refers to storage units themselves, while AU refers to archaeological excavation units. The Thunderbird collection fills approximately 18 MUs. Drawers are primarily organized by AU and level, or by feature. Tools were separated from the collection and consolidated into a specific MU. These were grouped by AU, level, or feature. Although organized in this way, analysis of the collection required opening every MU and observing the contents of each drawer as the collection has never been catalogued. Each drawer contains individual trays of roughly classified materials, or those organized to various extents by previous researchers (Figure 6). All artifacts were examined and measured at the MSC with the permission of MSC curation staff. Workspace was provided ajacent to the collections to setup and condust analysis (Figure 7).

Figure 5. Collections storage at the Smithsonian Museum Support Center in Suitland, Maryland. Each two-door cabinet is designated a MU number, unrelated to the term used to describe an AU. The Thunderbird collection filled 18 MUs which is nearly all the cabinets on one side of the lighted hallway. Photograph by the author.

Figure 6. Drawers within MU at the Smithsonian housing artifacts from the Thunderbird collection. Photos by the author.

Figure 7. The author at the Smithsonian archives and associated workspace.

4.3 Artifact Selection

Given that the aim of this study is specific to answering questions about the Clovis period, only those drawers with artifacts from levels 6, 7, and 8 were examined. Previous research found that these levels correspond to the Clovis period, while levels 5 and above are Archaic and later (Carr et al., 2013). During the initial cursory examination of the collection, notes were applied to each drawer to indicate the levels and AUs it contained. Once the appropriate levels were identified, each artifact in those drawers was visually examined for attributes related to blade technology and pulled for closer examination (Figure 8). For this study, this means any lithic with one or more arrises originating at the proximal or distal, and the appearance of flake removal running parallel to the arrises. Arrises refer to the sharp crests on the surface of the stone where two or more flat or curved surfaces meet, or literally in this case where previous flake scars terminate (Figure 9). Flake removal perpendicular to the proximal and distal ends would be indicative of biface manufacture. The notable exception would be in the creation of formal crested blades and potential core preparation blades. For this reason, attention was paid to the direction of flake removal when selecting blade like flakes to analyze further. This was not always obvious. These criteria apply regardless of length, as blades may be represented in a collection as shortened, intentionally snapped, or used segments (Sorensen, 2017). For this reason, many of the blade like flakes examined would likely be classified as debitage and not true blades by most classification systems as they lack the minimum necessary 2:1 length width ratio.

Figure 8. A selection of blade-like flakes pulled from boxes of debitage for further analysis at the Smithsonian archives. Photo by the author.

Figure 9. A single arris on a small blade-like flake originating at the proximal platform and extending to the distal end. Photo courtesy of Mike Johnson.

4.4 Measurement Tools

The following tools were used to collect measurements and imagery of each artifact.

- Sliding caliper 0-80mm
- Digital scale 0.01-200g
- Contour gauge consisting of 145, 1mm blades.
- Digital angle ruler
- iPhone 12
- Photo booth with lights
- Rubber pad – anti slip and impact proception for artifacts
- Foam pad – anti slip and tool storage
- Toothbrush
- Data collection forms
- 1.8X head mounted magnifier

Figure 10. The workspace as setup during the study containing a portable LED lighted photo booth, forms and measurement tools used to capture artifact data. Photo by the author.

4.5 Measurements and Recording

To answer the questions of this study it is necessary to efficiently document both the qualitative and quantitative data captured. Following the methodology of Pargeter (2023), this study segmented data into three classes. Ratio-scale attributes, examples of which include length, width, and weight. These attributes have equal intervals between neighboring points and scale from true zero. Discrete-scale attributes count variables on whole numbers such as arrises or flake scars. And Nominal attributes which are non-numeric such as thermal alteration or intentional surface polishing. By combing these variables artifacts can be effectively isolated by the core attributes related to blade production. This by no means verifies if an artifact is a blade but allows for further segmentation based on the available data during analysis. Blades, however, have both quantitative attributes, such as length-to-width ratio, and qualitative attributes such as the number and orientation of arrises and flake scars, which when combined are telltale signs of an intentional blade technology. If blades were at Thunderbird the combination of qualitative and quantitative data should separate blades from blade like flakes as well as from accidental blade like flakes. All data was captured by hand on a blade attribute form created for this study. The form was organized into four sequential sections: Administrative, Measurements, Blade Overview, and Modification (Appendix 1).

Administrative

Administratively, each artifact was assigned a date of analysis, a unique analysis identification starting with TB-001, the Smithsonian MU, MU side (Left, or Right), Drawer number, artifact location in the drawer (front, middle or back). Any original Thunderbird provenience or recording information either on the artifact or on any associated tags were captured for each artifact.

One thing that must be noted is that several drafts of the blade attribute form were created between May 2023 and March 2024 while the analysis was ongoing. And while each iteration refined the data being collected, it produced an increasingly complex dataset. This means that earlier artifacts have fewer data points than those collected later. However, many of the core attributes were present from the start of the analysis and samples were adjusted accordingly when performing more complex relational calculations later, as will be demonstrated in Chapter 5.

It became apparent during analysis that by taking measurements first, before conducting any visual analysis, the opportunity to study the object was increased. Although analytical examination is considerably more focused, by conducting measurement first it doubles the amount of time the object is held and viewed thereby allowing the analyst greater opportunity during handling to examine the artifact before entering more subjective analytical data such as use-wear or thermal alteration. It remains to be seen if this has an impact on the outcome of analysis, but it is this researcher's opinion that it improved the confidence of analysis. The average processing time per artifact was 15 minutes using this method. Processing time averaged more than 20 minutes when visual analysis was conducted first followed by measurement.

Measurement

Weight was captured in grams. Each segment was classified as whole, medial, distal, Proximal/Medial, Medial Distal, or Unknown. Proximal and distal segment terminus measurements were captured.

As a point of clarification, while researchers have commonly taken proximal, medial, and distal measurements, I was not able to find in my research a term specifically describing the broken span of a blade, from one lateral edge to another. Most blades are broken, leaving a proximal section with a break, a medial section with two breaks, or a distal section with one break. I propose the term proximal terminus, and distal terminus to specifically identify the span from one lateral edge to another. Proximal is commonly used to describe the top portion of a flake, closest to the platform. In this case I am using proximal terminus to indicate the break closest to the proximal end. Likewise, distal terminus refers to the break furthest from the proximal end. Thereby, a proximal segment would only have a distal terminus while a medial segment would have both a proximal and distal terminus. Likewise, a distal segment would have one proximal terminus. The purpose of the terminus measurement is to be able to compare in a dataset those segments with matching distal terminus and proximal terminus measurements for the potential refitting of broken blades. While these measurements have not been proven useful, it is a measurement of opportunity that may pay dividends across a large dataset already undergoing significant measurement (Figure 11). It also removes some ambiguity of the measurement of lower 1/3 measurements which do not specify where the measurement should be taken.

Figure 11. Capturing terminus measurements in the event two broken flakes have matching widths, possibly resulting in a mend.

Blade Overview

The morphology of the Proximal end was classified as hinged, stepped, or snapped. Distal morphology was classified as hinged, stepped, snapped, feathered, or overshot. Maximum dimensions of length, with and thickness were taken with calipers in cm, to the hundredth if needed. Width/Thickness measurements were taken at the Proximal 1/3, Medial 1/3, and Distal 1/3. Platform width and thickness were measured in cm, to the hundredth if needed. Bulb total thickness was measured for total thickness from the distal face to the ventral surface, as well as from the midline to the ventral surface. A contour gauge consisting of 145 1mm blades was used to capture the midline measurement. The contour gauge was applied to the ventral surface and pushed until the untouched blades were parallel to the observed midline, as viewed from the proximal end (Figure 12). A measuring tape or calipers were then used to capture the transferred bulb contour. Platform angles were captured from the medial, ventral, and dorsal positions using a digital angle ruler (Figure 13).

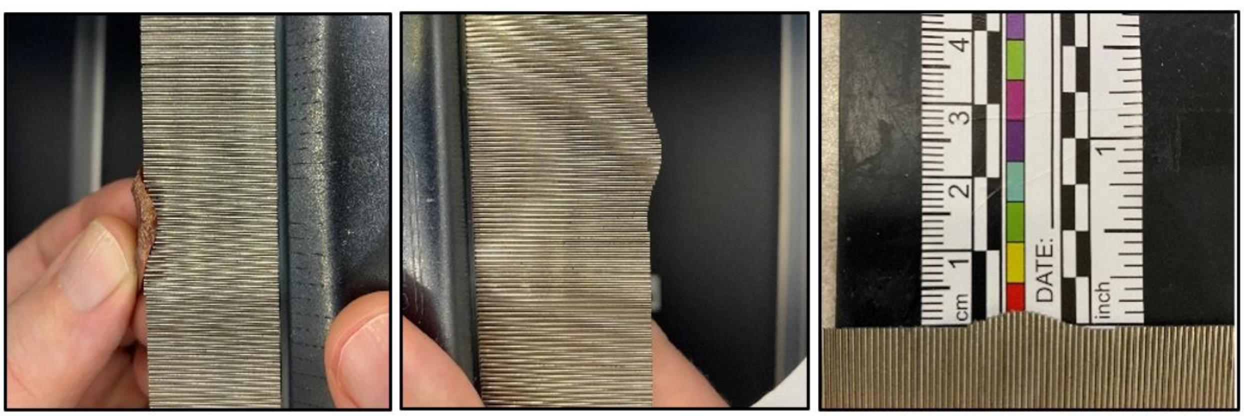

Figure 12. A contour gauge with 1mm blades is used to capture the thickness of the bulb of percussion from the midline of a blade like flake. The resulting contour is transferred to a measuring tape to calculate the total thickness of the bulb from the midline.

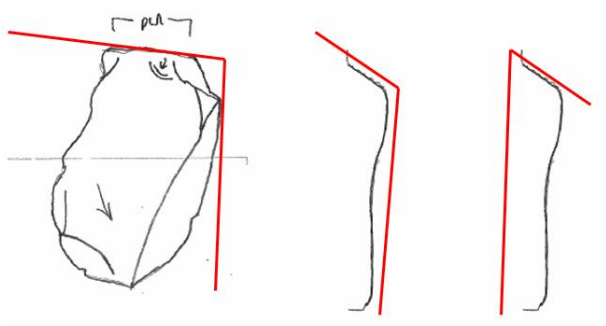

Figure 13. Platform angle measurements were captured from the medial, ventral, and dorsal positions. The most key measurement being dorsal, which indicates the platform as it existed prior to flake removal and following preparation. Illustration by the author.

Diagnostics, if obvious, were noted to include channel flake, core, and blade. Raw material was documented. Heat reddening of the material was noted as: All, Part, Edge, or None. Presumed heat vitrification that did not change color was not noted. Previous detachment attempts were noted as Yes or No. The presence of cortex was noted as Yes or No. The presence of a Dorsal Valley Platform or Dorsal Ridge Platform was captured as Yes or No. Platform impact was documented as any combination of Point, Diffused, Undetermined, or Crushed. Platform preparation was documented as any combination of None, Faceted, Ground, Polished, Lipped, or N/A. Ventral ripples were noted as None, Weak, Moderate, or Strong. The total number of dorsal arrises were estimated, as well as their origin from the proximal, distal, and lateral edges.

Modification

Any combination of Proximal, Distal, or Lateral modification was documented, as was Proximal, Distal, or Lateral edgewear. Pecking and pitting of the dorsal or ventral surfaces was also noted. The artifacts at Thunderbird present a unique opportunity for analysis. Unless they were damaged by trowel excavation, the fact they had not been disturbed since deposition indicates and wear likely occurred between detachment and discard.

4.6 Visual Documentation

Artifacts were traced in pencil to capture their approximate contour, noting location of arisis. Direction of previous dorsal flake removal was noted if discernable. The ventral arc was captured using the contour gauge and transferred to the form by tracing, as was a cross-section contour taken dorsally at a point best representing the dorsal contour (Figure 14). Artifacts were then photographed in a lighted booth using the rear camera of an iPhone 12. Artifacts were placed on a black background, with a cm scale at the distal end. A tag noting the site number, unit number, level and Thunderbird blade study analysis unique identifier, starting with TB and followed by a sequential number, written in dry erase marker (Figure 15). Dorsal, ventral and profile photos were captured.

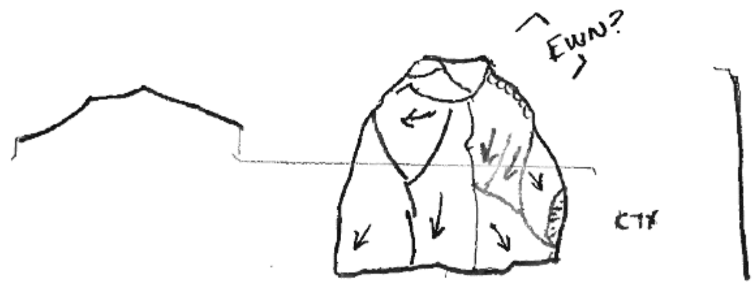

Figure 14. From left to right; dorsal contour showing high center mass; dorsal face with direction of flake scars as well as the presence of edgewear and cortex; low curvature ventral contour.

Figure 15. Example of an artifact with imaging tags. Photos by the author.

Following analysis and documentation, each artifact was individually bagged and labeled with any descriptive codes, such as BLA for blade, its associated TB-#, and examiner initials and date of examination. It was then returned to its location in the collection.

4.7 Cataloging

To process the data after collection a Microsoft Access database, Figure 16, was created by the author matching the fields of the blade attribute form. Each form's data were entered into the database and associated images were attached to each record to create a complete file for each artifact. Blade attribute forms were also scanned as a batch PDF for future reference. The database was an essential tool to organize and digitize the data in preparation for statistical and visual analysis. Ultimately the Thunderbird Blade Study database captured 55 quantitative and qualitative datapoints per artifact and produced a dataset with 18,503 points of data. Inherently the database stores all the datapoints in a table format that can be exported to Excel. Much of this data is raw with the exception of three calculated fields visible as light green in Figure 16. These calculated fields automatically returned the length-to-with and length-to-thickness ratios, which as mentioned in Chapter 3, are defining attributes of blades. Additionally, the number of total arrises was calculated. Once data was available in Excel it was cleaned and organized using pivot tables, which allow for the selection of one or more comparable values. These limited slices of data, such as platform width and platform thickness, can then be used to calculate mean statistics or standard deviation. Given the number of data variables the combinations are daunting, but common ratios identified in previous studies have provided a guiding light of which variables to compare first as part of the analysis. In the next section I discuss the most pertinent variables exported from that dataset.

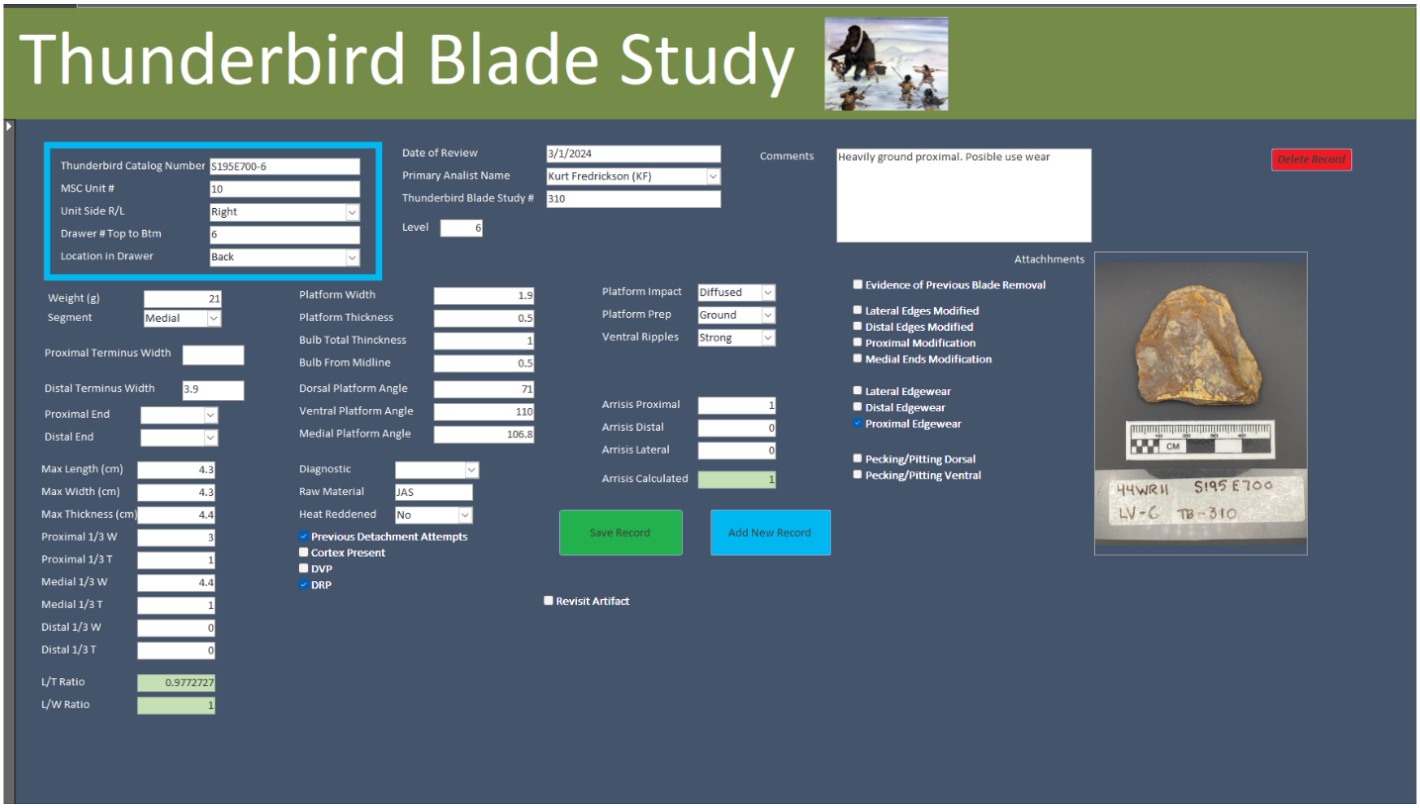

Figure 16. Microsoft Access database data entry form created by the author for the purpose of data entry and cataloging. Each artifact was given its own record locator, enabling the quick search and review of artifacts. All photos of artifacts were attached to each respective record. Screen shot by the author.

Chapter 5

5.1 Results

Examining levels six, seven and eight of the Thunderbird collection for blade-like flakes, blades, and evidence of blade manufacture such as blade cores resulted in confirmation that a blade technology existed at Thunderbird. This study intentionally departs from the typical typological definition of blades, for the reasons discussed in detail in Chapter 3, and instead looks to a more general typology from which blades could be later identified from the dataset. While a best effort was made to locate and measure blade-like flakes, it is possible not every artifact matching the criteria of this study was found within the un-catalogued collection. However, enough data has been recorded from across the collection to support a meaningful analysis. In total 324 artifacts were documented in this study between May 2023 and April 2024 (Table 1). The number represents artifacts identified in levels six, seven, and eight. Although there is a small percentage of exotic materials in the Thunderbird collection, all artifacts documented were jasper, likely sourced from the nearby jasper outcrops or river cobbles.

Table 2. Artifacts Examined and Documented

n=324	Level 6	Level 7	Level 8	Unk	
Blade-like flake	262	45	5	2	**314**
Blade core	6	—	—	—	**6**
Biface core	1	—	—	—	**1**
Hammerstone	1	—	—	—	**1**
Other/Tool	1	1	—	—	**2**
Total	**271**	**46**	**5**	**2**	**324**

A large amount of data was collected for each artifact as explained in Chapter 4. This was done intentionally with the foresight that additional questions may be asked in the future which could benefit from additional data. In retrospect the data necessary to support the identification of a blade technology can be distilled down to a few key quantitative and qualitative attributes. These include, in order of relative importance, artifact wholeness, platform and bulb dimensions, platform angle, ventral ripples, modification and edgewear, and the existence of blade cores and other waste. Flake removal directions and flake scars were also documented for blade-like flakes and blade cores in the form of drawings for future reference.

5.2 Artifact Wholeness

Blade-like flakes were evaluated to determine intactness, and morphology (Table 2). Overall, the vast majority of blade-like flakes were not whole but represented a portion of a flake. As noted by Sorensen (2017:216), blades may be broken systematically for use as segments as part of an intentional technological process. For this reason, the identification of segments was a primary measurement. Two flakes were omitted due to lack of recorded level context during examination and recording thereby reducing the overall sample for analysis to 312.

Table 3 Blade-like flake wholeness levels 6,7, & 8

n=312	Whole	Proximal	Proximal/Medial	Medial	Medial/Distal	Distal	Unk
	71	95	39	44	19	24	20

5.3 Maximum length, Width, and Thickness

Maximum length, width, and thickness were secondary to segment integrity. Proximal, medial, and distal measurements of L/W/T were captured, but due to the irregular surfaces, and judgment of the evaluator on where to take these measurements, 1/3 measurements were irregular and not suitable for definitive analysis. Mean Maximum L/W/T measurements are reflected below for all BLF in levels 6,7, & 8 (Table 3). The ratio of length to width is a crucial factor when analyzing artifacts as blades. As noted in Chapter 3, blades are frequently twice as long as wide, which provides a key indicator for those artifacts that are found intact. Bifacial flakes have dimensions that do not normally fit this ratio.

Table 4 Mean maximum length, width, thickness for all blade-like flakes

n=312	Length (cm)	Width (cm)	Thickness (cm)
Mean	3.57	2.21	0.69
Range	1.0-14.50	0.7-5.5	0.1 -4.4

5.4 Platform and Bulb Dimensions

Platform measurements for width and thickness were recorded on 175 artifacts having identifiable platforms from the subset selected for analysis. Platform size is an indicator of the type of preparation, with Clovis blades typically having small platforms (Collins 1999). Bulb of percussion measurements were taken from 150 artifacts having identifiable bulbs from the subset. The prominence of bulbs can demonstrate the type of material used to strike the stone and the force applied, with smaller bulbs being an indicator of soft billets and indirect percussion typical of blade manufacture. Two measurements were captured on the bulb of percussion as described in Chapter 4.5. These were the total bulb thickness and the thickness from midline.

Table 5 Mean platform width, thickness/Bulb total thickness and thickness from midline

	Width (cm) (n=175)	Thickness (cm) (n=150)
Platform	0.84	0.32
Bulb (total)	—	0.52
Bulb (midline)	—	0.22

5.5 Platform Angle

Dorsal platform angle is a key variable when distinguishing if an artifact is a blade, or a blade-like flake. There are key variables in analysis performed by Sain (2012) when examining artifacts at the Topper site for blades vs blade like flakes. The distinguishing attributes are also present at Thunderbird and are useful for further refining the classification of artifacts. Acute dorsal platforms are indicative of biface technology whereas platforms closer to 90 degrees are common to blade technology. Blade like flake platform angle was captured from the dorsal (*n*=165), ventral (*n*=122), and medial (*n*=98) positions of artifacts from the subset (Table 5). Ventral and medial measurements were added as the analysis process evolved resulting in varied numbers.

Table 6 Mean platform angles in degrees

	Dorsal (n=165)	Ventral (n=122)	Medial (n=98)
Mean Platform Angle	81.13	108.57	93.0

5.6 Ventral Ripples

The presence of ventral ripples is closely related to the prominence of bulbs of percussion and indicates the type of billet used to strike the stone and the intensity of the strike. A smoother ventral surface is indictive of blade technology whereas more pronounced ripples would indicate a bifacial process with a harder hammerstone. Ventral Ripples were evaluated on 286 samples. The degree of rippling was classified as none, weak, moderate, or strong.

Table 7 Ventral ripples

n=286	None	Weak	Moderate	Strong
Ventral Ripples	109	91	45	41

5.7 Modification and Edgewear

Analysis for Lateral, Distal, and Proximal modification and edgewear was conducted on a sample of 312 blade-like flakes from the subset. It is no surprise that one of the last criteria of analysis would produce the least number of samples. Only 30 artifacts met the criteria of blade like flakes that had some degree of edgewear, modification, or a combination of the two. However, preliminary identifications of wear and modification of blade-like flakes in this thesis are subjective and should be reevaluated as other natural processes could create damage similar to modification or edgewear. Each artifact was examined using a 1.8x magnification, and closer analysis with greater magnification may determine the specific activities and materials producing wear during utilization of blade-like flakes at the Thunderbird site.

Table 8 Blade Like Flake Modification and Edgewear

n=312	Lateral Edge	Distal End	Proximal End	Dorsal	Ventral
Modification	10	3	1	—	—
Edgewear	19	3	7	—	—

5.8 Blade Cores and Debitage

The study identified a total of six blade cores of different sizes and types. As a byproduct of blade manufacture cores are an important part of analyzing a blade industry at a site. There are a variety of cores possible when making blades. The conical cores of the Old-World are perhaps the most well-known, with their clear parallel blade scars running around the circumference. But polyhedral, bipolar, and wedge-shaped cores are also possible and should not be overlooked as they still produce functional blades. Well defined conical cores were absent, with the majority being wedge or polyhedral with multidirectional removals. In addition to blade cores, the waste material represents a clear step in the blade production process. A defining waste product is the crested blade which is setup and removed to establish the first ridge on a core for the serialized production of blades. Several crested blades are in the collection, one of which is examined in greater detail in the analysis section. Additionally, early blade production waste may have blade like attributes, but are evident by the presence of cortex or other attributes which indicate stages of blade core reduction. These blade-like flakes may be discarded in favor of cleaner interior material with better form. Double crested blade TB-340 is an example of a later stage blade.

5.9 Proximal and Distal Terminus Mends

As proof of concept, and not directly related to the identification of blades, proximal and distal terminus measurements were taken on blade-like flakes as noted in the methods section. Measurements were captured on 23 artifacts. Despite the small same size this measurement of opportunity produced two matches (Figure 17). Although these blade mends were noticed during examination of the artifacts, the data once entered in Access, exported to Excel, and classified for matching values, returned the same matches. This research demonstrates that across a large dataset the proximal and distal terminus measurement may aid in finding cross mends. TB-334 and TB-335 had a matching proximal and distal terminus of 1.7mm, and TB-294 and TB-295 had a matching proximal and distal terminus of 2.1mm.

Figure 17. Two sets of broken blades that were mended using proximal and distal terminus measurements after being entered into the data collection form. Photos by the author.

5.10 It's All In The Numbers

The data collection process produced more attributes and variables than were beneficial to this study. The more than 18,000 data points collected may seem excessive, but the ability to sort the data into meaningful categories, and isolate key attributes demonstrated that sufficient data existed to analyze the collection for traits inherent to intentional blade production. The key attributes were the platform and bulb dimensions, platform angle, and evidence of modification and use. These few attributes are the most telling when trying to assess the final desired output, whether it be a blade or a bifacial tool. In the next chapter these qualitative and quantitative attributes will be examined and brought together to form lines of evidence supporting the existence of true blade technology at Thunderbird.

Chapter 6

6.1 Analysis

The materials excavated at Thunderbird represent a Clovis age Paleoindian settlement employing a wide range of diagnostic lithic technologies. Of concern to this research is the analysis and opinions regarding blade technology at Thunderbird. In his 1974 preliminary report, Gardner (1974:5) explicitly states that “All tools were either made from flakes or cores.” And that “Deliberately manufactured blades are absent.” This is true when assessing blade technology using the long-standing length to width ratio of 2:1 and Clovis conical cores. However, this “absence” of blades at Thunderbird may be due largely in part to the typological lens, or rather more restrictive typology being used by Gardner at the time. It may also be a cautionary tale in reaching conclusions before fully cataloging and analyzing an assemblage. This was not a point Gardner missed and to this end said, “While rigid terminology is perhaps desirable from certain perspectives, inflexibility has its dangers in a field of investigation as inexact and dependent on inference and intuitive interpretations as archaeology” (Gardner, 1994:5).

It became evident while analyzing the Thunderbird collection that the formal diagnostic tools were a focal point for those researchers. Anything with obvious secondary working, and the potential to have been a tool, had been meticulously mapped, pulled, and consolidated with other similar diagnostic artifacts by Gardner and his team. Fluted points, scrapers, and burins are just some of the overt cultural markers found at the site. The rest was categorized as waste and bagged by AU and layer. The condition of the collection was mixed, with some units having been thoroughly cleaned and each item labeled on the artifact. Yet other artifacts remained caked in dirt and in bags sorted by unit. This made analysis at times slow and challenging. For researchers looking for anything less than an obviously worked or worn tool, this is a problem. As noted by Sorensen (2006: 278), "Blades are often not secondarily worked or retouched and were traditionally believed not to be tools. Neither can they be described as waste." Therein lies the problem with blades, which may or may not fit a true blade model. Sorensen (2006:280) clarifies this issue when he explains how "through the use of one metrical blade definition and the selection of only some aspects of the blade production sequence, the lithic analyst misses the opportunity to recognize different technologies, to specify blade concepts and culture/groups or to interpret social interactions through technology" (Sorensen 2006:280).

One crucial fact remains constant during the process of identifying blades, which all researchers must consider. A blade without demonstrated intent could very well be the accidental product of chance. To this point Gardner (1994:19) noted of Thunderbird, "Flakes conforming to blade length-width ratios do occur but are so rare as to be considered accidental." It is not unheard of to create blade-like flakes during biface manufacture resulting in similar measurements to blades. Multiple lines of evidence must converge for an analyst to make a sound determination to rule out chance. Fortunately, "intentional and systematic production of true blades will leave a distinctive archaeological record composed of blades, blade cores, exhausted blade cores, and an array of characteristic debris from the reduction and maintenance of blade cores" (Collins 1999:10). It is with this mindset that this study examined the artifacts of Thunderbird in search of multiple lines of evidence to remove ambiguity to the question of blades at the site. However, it is also possible, from a functional standpoint that blades can occur away from their place of manufacture and source quarry. A blade found at a non-manufacturing site might be due to its need to be there for intended reasons. And while measurements are important, context is also critical. Does the evidence within the Thunderbird collection point to an Ice-Age peoples knowledge and skill to intentionally produce blades alongside bifacial tools at the site, demonstrating the need for a varied toolkit suitable for the processing of locally sourced foodstuffs and natural materials?

6.4 Attribute Analysis

Studies have focused on understanding the quantitative measurements noted in Chapter 5, notably bulb prominence, platform angle, and length and width ratios in relation to blades (Boldurian and Hoffman 2009, Pelegrin 2006, Sollberger 1976, Sorensen 2006,). And while this research project made no attempt to conduct a detailed analysis of the quantitative attributes as done in previous research, by referring to attributes refined in previous research, the data collected can indicate the method of manufacture and desired output. The combination of attributes gives meaning to the artifacts as observed. And while one artifact may be missing an attribute due to incompleteness, by looking at parallel variables its relationship to a blade technology can still be assessed. Finding whole artifacts is an ideal means of identification, but this is rarely the case. Only 71 artifacts in the selected assemblage were classified as whole, with the remainder being incomplete segments. When examining the wholeness data, 83 of the 312 blade-like flakes analyzed had at least one termination classified as snapped. This is noteworthy as studies have shown that the intentional breaking of blades is a genuine prehistoric practice (Sorensen 2017), much like snap-blade knives used today (Figure 17). He observed this though a refitting study of Mesolithic blade segments and noted how snapping produced an ideal sharp corner on prismatic blades for uses as a burin (Sorensen 2017:216). Without the mending of multiple segments of utilized blades, as in the previously noted example, it is difficult to confirm intentional snapping. However, failed blade removal results in other types of breaks such as hinged or stepped terminations. This means that even the smallest segment of a blade can have analytical value and length to width ratio should not be used to invalidate a segment as a blade as has been done in the past. Medial segments with use-wear, as shown in Figure 17 are particularly noteworthy and worthy of deeper analysis.

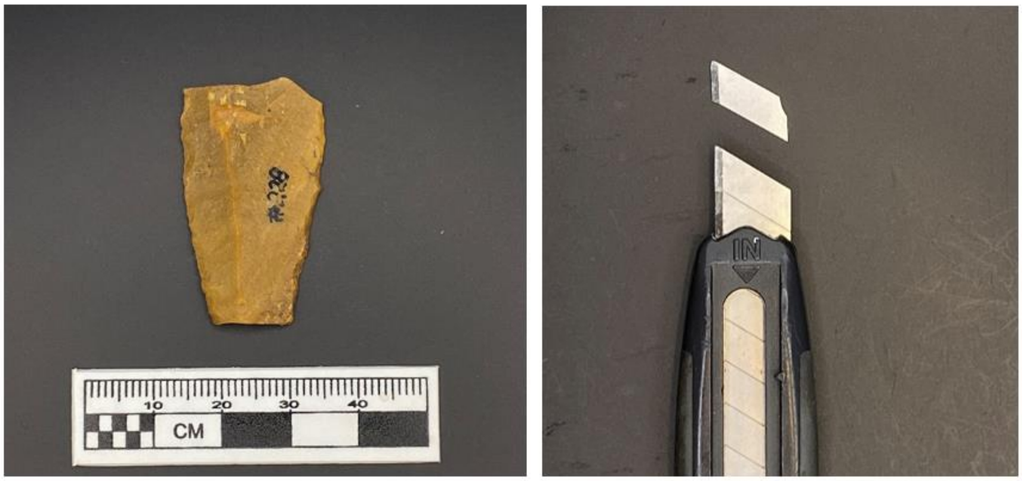

Figure 18. Left, a medial section of a blade with modification and use-wear, snapped at the proximal and distal ends, compared to a modern snap-blade utility knife. Photos by the author.

The attributes related to platform size and angle, bulb dimentions, and ventral ripples all relate to the control and application of physical force to remove the desired flakes. Platforms on the blade-like flakes analyzed return a mean platfrom width of 0.84cm. This type of small platform is characteristic of Clovis blade technology as noted by Collins(1999). Additionally the dorsal platform angles when analysed returned a mean of 81.13 with a range of 115 to 42. Refer back to Figure 11 for the method of angle measurmeent.

To understand blades, one must also have a basic understaing of biface reduction and the debitage that come from that process. Bifacial tool production, which occurs in progressive stages, has a mean stage 2 dorsal platform angle of 60.8, a mean stage 3 angle of 50.2, and a mean stage 4 angle of 40.6 (Callahan 1979:32-33). Not only do angles become more acute as a biface is reduced, they move further from the mean angle inherant to blade production, which

Sorenson (2006: 291) noted as between 70 and 90 degrees depending on the desired blade and method of manufactire. As shown in Figure 19, the majority of the 165 blade-likle flakes examined in this study with platfoms have an angle between 70 and 90 degrees, well outside the range of flakes produced during bifacial reduction. The graph shows the angle in relation to the distal face. When plotted it becomes aparenmt that a large number of the blade like flakes analyzed are within the range for blade production. In an alternate representation, Figure 20 shows that the mean angle of blade-like flakes analyzed was 81.13 degrees, concurent with blade manufacture.

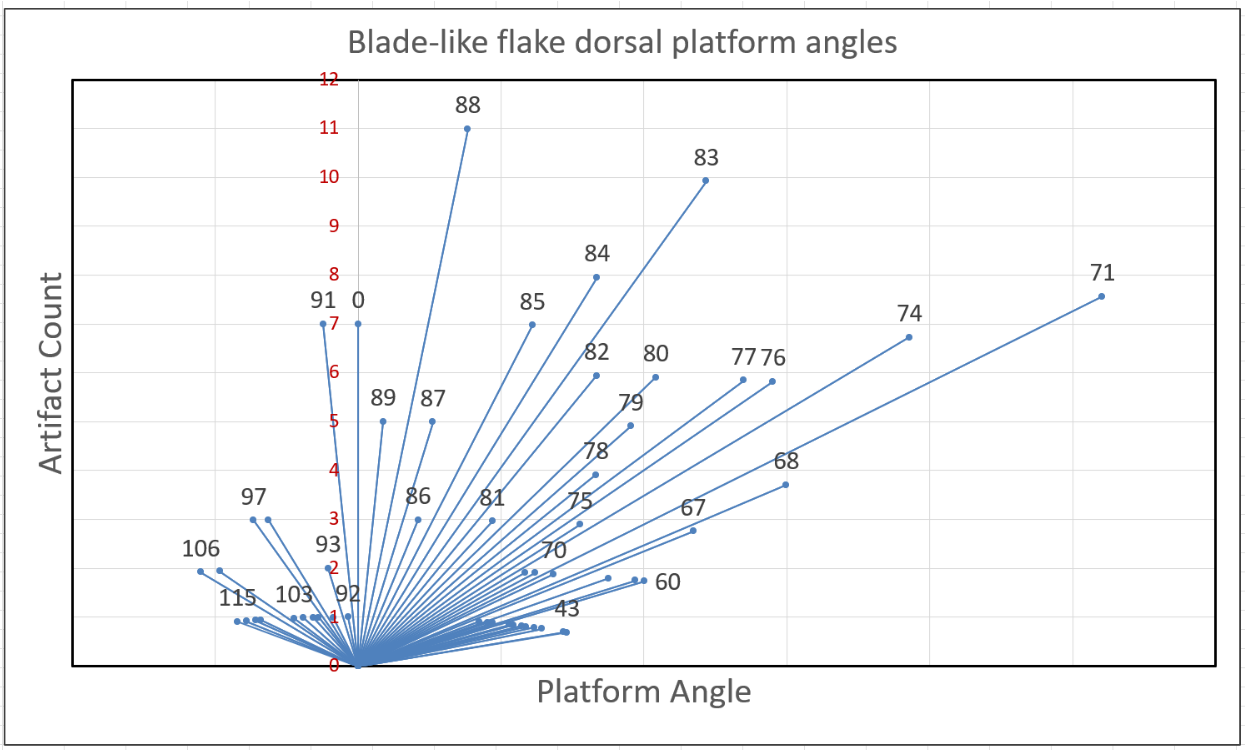

Figure 19. The X axis in this graph represents the dorsal face of the flake. Y indicates the angle of the platform face in relation to the dorsal face. The 165 dorsal platform angles represented in the study reflect a mean between 70 and 90 degrees. Very acute angles and obtuse angles were very few as they are outside the range typical of blades. It is possible that acute angles on the low end represent biface thinning flakes with blade like attributes which could result from parallel flaked bifaces.

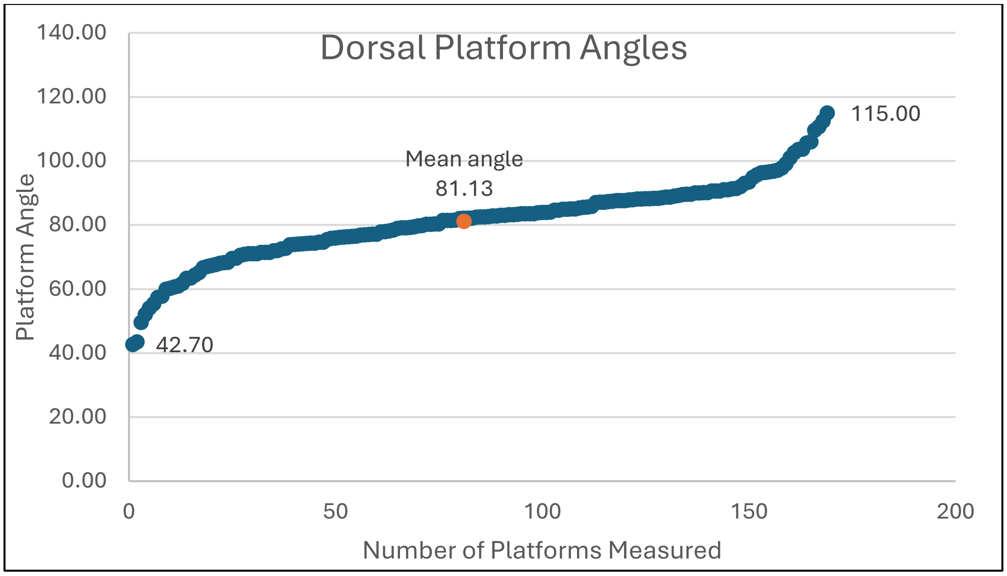

Figure 20. The dorsal platform angle of the 165 blade-like flakes examined resulted in a range of 42.70 to 115 degrees, with the mean being 81.13 degrees. The optimal blade platform is between 70 and 90 degrees. There are outliers which could be related to biface manufacture which have more acute angles.

Directly corresponding to the platforms is the bulb of percussion. Because the intent for a blade is to have it be long with a maximized cutting edge, the force applied is not severe. A hard hammer stone used with a high level of force will produce a pronounced bulb. A low bulb is more characteristic of carefully created platforms and percussion to extend the length of the blade. Of the 150 bulbs measured from the midline, 99 were under 0.02 cm (Figure 21). These low bulbs indicate a technical approach to maximize blade length and may be performed by soft hammerstone or indirect percussion, as experimentally demonstrated by Sorensen (2006).

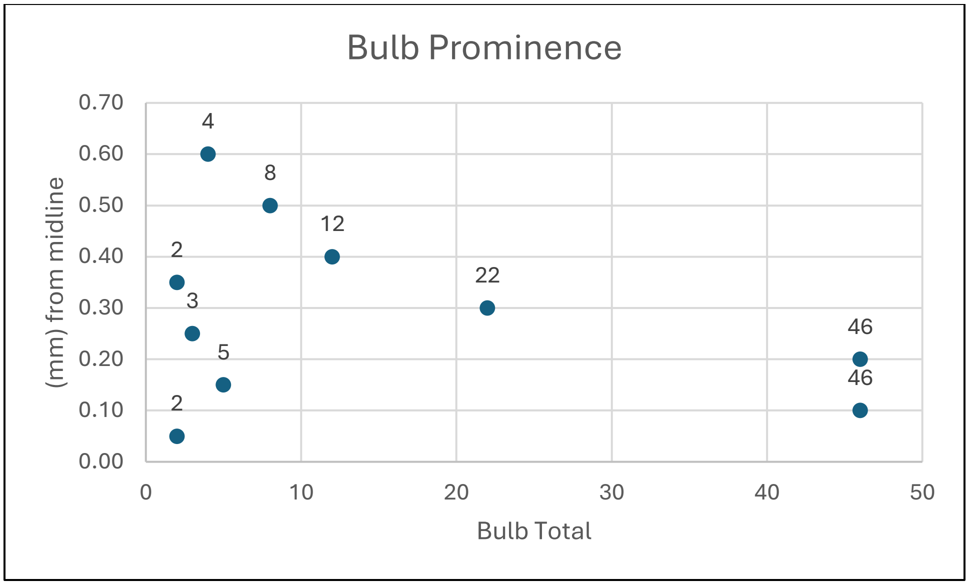

Figure 21. Most bulbs in this study fall under 0.02 cm indicating controlled removal and dispersion of energy laterally through the stone.

From the quantitative data collected we can conclude that it is likely that platforms and platform angles were set up for the removal of low-curvature and laterally-extended blades. This indicates intentional, as opposed to inadvertent, removal of blades for specific applications in use. The shallow bulbs are also representative of controlled dispersion of energy. This also results in less prominent ventral ripples. 200 of 286 ventral surfaces have ripples that were weak or nonexistent. The quantitative data collected indicates that blade-like flakes analyzed match dimensions noted by previous studies and lean heavily toward the presence of intentional blade production.

6.2 True Blades at Thunderbird

If it walks like a duck, quacks like a duck, and swims like a duck, it must be a duck. But having stressed the bias inherent in measurements and typology throughout this paper I exert caution especially when certainty seems apparent. The double-crested blade catalogued as TB-

340 located in level 6 of Feature 68 would seem to end any debate regarding the presence of true blade technology at Thunderbird (Figure 22). After all, true blade technology encompasses the skill, technique, material, activities, and tools involved in the intentional creation of true blades (Collins 1999). It is also “one directed toward the continuous and repetitive production of blades, and not opportunistic or casual production of elongated debitage” (Carr et al. 2010:97).

With a length-to-width ratio of 3.17 to 1, a maximum length of 7.3cm, and a platform width and thickness of 1cm and .2cm respectively, the dimensions dictate TB-340 is a true blade. Additionally, the double crested nature of the blade meets the requirement of demonstrated previous blade removals (Figure 23). It would be easy to say this is a true blade, which directly contradicts previous assessments of true blade technology at the site. However, being conscious of bias, one blade regardless of its defining features is not sufficient to challenge this assessment, and I must assume this was a beautiful mistake until proven otherwise. But this was not the only example. There were several clear examples of blades identified based on their measurements as well as characteristic supporting materials, listed as crucial by Collins (1999), and Sain (2012), prior to making claims about the existence of an intentional blade technology in use.

TB-340

Figure 22. TB-340, a double crested blade form level 6 of Feature 68. Previously mended from four segments. Photo by the author.

Figure 23. Double crested blade recovered from Feature 68, proximal end up, dorsal face, left, ventral face, middle, profile, right. Flake scars on the surface inciate previous blade removal. Photos and line drawing by the author.

TB-318

In contrast to TB-340 , artifact TB-318 is an example of a large Clovis blade, similar to one hilighted by Collins (1999:62). Despite its large size, this blade has all the attributes of Clovis blade, notably its small, carefuly prepared platform. Clovis blades have been noted for their small platforms and curved surfaces, robust cross sections, a length in excess of 10cm and length to width rations alsmot always exceeding 3 to 1, often exceding 4 to 1 (Bradley, etal. 2010). In this case, TB-318 has a maximum length of 14.5cm, this blade has an intact platform of only 0.9cm. The small lipped platform is visible in the middle image of Figure 23 and on the coresponding illustration. Its length to width ratio is 2.63 to 1, and it has a robust prismatic cross section.

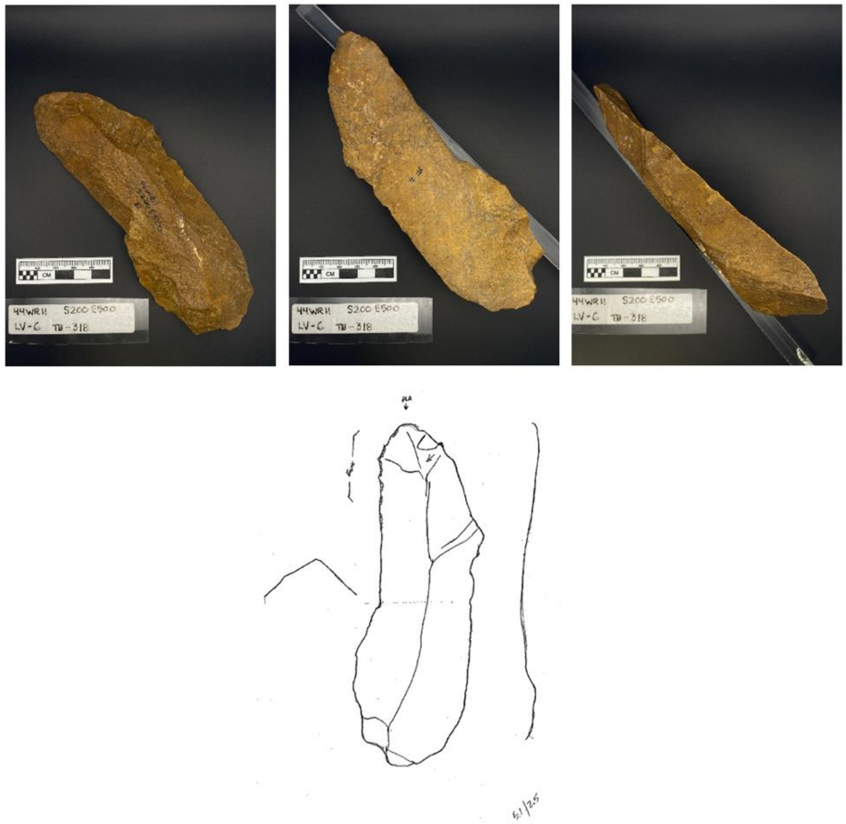

Figure 24. A large blade from Thunderbird with traits consistent with Clovis blade technology.

6.3 Macro Blades

Using a rigid application of blade definitions by modern archaeologists a wide variety of macro blades and micro blades were identified through this study. Macro blades may be defined as those blades between 5-15cm in length, while micro blades are less than 5cm, ambiguity to these definitions and sizes still exist (Collins, 1999:10). However, defining blades by length can be misleading. Long macro blades snapped into short segments for use are no longer macro blades. Of the 312 blade-like flakes analyzed many could be classified as macro blades, but an equal if not greater number would fall into the micro blade category by the fact they have been snapped or terminated in other ways. Macro blades are robust and prismatic which adds to their durability and utility. They are not thinning flakes from biface manufacture. Artifacts TB-231,

Figure 25, and TB-206, Figure 26, and TB-209, Figure 27, are examples of prismatic blades with evidence of parallel removal. TB-206 in Figure 27 shows curvature and mass of a macro blade. TB-209 shows not only curvature and blade like attributes, but we see the intentional modification of the blade into a tool. Something that will be addressed later.

TB-231

Figure 25. Prismatic macro and corner blade TB-231 has a length of 5.6cm. Photo courtesy of Mike Johnson

TB-206

Figure 26. TB-206 shows curvature and mass of a macro blade with evidence of prior blade removal.

TB-209

Figure 27. Macro blade TB-209 with modification and edge wear. Photo courtesy of Mike Johnson.

6.5 Crested Blades

It is fine to find lithics that have the appearance of blades, but as Collins (1999) noted, a blade alone is insufficient to demonstrate that a blade technology was consciously executed at a site or that the people had the inherent skill to produce blades. To prove this, we must have evidence of the byproducts of blade manufacture, those being blade core preparation waste, blade cores or depleted blade cores, and core maintenance flakes. The identification of several crested blades within the collection changes the picture of blades at Thunderbird significantly and meets the criteria required by Collins (1999) to establish the presence of a blade technology. A characteristic type of debris from blade manufacture is the crested blade. "If a core lacks any suitable natural face for the removal of the first blade, a ridge can be produced by bifacial flaking" (Collins 1999:19). These bifacially flaked crested blades use a similar process to bifacial reduction, with extreme acute angles creating short fake removals from either side, resulting in a central crest. This central crest is then used to remove the first flake in the form of a crested blade. This process creates subsequent lateral ridges that the first blades can be removed from. Initial blades will not only have a lateral flake scar, but also perpendicular flake termination where the bifacial flakes were removed. These may not be desirable blades but contain important information as a marker of blade technology. TB-207 is a large example of a bifacially flaked crested blade. The small platform is at a nearly 90-degree angle to the dorsal face, allowing for a long transfer of energy and a maximized blade length.

TB-207

Figure 28. Crested blade TB-207 with rough bifacial preparation along the dorsal surface, a small platform, nearly 90-degree dorsal platform angle and high ventral curvature. Photo by Mona Fredrickson.

Crested blades are unique because they represent a conscious singular initiating flake. The key being conscious and not accidental. Crested blades could be considered rare because only one is created compared to all the pieces of debitage that may follow from a core. TB-248, Figure 29, is a prime example of a crested bade from level 6 at Thunderbird. Analysis indicates intentional flake removal from the central arises down both sides of the blade. The arises scars produced from this removal would have provided media arises for subsequent blade removal on the right and left. There is no question that this was intentionally prepared and flaked as a crested blade, and there is no other reason for this than to prepare a blade core for subsequent removals.

TB-248

Figure 29. Left, crested blade TB-248 from level 6 at Thunderbird showing bifacial removal of flakes to form the signature crest for subsequent removal. Photo by the author. Right, TB-248 showing the inherant curvature of the crested blade upon removal. Photo by Mona Fredrickson.

6.6 Blade Cores and Debitage

As stressed by Sain (2012) in his evaluation of blades and blade-like flakes at Topper, the identification of “a specific technology requires evidence not only of particular blade attributes, but attributes of the associated cores and debitage as well” (Sain 2012:3). Within the Thunderbird we find several examples of depleted cores which warrant further analysis to determine intentional and serialized blade removal. No complete and unused cores were identified during examination of the collection during this study.

A primary attribute of cores is the direction of flake removal. The surface of blade cores should show the sequential and serialized removal of blade-like flakes. The expenditure of the core results in an increasing angle which makes further blade removal impractical. The final shape is often a large flat top with a tapering base and multiple blade removal scars. Within level 6 of Feature 68 a large, depleted blade core was identified that meets these criteria (Figure 30). While the collection was examined in its entirety some of the most noteworthy finds of this study occurred in Feature 68. This is because Feature 68 is regarded as not only Clovis age, but also a single knapping event, likely to replenish a toolkit (Gross, 1974:102). No formal or used tools were found. Not only was Feature 68 considered a short-term single knapping event, but it was believed to be the work of one individual (Gross, 1974:102:). TB-314 also shows clear small platform removals leaving behind a saw tooth appearance on one side of the core (Figure 31).

TB-314

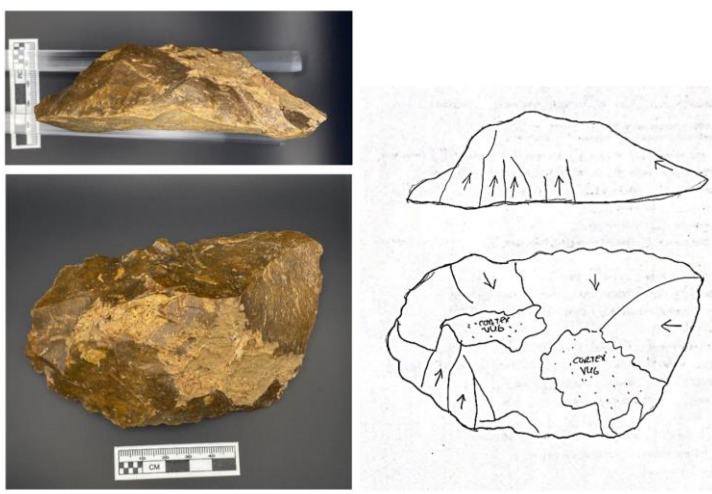

Figure 30. Depleted blade core TB-314 recovered from Feature 68 as shown from the dorsal face, bottom left, and profile view, top left. Line drawing showing direction of flake removal from the dorsal face, bottom right, and profile view, top right. Photos and line drawings by the author.

Figure 31. Blade core TB-314 recovered from Feature 68, ventral side, showing sequential removal of flakes to prepare striking platforms or where previous blades were removed. Photo by the author.

Building upon what Sain 2012 said regarding the necessity of debitage presence, feature 68 at 44WR11 also produced blade debitage, all with similar atributes. Some have the atributes for classification as macro blades (Figure 32). While X-ray Fluorescence (XRF) analysis was not performed, the blade-like flakes and double crested blade TB-340 appear to be of the same material as core TB-314. I can only assume that TB-340 was discarded as it broke into four segments during removal. Based on side-by-side analysis of the core, debtage and blade TB-340, I believe they represent materials from a single blade manufacturing event. This meets the criteria of having blades, cores with evidence of intentional serialized removal, and associated debitage contained in a stratified Clovis context. To further this argument TB-329 (Figure 33), TB-299(Figure 34), and TB-348 (Figure 35) all represnet varying forms of depleted blade cores found in separate units, all withn level 6.

TB-342/343/344/345

Figure 32. Blade core debitage from Feature 68, likely related to depleted core TB-314. Photos by the author.

TB-329

Figure 33. Expended polyhedral core with removal of flakes. Photos by the author.

TB-299

Figure 34. Expended polyhedral core with removal of flakes. Photos by the author.

TB-348

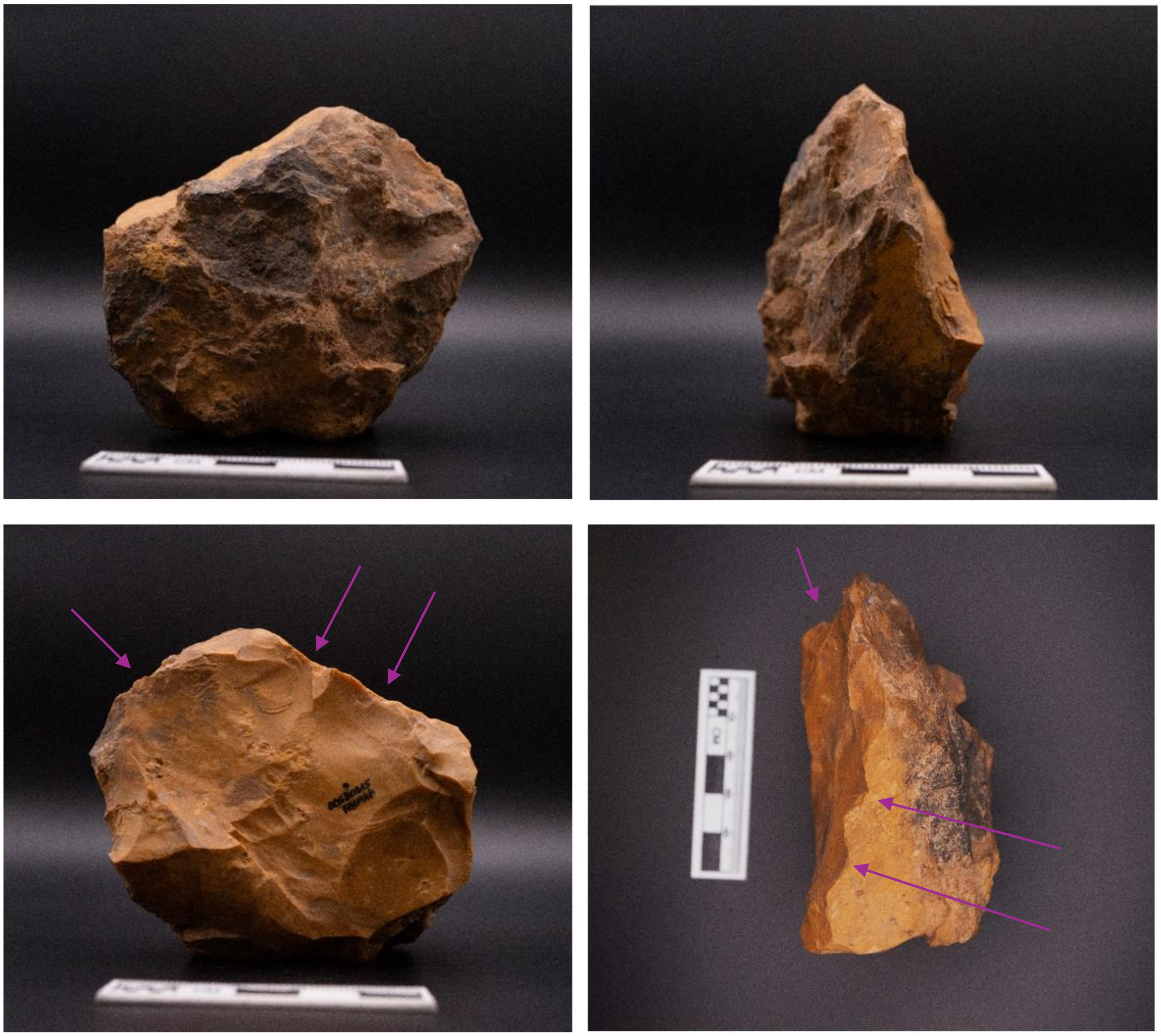

Figure 35. Expended wedge core with removal of flakes from one face as indicated by arrows. Photos by Mona Fredrickson.

6.6 Modified and Edgeworn Blades

A close second in importance to the identification of blades at Thunderbird is the identification of use-wear on artifacts. Rots (2015) notes production, use-wear, and hafting as three primary ways edge-wear is created, each producing a distinct set of wear patterns. Each has its advantages to researchers. “Production traces permit insights into how the stone tools were produced; use-wear traces, into their potential use; and prehensile wear, into the way they were held or hafted during use" (Rots (2015:111). A varying degree of use-wear is produced when working materials with different hardness such as stone, antler, bone, wood, hides, or other fibrous materials. "In addition, sharpening can be identified based on either interrupted use-wear in combination with retouch striations or discontinuous use-wear development" (Rots 2015:111). While use-wear analysis is a study in itself, noting modification and use-wear was something looked for from the start of this study due to its importance. Small, scalloped removals along ventral lateral edges are an easy indication of modification, often accomplished through pressure flaking as shown in Figures 36 and 37.

A variety of tools can originate from blades, such as blades, burins, scrapers, or preforms for points. Blades are often a tool for making more complex tools and refined materials. They are used to process fibrous materials, process hides, or carve wood, bone, or antler for the creation of tools or to create hafted tools. While answering how blades were used at Thunderbird would take extensive use-wear analysis, several lithics examined showed signs of retouching and heavy use-wear which created polish on the surfaces and rounded once sharp edges. TB-332, Figure 36, shows edge modification and extensive use-wear. As a medial section it is also noteworthy and alludes to intentional breakage, as noted previously by Sorensen (2006). It should also be known that TB-332 was found with debitage in the Smithsonian archive, supporting the claim by Sorenson (2006) that blades, through confined typology, often ended up with debitage. TB-209, Figure 36, is also an excellent example of a modified and used micro blade.

TB-332

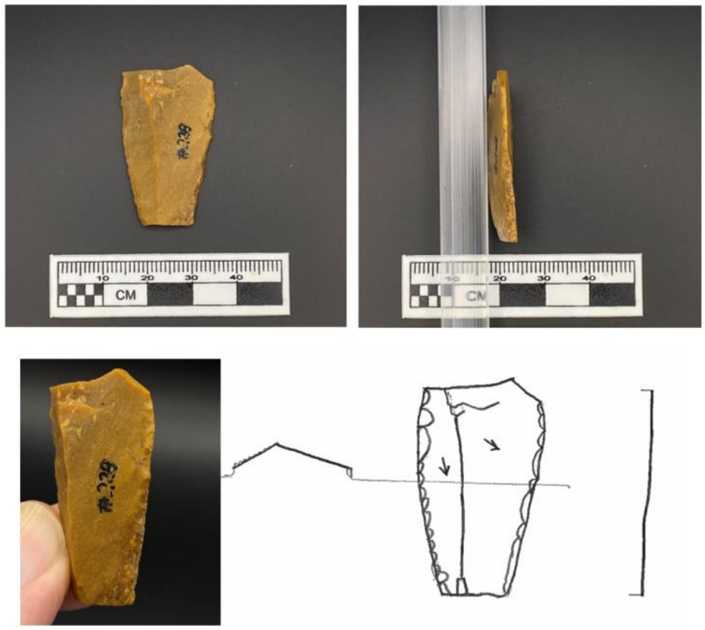

Figure 36. A prismatic micro blade with modification and use-wear. Photos and line drawing by the author.

Finally, one unique artifact can be analyzed for its blade attributes, for its demonstrated blade core remnants, as well as modification and edgewear. TB-347 (Figure 37), which was recognized for its use and pulled into the tool drawer of the collection, is more than a simple tool or a simple flake. Upon further analysis TB-347 has traits of a double-faced core which has two active faces allowing blades to be removed from one direction, and then from another (Lohse 2010:168, in Bradley, 2010). In the case of TB-347 both ends terminated in hinge fractures making it a medial segment originally longer than it is presently. The central arises was formed by the removal of flakes that feathered at the midline from the lateral edge, shown in Figure 37 with orange arrows. The vertical flake scar indicated by a blue arrow in Figure 37 runs from the proximal to the distal end as indicated by micro step fractures. Notably there is modification along the lateral edge and heavy use-wear. This artifact would benefit from use-wear and protein residue analysis. Given the low degree of curvature the platform, although missing, would have been 70 to 90 degrees enabling a long and low curvature removal, all traits of blade technology.

TB-347

Figure 37. Modified and used medial section of macro blade TB-347 shows unique properties of prior blade removal. Using reflectance transformation imaging (right) the blade exibits signs of modification along lateral edges, as well as removal of previous blade like flakes prior to subsequent blade removal, as indicated by arrows. Photos by the author.

6.7 A New Outlook on Blades at Thunderbird

Thunderbird was well known for its bifacial technology and fluted Clovis points. By examining the debitage not classified as formal tools this study identified a tool group previously believed absent from the site. This places Thunderbird among the growing list of Mid-Atlantic sites listed by Sain 2012, demonstrating evidence of concerted blade manufacture. The combination of numeric attributes and qualitative assessments demonstrate an intentional production of true blades at the site. And while these blades may not have the same dimensions or appearance as those at other sites, their differences align with the concept of regional variation in Clovis technology. Their similarities of platform angle and morphology raise questions about shared knowledge and diffusion of innovations across the Eastern United States. Blades also demonstrate behavior and movement. At Shoop, the blades found were not made of local materials, indicating that people traveled to the site with the stone in hand. In inverse is true of Thunderbird. Not only did they produce blades from local materials, but very little exotic stone is found at the site. Exotic materials are often deposited at sites when people reach the end of a long journey and need to replace worn and depleted tools. They are then dropped at the new location as toolkits are refurbished with fresh local stone. But the non-local materials found at Thunderbird may imply the range of these people was much further than previously believed (Gardner, 2023). The lack of exotic material at Thunderbird further strengthens Gardner's (1974) assessment that the site was a place where people came and stayed because of its rich natural resources. This may have contributed to a larger group using the area for longer periods of time in different ways than those during the Archaic period (Gardner, 2023:59). Whatever its use, the Shenandoah River Valley may have been a refugia in a dynamic and changing world.

Chapter 7

7.1 Observation and Future Opportunities

Like our understanding of history, archaeology is an evolving science. Each piece discovered adds to our understanding of the bigger picture. The work done at Thunderbird set the foundation for more refined studies such as this, and those to come. But with Clovis ranging across much of the United States, a great deal of variability exists in blade assemblages, and their remains no established boundaries or range of what entail "clovis blade" technology (Collins, 1999:147). Although that outlook is improving with studies like those of Sain (2012, 2016) and Sorensen (2006, 2017) which continue to specifically address the role and definition of blades in a broader context. If we look to the variability of climate and environmental conditions at the end of the Pleistocene, things were far from uniform, and as noted by Collins, "likely the operative social units and their political interactions with other social units were equally variable." Gardner (1994) noted that the bands at Thunderbird likely lived in small groups of no more than two to three nuclear families, moving as environmental stressors dictated through a relatively wide but ecologically homogenous region. The nuanced examination that builds on Gardner's take on cultural ecology and environmental reconstruction is a necessary foundation to understand the context in which blades existed as a critical tool in the Paleoindian toolkit. Without ecological understanding we would not be able to place the tool in the context in which it is used, nor put ourselves in the place of the individual who created it to overcome environmental challenges. By knowing the environment, we can imagine the activities necessary to thrive in that environment and begin to understand the morphology of tools best suited to manipulate that environment's resources. This takes aspects of normative, processual, and cognitive theories to develop deep conclusions that go beyond the mere existence of a tool and dig into what the tool means for social structure, settlement patterns, culture, and lifeways. The discovery of blades at Thunderbird adds a necessary piece to the understating of Clovis culture at the Flint Run Complex.

As noted in the Forward, Jasper Ridge was a driving factor of this research. Dozens, if not hundreds, of blade like flakes have been found at the site. The only reason they have not been classified as blades is they require additional analysis. This final analysis is about bringing pieces together that run parallel to the creation of blades. Gardner identified some of the key aspects that have shaped my thinking about the social constructs, economics and migration patterns of the people who inhabited Flint Run at the terminal Pleistocene. Gardener (1994) noted that Thunderbird was a site of repeated habitation, indicating it was a known resource rich refugia that was part of a seasonal round. Gardner (1994:33) also believed these sites also served a social as well as technological function. But knowing when they were occupied is as important as why they were occupied. I agree with the assessment that "winter would have been the ideal time to have camped in the sheltered Thunderbird location" (Gardner, 1994:26). This is due to the geography whereby the river reduced the effect of wind, there were multiple springs, and its orientation received full sun during the day.

In the climate section of this study I noted how the remaining glaciers and glacial lakes in the north would have created harsh winter conditions in the East, despite climate warming, with sustained northerly winds originating from the glaciated regions (Mike Johnson, personal communication 2024). Having personally walked glaciers in central Asia and Alaska, I can attest to the sustained katabatic wind originating due to the dense cold air emanating from ice and glacial lakes. Not only are lowlands warmer, but they are also a reprieve from these constant frigid winds. Jasper Ridge in contrast sits 200 feet above Thunderbird and would have been deadly in winter. Not only would Jasper Ridge have been directly exposed to the wind, but food resources would also have been scarce. But Witthoft (1952) noted that we should find additional sites at higher elevations and Jasper Ridge is just that. In seasonal contrast, the criteria that made Thunderbird ideal in winter would have made it miserable in summer. The full exposure to sun, lack of wind and plentiful wet environment would have made it a bug infested heat sink. Therefore, assessing hunter gatherer settlement for nearby vertical migration is as important as ranged migration patterns. This concept of short-range seasonal mobility patterns is not new.

There is evidence worldwide of Paleolithic short-range seasonal mobility, like that at Thunderbird. A study of Acheulian settlements between 250,00 – 150,000 BP in Israel found that in regions with sufficient natural resources, and occupied by small bands, traveling outside the immediate area was an unnecessary risk when small family groups could just relocate nearby (Ohel 1990). This aversion to ranged travel is demonstrated by vertical movement of humans, similar to that of animals that seek higher ground in eth summer where breezes and exposure create a more comfortable environment (Ohel 1990:52) Hou (2020) identified similar evidence of winter-to-summer seasonal migration among Neolithic hunter gatherers on the Qinghai-Tibetan plateau between 8400 – 6000 BP. In this model movement to the uplands occurred from April to May and they returned to lowlands from September to October to take full advantage of the resources in both altitudes. Based on my personal experience north of the Arctic circle in Alaska in summer I can attest that lowlands are miserable. Ridges are ideal as they have a constant breeze which cools and keeps bugs away.

Knowing this about the environment, we can begin to look at the tools or lack of tools found at Thunderbird within an environmental context. Collins (1999:183) noted that blades and blade cores are synonymous with mobility and were cached as a means of insurance. True blades are lacking at Thunderbird, but evidence of serialized and intentional blade creation is not. So where are the blades? I believe the blades produced at Thunderbird, possibly in the winter, were cashed in preparation for a known migration where they could be used for a variety of tasks either enroute or upon arrival. Blades were versatile, with unmodified true blades used as cutting tools due to their extremely sharp edges, segments modified into scrapers, particularly end scrapers, (Collins 1999), and other tools like gravers and burins. As shown with the double crested blade TB-340, there was a method of blade production applied at Thunderbird which was not accidental, implying the diffusion of innovation between groups at some point. The ability to remove a double crested blade is not accidental and is a process filled with preplanning and foresight. Of the origin of Clovis blades, Collins (1999:179) said, "it seems plausible that Clovis blade technology is ultimately derived from the often very similar ones in Upper Paleolithic cultures of Eurasia, even though independent invention is not an impossibility."

Blade morphology holds information about diffusion of innovation, resource exploitation and migration that should not be ignored. At Jasper Ridge, although undated due to stratigraphy, we find unique examples that fit the description of blade derived scrapers noted by Collins (1999). Figure 38 represents a scraper on a double crested blade found at the site just weeks before this writing. The double ridged dorsal top of the scraper coupled with its ventral curve strongly suggests the scraper blank on which it was made was a double dorsal ridged macro-blade (Mike Johnson, personal communication July 20224). Ramped endscrapers are also present in the Early Archaic but are normally not spurred or formally made on prismatic blade-like flakes which is a characteristic of "Clovis" endscrapers (Mike Johnson, personal communication July 2024). What we can infer is if the scraper was used on the ridge, it would not have been during winter. Hou (2020) noted the presence of microliths at both upland and lowland sites, demonstrating seasonal activity. A comparative analysis of the microliths from each elevation was not provided in the study. Gardner (1994) described the many types of sites in the Flint Run complex and noted the varying tool types found at each site type. This aligns with behavioral outputs shaped by the environment. The need to accomplish a specific task governs the type of tool needed, and that need is governed by season, weather, social structure, and available resources. An analysis of Paleolithic summer site occupations in Israel afford comfort that directly translates to more carefully crafted and variable tool assemblages, vs winter sites which demonstrate assemblages that are produced expediently solely to overcome the task at hand (Ohel 1990:53). Ohel (1990:53) noted a “considerable dissimilarity apparent” between the assemblages found at summer and winter sites despite the sites existing in a similar technical mode, thereby displaying “function-seasonal differentiation tasks and necessities”.

Figure 38. A scraper produced on a double crested macroblade found at Jasper Ridge during the Summer 2024 field season. Photos courtesy of Mike Johnson.

I believe that the absence of blades, but the remains of cores and waste flakes at Thunderbird indicate that the Clovis level around Feature 68 was created during a winter occupation, using cashed blade cores of high-quality stone, possibly procured from local upland quarry sites such as Jasper Ridge, in preparation for an anticipated move or to overcome seasonal tasks essential for survival. This is why we find no utilized flakes in the 1,298 pieces of debitage (McNamara 1980 as cited in Carr et al. 2013) from Feature 68. In this respect blades and varied tool forms should be viewed not only for their use, but as a functio-seasonal representation of occupation and mobility. If groups at Thunderbird followed a localized seasonal migration pattern like this, other groups in the region may have also followed a similar pattern in neighboring microenvironments, only coming together when seasonal rounds allowed them to converge on the edges of abutting migratory patterns for periods of information exchange, ceremony, etc. Much like gears moving around a central cog driven by the seasons.

Blades found expended at a site could indicate the end or a stopping point in any stage of this cyclical migration, in which case careful attention to the origin of the material will play a vital key to the migration pattern. To this point, the scraper in Figure 38 is intriguing because it appears to be a non-native chert, in a technology dominated almost exclusively by local jasper. However, as noted earlier, Clovis people were skilled multi lithists. The scraper in question certainly warrants further investigation. If migration occurs seasonally, and the chert is from a distant location, we can infer that the journey, which is also a behavior, was conducted when the weather and resource availability allowed.

Building on Gardner's already robust models of regional settlement, resource exploitation and mobility, and social structure, we can add tool variation at individual sites as indicators of seasonal behavior (Ohel 1990). Through additional cataloging and georeferencing of blades, patterns will hopefully emerge of sites that contain only blade manufacturing debitage, those with utilized blades and those with neither. Each is telling in its own way. By conducting use-wear analysis on blades when they are discovered we can further refine the behaviors to a micro understanding of what types of resources they were processing, thereby adding information to make inferences about lifeways. Lithic analysis is no small feat and requires a skill which I do not yet possess. Understanding how a tool was used and to what extent puts us one on one with the individual by forcing thought provoking experimental work, and ultimately revealing a moment in the life of the object and its user.

7.2 Final Thoughts

More than 150 years ago scientists struggled to find evidence of Late Pleistocene people in North America. Ongoing research has not only verified their existence but allows us to understand simple aspects of their behavior and daily lives. Small artifacts, like blades, are personal items and are directly connected to an individual. For this reason, the importance of small artifacts cannot be overstated. “For in the seemingly little and insignificant things that accumulate to create a lifetime, the essence of our existence is captured” Deetz (1996:259). Small items like these begin to refine a broad and misguided narrative of a primitive people chasing mammoths with sharp rocks tied to sticks. “A major rethinking of the romantic notion that Clovis big-game hunters ranged over most of North America is long overdue. Likely, Multiple regional Clovis adaptations will emerge, each with distinct responses to specific kinds of plants, animals, and other resources” (Collins 1999: 40). With these regional adaptations it should be expected that we will also find regional variations of tools. The Clovis blades at the

Gault Site in Texas may not look anything like those found at the Adams site in Tennessee. But blade attributes stand out against attributes of other types of tools and their waste. A blade may vary in form but have similar functions as a utilitarian cutting tool.

This study faced challenges in how to examine the volume of material for only one specific artifact type. In a collection with tens of thousands of artifacts it could easily be a multiyear process to tease out subtle information. This study was able to process approximately 12 artifacts per day, so there are certainly artifacts that have been missed in the Thunderbird collection. The culling of the artifacts was performed with only seconds devoted to each to decide if it was worthy of further examination and measurement. To capture a complete and accurate picture of blade technology at Thunderbird would take a significant time commitment by researchers with knowledge of lithic analysis specifically in blade attributes. While these attributes are quickly learned, some can be subtle and hard to distinguish. Despite these challenges there remains significant room for future research at Thunderbird and with blades in general in the East.

Gardner (1974) noted the absence of finished or untilized blades at Thunderbird, and this study confirms there is an obvious lack of true blades at the site, but not a lack of blade cores. This raises the intriguing question of whether the blades produced at Thunderbird were used at Fifty and discarded there. Is there a higher ratio of blades at Fifty? It is intriguing to imagine that the blades and tools missing from Thunderbird may have made their way to the Fifty site. The Fifty collection is housed next to the Thunderbird collection at the Smithsonian and is still in the original paper bags. For lithic analysts it is literally a wrapped gift: an untouched collection with the potential to make behavioral connections across an entire Paleoindian complex.

Ideally, future research will compare blades found at Thunderbird to those at Adams, Shoop, and Topper, among others. This would be in line with Binford's assessment that "we should see similarities in technologies, such as blade manufacture, among groups facing similar circumstances shaped by their immediate environment" (Binford 1962:218). Given the variable dynamic environments across the continent during Clovis, we must also be ready to document distinct differences in blades across regions, while remembering to remain flexible, adjust typology as needed, and let curiosity deliver questions that fall somewhere between the impossible and probable.

Appendix 1

DATE__________ **TB-________**

BLADE ATTRIBUTE FORM (KF draft 3/14/2024)

SITE NAME: Thunderbird SITE NUMBER: 44WR11

REPOSITORY: Smithsonian MSC, Unit_____; Unit Side_____; Drawer_____; Location_____

T-BIRD CATALOG #:______________________________

MEASUREMENTS **WEIGHT:______**

SEGMENT: Whole ☐; Prox ☐; Medial ☐ ; Distal ☐; Prox/Med ☐; Med/Dist ☐; Unk ☐

SEGMENT terminus width: Prox _____; Distal _____;
Proximal End: Hinged ☐ Stepped ☐ Snapped ☐

Distal End: Hinged ☐ Stepped ☐ Snapped ☐ Feathered ☐ ☐
Overshoot

MAXIMUM DIMENSIONS: Length:_____cm.; Width:______cm.; Thickness_____cm.;

W/T: Proximal 1/3_____/_____; Medial 1/3_____/_____; Distal 1/3_____/_____

PLATFORM: Width_____; Thickness_____;

BULB Total Thickness_____; From mid-line_____

PLATFORM: Dorsal angle_____; Ventral angle_____; Med angle_____

BLADE OVERVIEW

DIAGNOSTIC: Channel Flake ☐; Core ☐; Blade ☐;

RAW MATERIAL_____; HEAT REDDENED: All ☐; Part ☐; Edge ☐; No ☐;

PREVIOUS DETACHMENT ATTEMPTS ☐ Cortex Present ☐

DVP ☐; DRP ☐;

PLATFORM IMPACT: Point ☐; Diffused ☐; Undetermined ☐; Crushed ☐;

PLATFORM PREP: None ☐; Faceted ☐; Ground ☐; Polished ☐; Lipped ☐; N/A ☐

VENTRAL RIPPLES: None ☐ Weak ☐ Moderate ☐ Strong ☐

ARISIS: Quantity_____; FROM: Proximal_____; Distal_____; Lat._____;

MODIFICATION

Lateral Edges Mod ☐ ; Distal Edges Mod ☐; Proximal Mod ☐; Medial mod ☐

Lateral Edgewear ☐; Distal Edgewear ☐ ; Proximal Edgewear ☐;

Pecking/Pitting: Dorsal ☐; Ventral ☐;

Trace blade outline below, note arisis, ventral arc & cross section,
or on back if insufficient room.

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