Where have all the arrows gone? A cross-cultural comparison of Lowland Maya and Central Ohio arrow use

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Abstract:

Arrow points are an abundant lithic resource, but exactly how abundant? Recent systematic surveys of the Mayan Lowlands and central Ohio permit a new cross-cultural comparison of arrow use, and factors that may lead to their differing accumulations in the archaeological record. Somewhat surprisingly, Mayan arrow use, at least in terms of recorded frequencies in the archaeological record, is less than that of Central Ohio Late Prehistoric populations. Central Ohio has a much smaller population density than the Yucatan peninsula, so the dearth of arrow points in the latter context is unexpected. There are many factors that may explain the paucity of arrow points in Mayan contexts, when compared to the relatively dense arrow assemblages in Ohio sites. These many factors warrant further research and analysis in both Ohio and Mayan lithic arrow studies. This research presents the results of a preliminary comparative analysis. Several factors likely explain the difference between Ohio and maya arrow frequencies. Given that most arrows in Ohio are found as isolated finds, the most likely explanation is a difference in survey coverage between Ohio and the Mayan Lowlands. The other contributing factors include the relatively short use-life of Ohio arrow points, and the lack of weapon diversity in Ohio. Both factors result in higher usage of arrows, and a higher rate of deposit when compared to the Mayan Lowlands. With the increase in digital archives and records, large-scale comparative studies such as this have the potential to change our collective understanding of warfare, conflict, and tool use by past peoples.

Keywords: warfare; hunting; use-life; data analytics; curation rate; comparative studies

1. Introduction and background

For the present paper, I am comparing bow-and-arrow use in Post-Classic Lowland Maya and central Ohio Late Prehistoric contexts. Both cultural areas practiced intensive maize agriculture and utilized bow and arrow technology for roughly the same length of time. However, the distribution of arrow points in these two regions is noticeably different. The aim of this paper is to understand why these distributions might be different.

The lowland Maya region is roughly bound to the south by the Chiapas and Alta Verapaz provincial borders of Mexico and Guatemala, respectively (Figure 1). This area roughly coincides with Meissner's (2014: 14) regional study of arrow points in the Maya lowlands. In both regions, the wide-spread use and adoption of the bow-and-arrow occurs roughly around

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C.E. 800 (Aoyama 2005; Aoyama & Graham 2015; Blitz & Porth 2013; Justice 2009). The use of stone arrow points in Mayan contexts was abandoned by the 18th century (Meissner 2014: i-ii), and circa 1650 in Central Ohio (Drooker 1996; Kennedy 2000).

"Central Ohio" is based on previous research (Figure 2), and for the purpose of this comparison, is bound by eight counties (Nolan 2014; Olson *et al.* 2021). This is the scope of the Central Ohio Archaeological Digitization Survey, or COADS (National Science Foundation BCS 1723879 and BCS 1723877) and the extent of a prior regional study by Nolan (2014).

Population estimates for the lowlands and Ohio are extremely different. Smith (2005) has estimated Late Post-Classic city size in the lowlands and arrives at city sizes in the tens of thousands, such as Mayapan at 21,000 and Santa Rita Corozal at 7,000. Webster (2018) provides detailed estimates of total population in the Maya lowlands at around 519,000, with extreme estimates at 1,200,000. This equates to a population density of roughly 2.07 to 4.8 people per square kilometer.

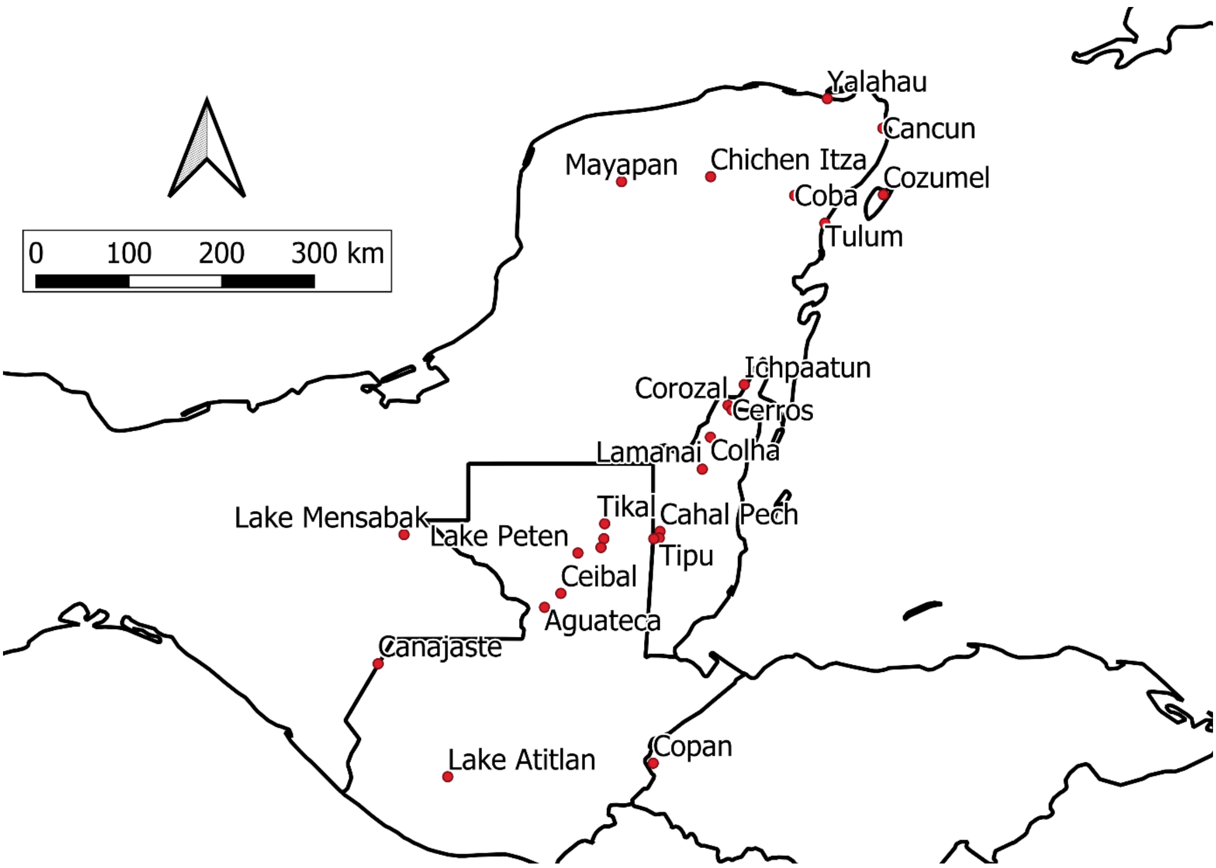

Figure 1. Geographic extent of cross-cultural comparison sites in Yucatan (Peten includes over 6 different sites, while Tipu includes three).

In Ohio, Kennedy (2000: 61) estimates approximately 40 families (two adults and three children) or roughly 200 people as the average village size. Using this estimate, Figure 2 and the projectile point data from this study, we can make a rough population estimate for central Ohio. There are 12 "known" village sites with house remains (Brady-Rawlins 2007:248; Redmond 2000:427) that have been professionally excavated, and another 14 likely village sites (based on surface assemblages only). Multiplied by Kennedy's (2000:61) village size estimate yields a population estimate between 2,400 and 5,200 people in central Ohio. This seems reasonable when compared to historic population estimates for Shawnee Town, 1,200 to 1,500 inhabitants near what is today Portsmouth, Ohio (Henderson & Pollack 2012:23). This equates to approximately 0.21 to 0.47 people per square kilometer.

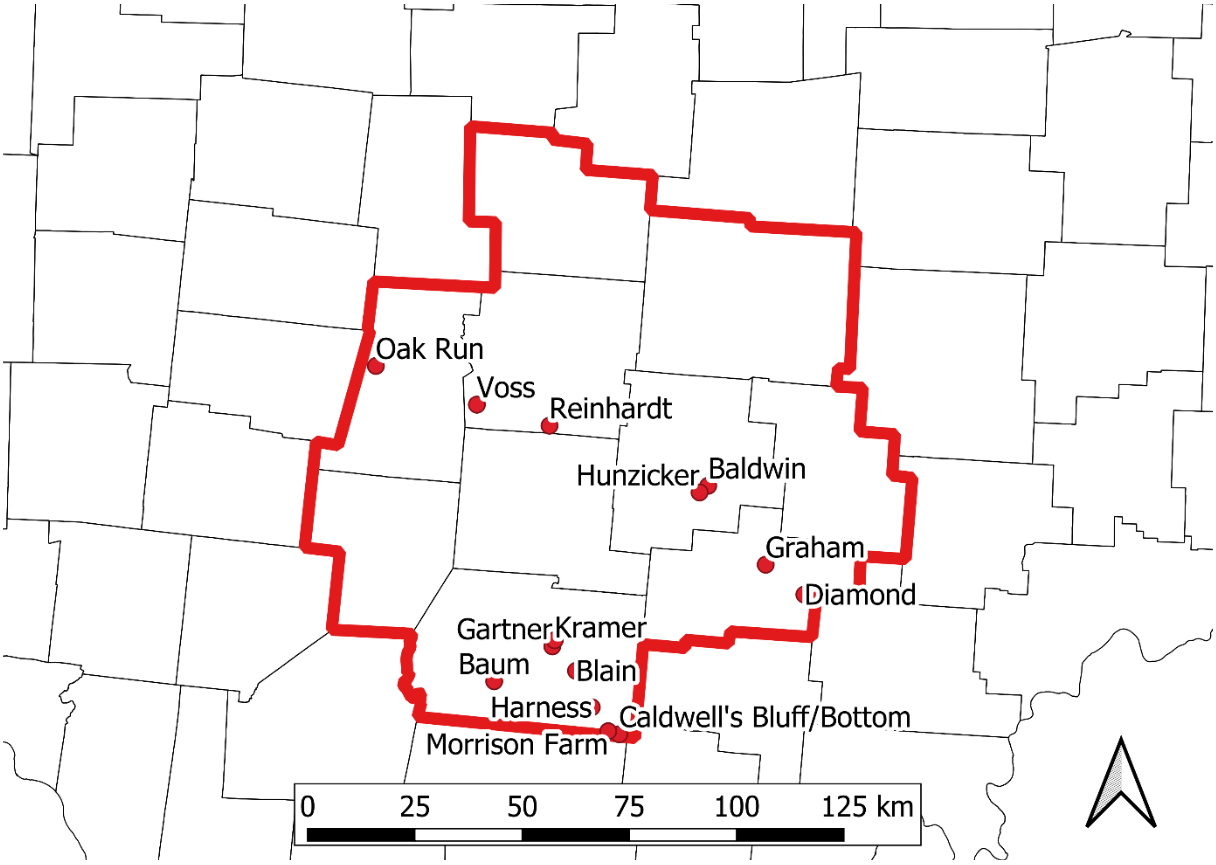

Figure 2. Geographic extent of cross-cultural comparison sites in Ohio (Harness Site includes over a dozen different sites).

Population estimation is a tricky calculation in archaeological contexts. Recent research by Ortman & Cooper (2021) demonstrate that structural remains are integral to estimating populations. In the case of Mayan sites, structural remains are easily identified and preserved (stone foundations), while Ohio structures are often truncated posthole features identified within a plowed field. The population estimates for both Ohio and Maya populations may change as new data are identified that increase the accuracy of estimates. However, the relative orders of magnitude differences in both population and occupational density between Ohio and the Yucatan should not be up for debate.

A cross-cultural comparison of arrow use must inherently be operationalized into archaeological (lithic) terms. One of the simplest ways to compare these two regions is through a simple frequency distribution of arrow points. The higher population density (and subsequent population pressure) and warfare of the Post-Classic period should yield higher evidence of arrow manufacture and use in Mayan contexts than in central Ohio.

2. Methods

The distribution of arrow points in Mayan and Ohio contexts is ultimately an investigation of opportunity costs. When considering the use of stone tools, versus bone, shell, or other material types, there are trade-offs (*e.g.*, material access, manufacturing, use-life). Many of the factors that affect opportunity cost are beyond the study of lithics alone, such as agriculture, trade networks, and gender roles. However, stone tools are one of the most abundant artifact types found in both the Maya lowlands and Ohio.

Only small point weaponry was utilized for this comparative analysis. In Ohio, there is an astonishingly homogeneous morphology to arrow points: isosceles triangles or unnotched triangular points. Other archaeologists have attempted to classify these morphological similarities into typologies (Bradbury *et al.* 2011; Pollack *et al.* 2012); however, for this study, all these points were lumped together since their primary function was as arrow points, despite minute morphological variation. Michael J. Shott (personal communication, 2021) suggests prior morphological types such as Jack's Reef Corner notched may have also been used as arrow points; however, for the purpose of this paper these points were not considered in analysis due to the nascency of geometric morphometric analysis of projectile points in Ohio.

By contrast, in lowlands contexts, there is a considerable amount of morphological variation in small point weaponry (Meissner 2014: 296-297). The variability in design is mostly in the haft elements of these arrow points (Figure 3). The variability of haft element, and overall size of these points has led to several studies examining the identification of arrow versus dart points (for *e.g.,* Marino 2014: 1-4; Meissner 2014: 2-5; Shott 1997). Going back to Proskouriakoff (1962), small arrow points have been distinguished from dart points primarily through ethnographic evidence and size constraints. Anything smaller than three centimeters in maximum length has, as a general rule, been considered an "arrow." Likewise, the haft elements of atlatl darts are morphologically distinct from those of small points, something that Proskouriakoff (1962) noted was particularly evident in the large projectile points of Chichen Itza and the small points of Mayapan. However, recent work by Ciofalo (2012: 3), which applies the metric discrimination outlined by Shott (1997) indicates that a handful of points with similar morphology to atlatl points may have been arrow points. These points were recovered in the 1990s from the "Sacred Cenote" at Chichen Itza.

Meissner's (2014: 4-6) extensive analysis of small point weaponry further elaborates the distinctions between atlatl darts and arrow points, not just in size but also haft morphology, thickness, and the preparation of blanks. Aoyama (2005) and Aoyama & Graham (2015) have conducted microwear analysis of small blade and chert small unifacial points and concluded these were mainly used as arrow points.

While there is continued debate about the origins and transition from atlatl to bow and arrow technology in both regions, there is a clear shift in the archaeological record. In both Ohio and Mayan contexts, what is clear is an increase in popularity and production of arrow points that was sustained roughly around the same time (C.E. 800 to 1650).

The data compiled for this cross-cultural comparison were gathered using a wide array of sources, including open access databases, digitized collections, dissertations and theses, and other published works. In particular, the open access information contained within the Foundation for the Advancement of Mesoamerican Studies (FAMSI), the Harvard Peabody online catalog, Cerros Online Research Catalog (CORC), and the various University's online digital dissertation and conference archives proved invaluable in compiling data on Lowland Maya sites (Andersen 1976; Ciofalo 2012; Hamblin 1984; Oland 2013; Phillips 1979: 89-109). Older site reports and survey data were gathered from Holmes (1896), Lothrop (1924), and Sanders (1960). However, the most invaluable research involving systematic study of lithic arrow technology in the Maya lowlands came from Meissner (2014: 463-529). Nearly 85 percent (n = 1925) of the Maya sample comes from frequencies reported by Meisner (2014). Of the Meissner (2014: 365-427) data, 220 of these arrow points were tips or medial fragments that were not included in analysis since they were highly fragmentary and their identification as arrow points was uncertain.

Figure 3. Lowland Maya arrow points from Barton Ramie (reproduced from the Peabody Museum, Harvard).

For central Ohio, most data come from the Ohio Archaeological Inventory (OAI), a state-wide database managed by the Ohio Historic Preservation Office, containing thousands of site-forms with meta-data about archaeological discoveries within the state. Remaining Ohio data were compiled from the Central Ohio Archaeological Digitization Survey (COADS), dissertations and theses (Brady-Rawlins 2007; Kennedy 2000: 111-113; Nolan 2010: 75-80) and data provided from Mika *et al.* (2020) and Nolan (2014). Additional site report data came from Mills (1904: 44-49; 1906: 37-60).

3. Data results

Table 1 breaks down the composition of arrow point data by frequencies of broken (incomplete) points, complete points, by material, and by two main provenience categories: site and unprovenienced. “Unprovenienced” means any documented arrow points which cannot be placed to a location less than 100 acres (*i.e.*, a plowed farm field) such as county or regional provenience (*e.g.*, Hocking County, Belize River Valley, Lake Atitlan), but still enough spatial context to be smaller than the entire study area (Yucatan peninsula or Ohio). The distinction between broken and complete points is analytically useful in distinguishing impact fractures (Meissner 2014: 368; Mika *et al.* 2020). Chert and chalcedony, for the purpose of this study, were treated as the same lithic raw material category.

What is obvious, from a cursory examination of these tabulated frequencies, is a lack of representation of arrow points outside of large Mayan settlements, and a complete absence of reported frequencies from Campeche sites. There were only 35 Mayan sites with point frequency data. This is in stark contrast to the hundreds of archaeological sites in Central Ohio with arrow points. However, if we examine site level data, there is an inverse pattern in arrow point density. Nearly a third (28%, n = 10) of Mayan sites had assemblages over 100 points. Meanwhile, half (50%) of Central Ohio sites were isolated finds (Figure 4).

Table 1. Frequency table for arrows, separated by provenience and raw material.

	Sites	Total Arrows	Complete Chert	Incomplete Chert	Complete Obsidian	Incomplete Obsidian
Maya	35	2276	607	513	421	392
Unprovenienced Maya	4	9	1	2	4	1
Total	**39**	**2285**	**608**	**515**	**425**	**393**
Ohio	298	2414	660	892	0	0
Unprovenienced Ohio	10	328	168	160	0	0
Total	**308**	**2742**	**828**	**1052**	**0**	**0**

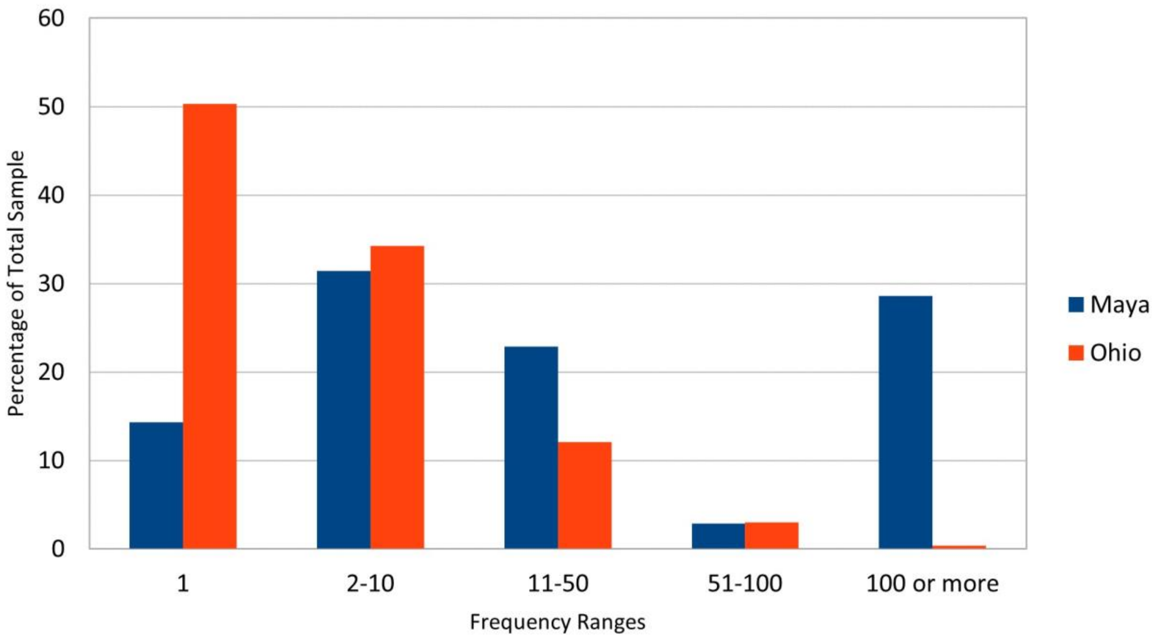

Figure 4. Histograms of Maya and Ohio arrow frequencies per site.

The Reinhardt Village (Nolan 2010) has the smallest reported number of arrow points recovered from a site with known village architecture within the survey area (n = 32). Sites with frequencies smaller than this may also be village settlements, but there are no known house remnants at these sites to substantiate this. If we assume Reinhardt represents the lower end of village arrow point densities, then over half (51.8%, n = 1152) of all site-provenienced arrow points were recovered from village or probable village sites (n = 20) in Central Ohio. Arrow assemblages with less than 32 recovered points may represent village settlements; however, it is more likely these sites represent more ephemeral hunting, warfare, discard, or loss events. It is far more likely that Ohio village and Mayan city settlements will contain most arrow points, and thus the focus will be on understanding the distributions at these sites. "Village" is used here to distinguish the rather small population settlements of Central Ohio compared to larger

Mayan cities in the Yucatan. Median arrow frequencies of the 20 "village" settlements are 51. Median village population is 200 (Kennedy 2000). If we reduce this to a singular measure, arrows per person, this equates to 1 arrow for every 4 people in an Ohio village.

The 10 Mayan sites (all of them cities) with 100 or more arrows account for 86.8 percent of the total sample of arrow points, while only representing 28 percent of the sample by site. The median frequency of arrows for these 10 Mayan cities is 198.5. The median Mayan population within cities in the Terminal and Post-Classic is 17,500 (calculated from Webster 2018: 48). If points are proxy representations of populations, we should expect the median site point frequency of Mayan cities to be proportionally higher than those of Central Ohio village settlements. However, Mayan cities have 1 arrow for every 88 people, or 29 times fewer than Ohio villages per person.

In Ohio, this high point to person density may reflect household level arrow use, such as a singular hunter or warrior who uses arrows in a nuclear family (Kennedy 2000). Several burials at Baum (Mills 1906) and Gartner (Mills 1907) villages had 2-3 arrows within the burial, suggesting a small quiver of arrows per archer. However, this is severely underestimated when considering other burials and ethnographic data. Burial 14 at Secrest-Reasoner site in East-Central Indiana contained 43 triangular arrow points (Black 1935). An ethnographic account from Wetfish (1977) of the Pawnee suggests 20-40 arrows is not uncommon for a hunter to carry at any given time.

Ethnographic data for the Maya indicates a similarly large (to Ohio) quantity of arrows should be identified in the archaeological record. Meisner (2014: 242) observed 'Lacandon flintknappers often produced arrows in quantities of 11 per session.' The Lacandon people are not living in analogous social environments to the Post-Classic lowland Maya, and may represent a subsistence economy less dependent on intensive agriculture (Palka 2005). If we apply 11 arrows per flintknapper, or archer, these numbers simply do not mesh with the population estimates and the recorded arrow frequencies at Mayan cities. Even if we assume a knapper makes arrows only once a month over the course of their lifetime, that is 132 arrows per year. In a decade, a productive knapper could feasibly produce 1,320 arrows by this estimate. The extant frequencies of arrows at known Mayan settlements does not reflect the accounts of early Spanish contact, either. Where are the remains of these 'showers of arrows' so often described by the Spanish (Meissner 2014: 381)?

There are several hypotheses that could explain the lower-than-expected frequencies of arrow points at lowland Maya sites. These broadly deal with the following topics, which will be discussed in further detail: recovery rates (both prehistoric and archaeological); curation or use-life; access to raw materials; types of warfare; and hunting behaviors. Engelbrecht (2014) has explored the relationship of arrow frequency at Iroquoian sites, though this same examination cannot be said of Lowland Maya sites. As Meissner (2014: 59) pointedly states "The reason for the paucity of arrow points [in northern Yucatan] is unclear".

4. Interpretations of the data

Many people have taken materials from lowland Maya contexts throughout the 19th and 20th century, thus scattering much of the archaeological record to the far corners of the Earth (Holmes 1895; Lothrop 1924; Salisbury 1877: 56). The final dispositions of the artifacts collected on these many different expeditions, surveys, and excavations is nearly impossible to ascertain in many cases. Did they end up at the Peabody Museum at Harvard, or the American Museum of Natural History, or above someone's fireplace? Northern Yucatan has a low density of recovered arrow points (Meissner 2014: 59). This area has been the focus of intensive survey, collection, and excavation by these early Mayanists. It is also possible that illegal artifact purchases or collecting by tourists has depleted this region more than other Lowland Maya regions.

Regional surveys tend not to yield projectile points (Andrews & Castellanos 2008). However, what appears to be more common among reconnaissance surveys in the Maya Lowlands are examinations for visible above ground features (Hernandez 2005), or excavation of known cities or sites (Philips 1979; Sabloff & Rathje 1975; Stanton 2002). However, within large settlement surveys, lithic frequencies in Mayan sites have been less than inspiring. Stanton's (2002: 15) systematic survey of the Santa Barbara site notes the 'paucity of non-ceramic artifacts [lithics] likely reflects low percentages of such artifacts at Santa Barbara' and Smyth's phrasing of 'abnormally high number of lithic remains' for 22 artifacts indicate the occurrence of lithic materials at Mayan settlements is not as frequent as one might expect given their population densities. As Meissner (2014: 59) and Gomez (1998: 59) also note, frequencies of obsidian artifacts overall are very low at Mayan settlements.

The vegetation of the lowland Maya Yucatan is much denser than that of central Ohio. The harder it is for past peoples to recover lost items makes this task no less difficult for modern archaeologists. Milpa agriculture (Batun Alpuche 2009) does not expose soils the same way that plowing and disking does (Olson 2019). And, unlike the Yucatan peninsula, there is a very strong collector culture which promotes walking farm fields by hobbyists. One of the oldest collector-based organizations in the United States was founded in central Ohio (Archaeological Society of Ohio). Nearly every square centimeter of central Ohio soil has been exposed now or in the recent past through agricultural or construction activity, while the same cannot be said of the Yucatan peninsula.

Given the dearth of regional surface surveys in the Yucatan, this raises the question of representative sampling of the lowland Maya data, especially compared to the abundant reporting in Central Ohio. The recovery rate of isolated projectile points in Central Ohio is almost certainly higher than the Maya lowlands. Nearly 50 percent of all arrow points recovered in Central Ohio are isolated finds or non-village contexts, typically recovered during surface survey.

However, this is at the very least a starting point in estimating those projectile points that may be recovered in the Milpas, forests, and underbrush of the Yucatan peninsula via systematic surface survey. Only 9 arrows in the Mayan sample represent unprovenienced contexts; the rest of the sample comes from excavation data within known Post-Classic Mayan sites. Thus, the proportion of Ohio non-village arrows to village arrows can be used to estimate the expected arrows recovered from a surface survey of the entire Yucatan Peninsula. Doubling the total number of arrows in the Mayan sample may be a more accurate reflection of total arrows in the Maya lowlands. The estimated number would then be 4,570 arrows total within the Maya lowlands.

Using the previously mentioned populations estimates, this new estimate translates to roughly 1 arrow per 113 (using the low estimate of 519,000) and 1 arrow per 262 individuals (using the liberal population estimate of 1.2 million people) in the Maya lowlands. The density for central Ohio is 1 arrow per 0.87 people (using the low population estimate of 2,400) and 1 arrow per 2 individuals (liberal estimate of 5,200). In both cases, these estimates are not factoring in population changes through time or the accumulation rate of arrows in the archaeological record. For these obvious reasons, these estimates are not a true reflection of arrows in either region at any point in time. However, they do illustrate that, despite doubling the number of arrows recovered in the lowlands, the density is still extremely low relative to Ohio.

Another explanation of differences between these two regions is cultural differences in use-life and curation. Meissner (2014: 394) and Meissner and Rice (2015) note the diverse uses for arrows among Lake Peten peoples, including bloodletting and cutting. The wide array of uses of arrow points may be explained in part to the reduction sequence or use life of an arrow point. Many Mayan arrows are made from prismatic blades (Andresen 1976: 172; Philips 1979: 108; Meissner 2014: 259), which means these arrow points are morphologically restricted by the original size of the blade. The assumption by others is that expedient tool manufacture and use is the result of access to raw materials either by proximity or through stockpiling (Stemp *et al.* 2021: 4). Stemp *et al.* (2021) have recently emphasized the importance of debitage analysis at Post-Classic Mayan sites, since many lithic raw material sources are distant and only accessible through trade (particularly obsidian), thus forcing many Maya communities to utilize whatever chert or obsidian material can create a sharp edge.

Sources for obsidian come from the highlands to the south and the Valley of Mexico to the west, while some cherts came from central and Northern Belize (Horowitz 2017; Lincoln 2018: 31). Relatively speaking, cherts were more prevalent and accessible in the lowlands by simple distance than obsidian. Aside from a few coastal zones in Yucatan and Quintana Roo, chert was readily available in the Maya Lowlands. The limited access to chert for Quintana Roo and coastal zones may be a key factor in the low arrow densities noted by Meisner (2014: 59). The limestone bedrock of the Yucatan provides a ready supply of evenly distributed chert resources (Andrieu 2014). Ohio also has readily available chert sources. Glacial deposits of cherts can be found in the till plains of central Ohio (several cobbles were noted during COADS), while the outcrops of cherts such as Delaware or Columbus run nearly from the Ohio River to Lake Erie (Vickery 1993). The Scioto River and tributaries cut into outcrops and transport cobbles into gravel beds in rivers and streams.

Meissner (2014: 64) suggests resharpening and repair of arrow points was far more prevalent among the Lowland Maya than previously thought. If arrows are being utilized for more than just projectiles (Meissner & Rice 2015) then it stands to reason these tools will dull and need resharpening. Figure 5 outlines the possible stages of obsidian tool use-life. As Shott (2020) has noted, projectile points "must be calibrated to ratio-scale rates of use" when examining assemblages. It is possible, at least in the case of obsidian blades, that their versatile utility versus the very specific use of arrow points led to stockpiling of prismatic blades as future arrows, drills, awls, and scrapers as they were needed. They can be easily stored, provide a uniform cutting edge, and require minimal flintknapping abilities to use. We should expect arrows made from prismatic blades to be made only when necessary or when a prismatic blade has been exhausted. It may be more useful for households to store prismatic blades and unretouched flakes (which have a higher use value) than to modify them into arrow points. Since warfare is not an unplanned event, there is likely no need to keep large reserves of arrows.

Mayan warfare was anything but simple; many different types of weapons were available for use in combat, with lances favored more than other weapons (Aoyama 2005, 2017; Aoyama & Graham 2015). In iconography, there is no extant evidence of bow-and-arrows depicted in the Mayan world (Aoyama & Graham 2015; Ciofalo 2012; Meissner 2014: 379), which indicates a lesser importance of the bow-and-arrow, at least symbolically, in the role of warfare. Aoyama (2005; 2016; 2017; 2021) suggests the arrow was not the weapon of choice for Pre-Classic and Classic Mayan warriors. However, by the Post-Classic, weapon preference may have changed. Meissner's (2014: 53) argument, based mainly on historic accounts, is that bows were the preferred weapon starting in the Post-Classic. In either case, there was a clear decline in atlatl use in the Post-classic. The debate therefore is the rate and scale of atlatl versus arrow use in the Post-Classic. However, the same cannot be convincingly said of Central Ohio populations, who appear to altogether abandon atlatl use by the turn of the tenth century. Perhaps this difference alone may account for the varying densities of arrows in Ohio and Mayan contexts.

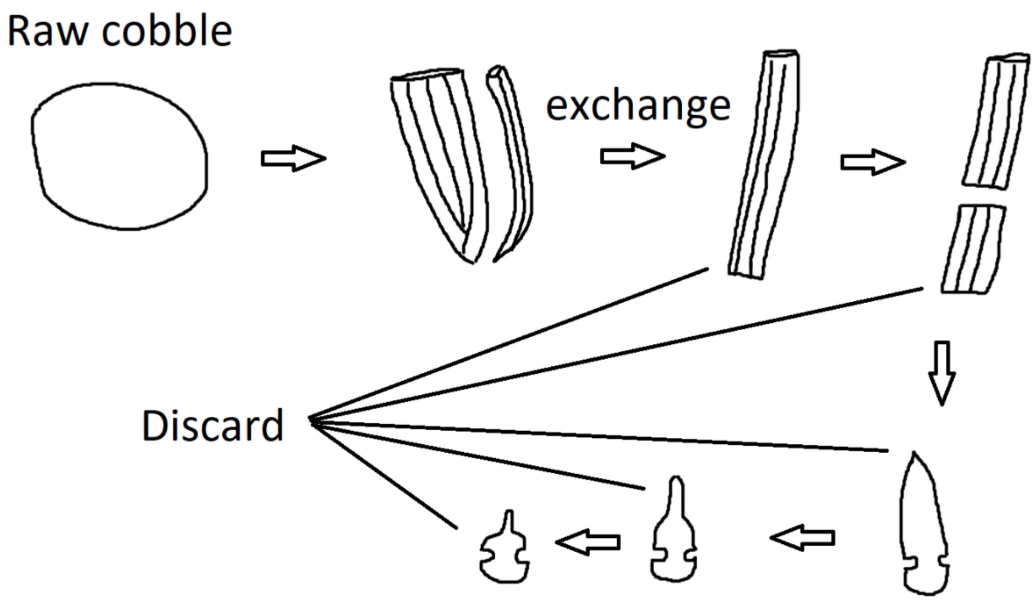

Figure 5. Reduction sequence of obsidian prismatic blades (figure by author).

The last aspect to consider is differences in hunting behaviors. Hamblin (1984: 308-310) notes the concentration of mammal remains in elite contexts on Cozumel. Peccary and deer increase significantly in consumption on Post-Classic Cozumel compared to Pre-Classic and Classic periods (Hamblin 1984: 314). Hunting game is not only about caloric and nutritional needs, but also as a source of bone for making tools. Contrary to Lowland Maya, indigenous peoples in central Ohio created a wide variety of bone implements from large mammal long bones (Brady-Rawlins 2007: 65; Oehler 1973: 25-26). The bone tool industry of Ohio was diverse; people did not just hunt for the consumption of meat, but also for the bones as tool sources (Lepper 2005). However, on Cozumel, only one percent of the entire faunal assemblage analyzed by Hamblin (1984) was modified into tools.

But do you need a stone tipped arrow to hunt? As others have noted (Meissner 2014: 460; Mika *et al.* 2020; Shott 2020) there is a correlation of prey size and arrow size, but also quite a corpus of ethnographic data that indicate arrow tips were not always made of stone (Kelly 2013; Shott 2020), thus the number of stone arrow points may be an underestimate of total arrows prehistorically. Aside from peccary and deer, it seems unlikely that stone arrow points would be necessary to kill most of the game identified by Hamblin (1984).

5. Conclusions, significance, opinions

There is likely an amalgam of explanations for why lowland Mayan arrows are not more prevalent in the extant archaeological record, or that central Ohio arrows occur at higher relative frequencies. Recovery rate and systematic survey plays a bigger role than any other explanation, but this likely does not tell the entire story. Mayan warfare was less about killing people and more about acquiring captives, thus reducing the need for projectiles that would mortally wound (Aoyama & Graham 2015). This is in stark contrast to central Ohio warfare, which potentially maximized mortal wounds to enemy combatants (Mika *et al.* 2020). The difference in warfare may in part be the result of the differential labor needs of central Ohioans and lowland Maya elites, since the later needed a large labor force to build stone structures and practice intensive maize agriculture (supporting upwards of 70 % of the Maya diet, White & Schwarcz 1989).

The hypothesis that the use-life of arrow points may have been longer due to extensive resharpening warrants further study. Meissner's (2014: 356) use of Clarkson's (2002) index of invasiveness is more subjective than quantitative methods such as Miller & Smallwoods's (2012) flaking index. Resharpening may not account for repurposing of "exhausted" arrow points into even smaller tools, such as drills or awls. The high breakage rate of Ohio arrow points (Engelbrecht 2015; Mika *et al.* 2020) suggests these points were not repurposed or resharpened once manufactured. Thus, the single-use design of Ohio arrow points may account for the high density of arrow points recovered in the study area.

While none of these factors is likely to explain most of the arrow distribution between either context, further cross-cultural comparisons of this scale have the potential to yield new insight into prehistoric human behavior. Cross-cultural comparisons between geographically distinct archaeological cultures were hampered in the past by the lack of sufficient data. However, as large, regional scale systematic surveys and inventories become accessible, these datasets allow for much broader comparisons which were previously not possible. The only thing for us to do as archaeologist is compile the data into cohesive analytical units for comparison.

In this study, all data were compiled from the reports and research of other archaeologists and required no additional fieldwork; in other words, no shovel required (Olson 2017). "Big data" has opened new lines of inquiry (see VanValkenburgh & Dufton 2020). Considering the COVID-19 pandemic, perhaps the lessons of big data and digital archaeology are that new research can continue even when excavation and survey cannot.

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Data accessibility statement

The data compiled for this study were compiled from open access databases, digitized collections, dissertations and theses, and other published works. In the case of Ohio archaeological sites, due to the sensitivity and regulations, access to the Ohio Archaeological Inventory should be sought through the Ohio Historic Preservation Office. Derived data supporting the findings of this study are available from the corresponding author on request.

List of supplementary files

Supplementary file 1
"Eric_Olson - supplementary file 1 – appendixtable2.xls"
Raw frequencies of tools, provenience, and sources from Yucatan sites.

Supplementary file 2
"Eric_Olson - supplementary file 2 – appendixtable3.xls"

Raw frequencies of tools, provenience, and sources from Ohio sites.

Supplementary file 3
"Eric_Olson - supplementary file 3 – appendixtable4.xls"
Frequency table of materials used in the creation of Figure 4 histogram.

Supplementary file 4
"Eric_Olson - supplementary file 4 – appendixtable5.xls"
Population estimates for Mayan cities, and their sources.

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¿A dónde se han ido todas las flechas?: Una comparación transcultural del uso de las flechas en las tierras bajas de los Mayas y en el centro de Ohio

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Resumen:

Las puntas de flecha son un recurso lítico abundante, pero ¿exactamente qué tan abundantes? Estudios sistemáticos recientes de las tierras bajas mayas y el centro de Ohio permiten una nueva comparación transcultural del uso de las flechas y los factores que pueden conducir a sus diferentes acumulaciones en el registro arqueológico. Sorprendentemente, el uso de flechas mayas, al menos en términos de frecuencias registradas en el registro arqueológico, es menor que el de las poblaciones de la Prehistoria Tardía del centro de Ohio. Ohio central tiene una densidad de población mucho menor que la península de Yucatán, en una escala de aproximadamente 10 a 20 veces menor que Yucatán. Dada esta diferencia extrema en las densidades de población, la escasez de puntas de flecha en el contexto de Yucatán es inesperada. Hay muchos factores que pueden explicar la escasez de puntas de flecha en contextos mayas, en comparación con los conjuntos de flechas relativamente densos en los sitios de Ohio. Estos muchos factores justifican una mayor investigación y análisis en estudios de flechas líticas tanto de Ohio como de los mayas. Esta investigación presenta los resultados de un análisis comparativo preliminar. Es probable que varios factores expliquen la diferencia entre las frecuencias de las flechas mayas y de Ohio. Dado que la mayoría de las flechas en Ohio se encuentran como hallazgos aislados, la explicación más probable es una diferencia en la cobertura del estudio entre Ohio y las Tierras Bajas Mayas. Puede haber un patrón similar de hallazgos aislados de flechas en Yucatán, pero la mayor parte de los estudios arqueológicos en la región se centran en grandes asentamientos y no en hallazgos aislados. La densa vegetación es un factor limitante en México, mientras que la mayor parte de Ohio se ha utilizado como campos agrícolas arados con una gran comunidad de coleccionistas de artefactos aficionados. Los otros factores que contribuyen incluyen la vida útil relativamente corta de las puntas de flecha de Ohio y la falta de diversidad de armas en Ohio. Las culturas de Ohio utilizan casi exclusivamente proyectiles basados en flechas una vez que el arco y la flecha se introducen en la región. Esta misma tendencia no se aplica a los sitios mayas de las tierras bajas. Ambos factores resultan en un mayor uso de flechas y una mayor tasa de depósito en comparación con las Tierras Bajas Mayas. Por último, el acceso a la materia prima dentro de las dos regiones ha dado lugar a tasas de curación de herramientas de piedra muy diferentes. La abundancia de canteras de pedernal y depósitos de grava en el centro de Ohio permite una inversión relativamente pequeña en costos de búsqueda o adquisición para la fabricación de herramientas de piedra, mientras que en muchas partes de Yucatán el pedernal es inaccesible para la extracción o no se encuentra naturalmente. El resultado es que muchas flechas en Yucatán, especialmente las de obsidiana, se crean a partir de hojas prismáticas, que funcionan como una forma o preforma de flecha. La escasez de materias primas probablemente favoreció el uso de hojas prismáticas el mayor tiempo posible antes de crear flechas con ellas. La conclusión de este estudio es que hay varios factores que contribuyen a las diferencias en la frecuencia de las flechas en Yucatán y Ohio central, pero la cobertura de la encuesta y la disponibilidad de materia prima son probablemente los factores más importantes en esta disparidad. Estudios como este no serían posibles sin el uso de datos adquiridos mediante minería de datos. Con el aumento de archivos y registros digitales, la extracción de datos a gran escala puede abrir nuevas vías de investigación en arqueología. Estudios comparativos como este tienen el potencial de cambiar nuestra comprensión colectiva de la guerra, los conflictos y el uso de herramientas por parte de los pueblos del pasado.

Palabras clave: Guerra; caza; vida útil; análisis de datos; tasa de curación; estudios comparativos