Sedentism, Specialization, and Economic Activity among the Lowland Classic Period Maya

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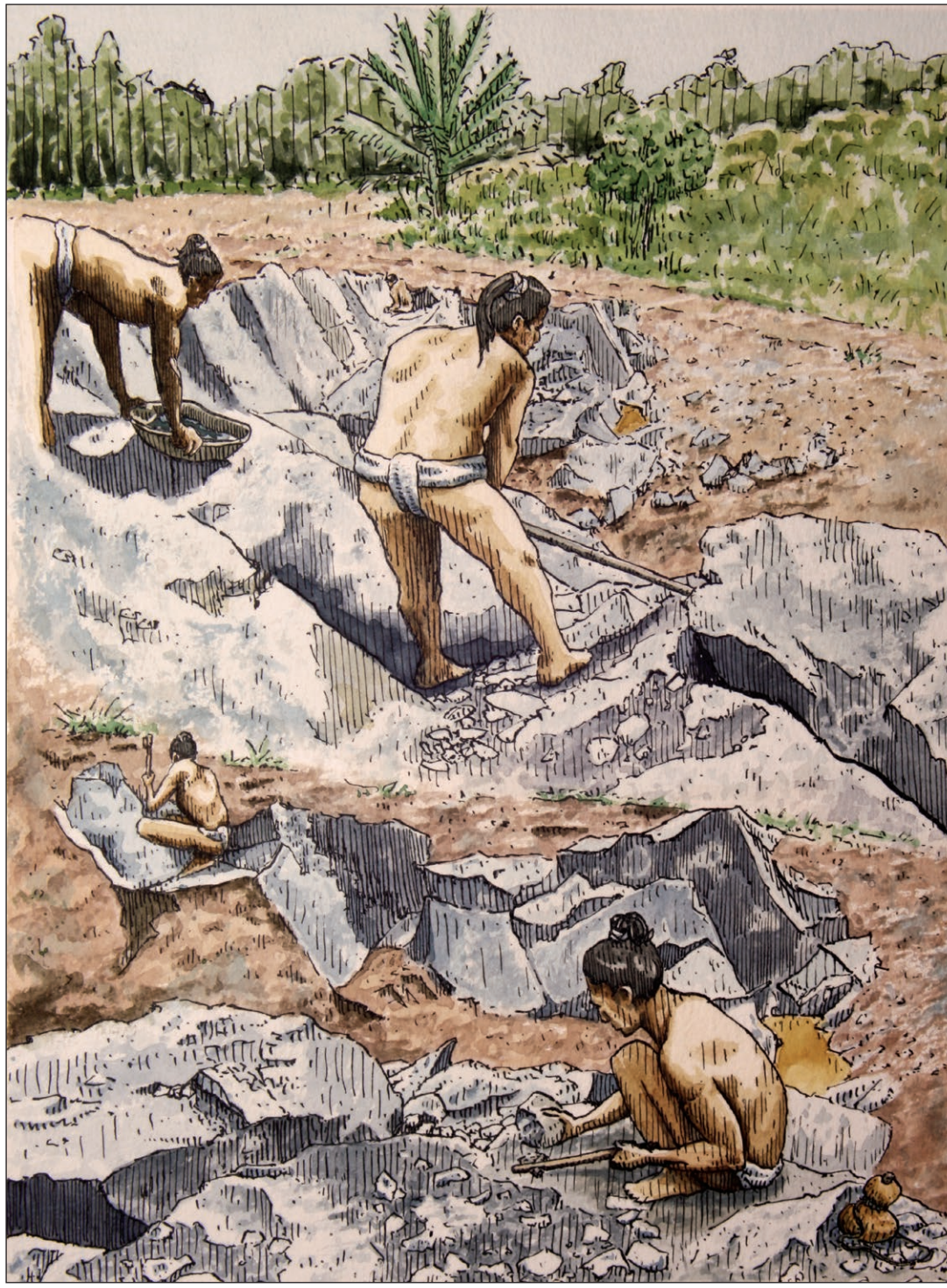
Lithics are one of the most widely encountered archaeological materials in both mobile and sedentary societies. This paper addresses the ways in which lithics are impacted by sedentism and what that illustrates concerning their integration into broader economic systems. In many sedentary societies, including the Maya, both formal and informal lithic tools were produced. This dichotomy can be explained by the presence of specialized and non-specialized lithic producers. Drawing on examples from the upper Belize River valley, this paper focuses on three main topics: (1) the role of sedentism on tool form; (2) the role of specialization in tool production; and (3) the importance of exchange mechanisms because of specialization. In addition, this paper discusses lowland Maya lithic production in comparative perspectives to other sedentary societies which also have the specialized and non-specialized production of formal and informal tools. Using these comparisons, broad discussions of the impact of sedentism and specialization on lithic economies can be achieved.

Keywords: lithics, Maya, specialization, economies, sedentism



The role of sedentism and its impact on tool production is a topic of much archaeological discussion (e.g., Clark and Barton 2017; Horowitz and McCall 2019; McCall 2019; McCall and Horowitz 2014; McDonald 1991; Parry and Kelly 1987; Testler 1991). The impact of sedentism on tool production can be seen both in how tools are produced and the ways in which economic organization is used to mediate peoples' need to acquire tools. Here I address general considerations about the impact of sedentism on tool form as well as how sedentism impacts specialized tool production. Using examples from the Classic Period Maya lowlands, I discuss specialized production and its implications for economic exchange networks. Broadly, this discussion can be used in comparison with other sedentary societies to examine how sedentism impacts production and economic networks.

Although the impact of tool production on sedentary societies might be thought of as a specific topic of interest only to lithic specialists, it has implications for our understanding of broader economic frameworks. Specialization and specialized production, particularly of utilitarian goods, necessitates trade (Costin 2004). The necessity of exchange indicates that economic mechanisms must be used to obtain goods. The types of mechanisms used to obtain goods might also impact both tool form and the ways in which people make tools.

When discussing the impacts of sedentism on tool technology, a dichotomy is thought to have existed between tools in mobile and sedentary societies (Parry and Kelly 1987). As with many other classifications in anthropology, the distinction between mobile and sedentary societies is a spectrum, with degrees of mobility occurring (e.g. Binford 1980). However, the use of these terms can aid in discussions of the constraints that different levels of mobility may place on technologies. Scholars studying these issues have proposed that mobile societies focused on formal tool production: tools which are prepared in advance of use and require effort in their construction, such as bifaces (see Beck et al. 2002; Binford 1980; Kelly 1988; Parry and Kelly 1987). In contrast, sedentary societies are thought to have produced informal tool technologies: unstandardized tools that require minimal effort in construction (Andrefsky 2005; Nelson 1991). This difference was generally argued to relate to different organizational strategies based on differences in mobility (see Carr et al. 2012; Nelson 1991; Vaquero and Romagnoli 2018 for an overview of organization approaches). Mobile peoples prioritize minimizing the weight of materials they carry (see Beck et al. 2002), while in sedentary societies, this is not an issue. Instead, the emphasis on informal tools in sedentary societies has generally been seen as a result of the ability to stockpile raw materials, which reduces the need to conserve raw materials, and thus allows people to produce more informal tools (Parry and Kelly 1987). Some studies, in fact, used the formality and informality of tools as ways of examining levels of sedentism (i.e. McDonald 1991).

Recent studies (Testler 1991; McCall et al. 2019; Vaquero and Romagnoli 2018) have proposed alternative explanations for the focus on informal tools, including limited access to and small size of raw materials and a lack of regionally available raw material sources. That is, rather than the lack of need to conserve raw material, lack of access to raw material can also result in informal tools. In addition to access to raw material resources, raw material quality can also impact the production of different types of tools. High quality raw material is often utilized for formal tools, which may be

more difficult to knap into these forms than lower quality raw materials (Andrefsky 1994a,b). The trade and exchange of lithic materials can further complicate the relationship between sedentism and tool types, as materials are brought in from long distances (Stemp 2001; Stemp and Graham 2006). Thus, the discussion of the impacts of sedentism on tool technology requires more investigation and seems to be reacting to multiple issues (see Horowitz and McCall 2019). That is, rather than a result of a simple correlation with sedentism, tool form in sedentary societies is influenced by multiple constraints.

Perhaps most interesting is that despite the shifts between levels of mobility and formal and informal tool technologies, sedentary societies also rely on formal tools. In the Maya region, blades and bifaces are two of the most common lithic materials identified and their presence as formal tools leaves an avenue for the examination of the organizational principles which result in the presence of these tools (see Horowitz and McCall 2019 for an overview). In other sedentary societies, we see similar trends in the presence of formal tools and informal lithic production, and in some cases, metallurgy. Such tools include blades in the Near East and Mesoamerica and bifaces in many other areas (see Cobb 2000; Gaxiola and Clark 1989; Goodale et al. 2002; Hirth 2003, 2006; Hirth and Andrews 2002; Quintero and Wilke 1995).

The co-occurrence of formal and informal tools could be a result of different constraints operating in sedentary rather than in mobile societies. In sedentary societies, raw materials tend to be acquired from nearby locations (McCall and Horowitz 2014; McCall et al. 2019) or obtained via long distance trade routes, such as obsidian in Mesoamerica (see Gaxiola and Clark 1989; Hirth 2006; Hirth and Andrews 2002; Levine and Carballo 2014). This difference will influence the ways in which tools of those materials are made. Non-local raw materials have been associated with formal tools, particularly when locally available resources are in short supply or are of poor quality for knapping (Andrefsky 1994a). In the situation discussed here, however, raw material is locally available, abundant, and of varying quality, so the relationship between raw material quality, availability, and tool form will be more complex (see Andrefsky 1994a: Fig 2). Furthermore, requirements for tools used in agriculture differ from those in non-agricultural economies (see Whittaker, Kamp, and Yilmaz 2009). Many examples of formal tools in sedentary societies have agricultural uses (see Anderson et al. 2004; Kardulias 2008; Whittaker 2019; Whittaker et al. 2009; Yerkes 2000), thus the presence of these tools results from specific functional concerns. Among the Maya, formal tools, particularly bifaces, are used for a variety of functions including warfare/hunting (Aoyama 2009, 2011; Meissner 2017), ritual use (Kwoka et al. 2019), and quarrying, shaping blocks, and agricultural tasks (Clark and Woods 2014; Lewenstein 1987; Titmus and Woods 2003; Woods and Titmus 1996). Furthermore, as discussed below, specialists also might impact tool production mechanisms.

Specialization and Lithic Production

In both the Maya region and in other areas, formal tools are associated with the presence of specialized producers. Although specialization is a complicated term and one with much anthropological baggage, it is of use here as it allows a discussion of who is producing tools. Here I define specialization as the production of items in greater quantities than necessary for one's own

consumption (after Costin 1991:4), or production for items used exclusively outside the household/workshop context. The latter part of this definition may be particularly important in reference to items used in ritual activities, which may not be produced in large quantities. Further discussion of specialization and its ensuing debates are outside the scope of this paper.

Lithics provide a unique opportunity to examine specialization as lithic production is a reductive technology, and thus the remains of lithic production are (relatively) easy to identify. The reductive nature of lithic technology makes it easier to quantify the amount of materials which may have been produced in a region, allowing discussions of the production of materials beyond the need of a single individual.

In the lowland Maya region, lithic specialization is almost always associated with the site of Colha. Colha (Shafer and Hester 1983, 1991) illustrated site-level specialization, where the entire site was devoted to lithic production. This scale of lithic production is unprecedented in other areas of the Maya region, and Colha cannot serve as a model for this type of production. It is located in an area of particularly high-quality raw materials, not found in the surrounding region, thus allowing a producer-consumer exchange network to develop (King 2012; McAnany 1989). As site-level lithic specialization has not been identified elsewhere in the lowland Maya region, studies of lithic specialization should examine smaller-scale production areas.

Here I briefly present evidence for specialization among lithic producers in the Maya Lowlands, using evidence from the upper Belize River valley in western Belize. I focus on specialization in chert lithic materials, as although prismatic blades (of obsidian) are a common formal tool, the raw material for their production is only present in highland areas of Mesoamerica, and there is little evidence of their production in the upper Belize River valley. However, evidence from blade workshops close to obsidian sources indicates specialized blade production (see Braswell 2002; Parry 2001; Rice 1987). Instead, I focus here on evidence for specialized biface production, as this is something visible in western Belize. Multiple workshops exist in the valley including the Succotz Lithic Workshop (VandenBosch 1999), El Pilar (Whittaker et al. 2009) and others (Connell 2000; Hearth 2012; Sullivan et al. 2016). I will also briefly mention specialized production of informal lithic tools, which is less common, but an important component for understanding lithic production and exchange networks.

Bifaces are formal tools that are worked on two sides. Their production results in distinctive debitage which allows recognition of biface production areas. Bifaces are used for warfare and hunting (Aoyama 2009, 2011), ritual/ceremonial purposes (Aoyama 2009, 2011; Kwoka et al. 2019), and for a variety of utilitarian functions (Clark and Woods 2014; Horowitz et al. 2019; Lewenstein 1987; Titmus and Woods 2003).

Upper Belize River Valley and Lithic Production

The upper Belize River valley of western Belize is located in the eastern part of the Central Maya lowlands. The valley is defined by the Macal, Mopan, and Belize Rivers, and has been extensively investigated (see Chase and Garber 2004; Houk 2015 for an overview). Although occupation in the region spans a lengthy period, my discussion focuses on the Late to Terminal Classic period (AD 670-890; see LeCount et al. 2002), the period of major use of the workshops discussed.

Multiple chert sources exist in the region, indicating that raw material scarcity would not have

Figure 1. The Succotz lithic workshop debitage (photo by author).

been an issue for lithic producers nor for local residents. Within the valley, chert is found in *in situ* chert beds, as cobbles eroding out of the limestone bedrock, and in secondary alluvial deposits along floodplains and in the river (Horowitz 2017; VandenBosch 1999; Yaeger 2000). The raw material varies greatly in quality, with high- and low-quality materials found within a single cobble and within the same deposits (Horowitz 2017). The variable chert quality probably impacted the production aims of knappers when using different sources. In this discussion of specialized production areas, I first relate evidence for biface production specialization, followed by a discussion of the specialized production of non-formal tools, or at least of the early stages of their production.

The Succotz Lithic Workshop consists of quarry areas with adjacent workshops (VandenBosch 1999). The analysis of the debitage from these areas indicated biface production as the predominant activity (Figure 1). Excavations revealed densities of between 900,000 and 2 million flakes per cubic meter (VandenBosch 1999; VandenBosch et al. 2010), indicative of intensive production. Analyses of the lithic materials suggest an exclusive focus on formal tool production, with the goal of producing General Utility Bifaces (GUB's). The workshop is located within a household group, indicating the residents of this household group were lithic producers (VandenBosch 1999; VandenBosch et al. 2010). The density of debitage indicates that the occupants were specialized biface producers. They were probably not full-time specialists, but rather part-time specialists who also participated in other activities (see also Horowitz 2019).

Other investigations of biface workshops in western Belize include excavations at El Pilar

Figure 2. Visible surface of the El Pilar workshop area (photo by author)

(Whittaker et al. 2009). This example differs from Succotz, as it is in the site core of a major center, rather than in a household group. Evidence from the workshop again suggests almost exclusive biface production (Figure 2). A platform for lithic production and associated disposal area had evidence for GUB production as well as some evidence for thinned bifaces. The density estimates resemble those found at Colha, and Whittaker and colleagues (2009) suggest that between 66,000 and 250,000 axes could have been produced in the workshop. This is much greater than any household would require, thus indicating specialized production.

In addition to these two large workshops, some investigations of other biface production areas have been performed (Sullivan et al. 2016). The investigation of these workshops suggests that these rural biface production areas resemble those at the Succotz Lithic Workshop. Smaller scale workshops are also found at households around the upper Belize River valley, such as at Chan (Hearth 2012) and Chaa Creek (Connell 2000). These households produced chert bifaces in small quantities, but as only a single household in each community produced bifaces, these producers were specialized biface creators, only on a small scale intended for exchange within the broader community.

Biface production has also been identified in the Buenavista and Xunantunich marketplaces (Cap 2011, 2015, 2019). The debitage from the marketplaces shows that final stage finishing and retouching of lithics was performed in these locations (Cap 2011, 2015, 2019). The presence of

production debris in the marketplaces suggests that bifaces were distributed through markets, although they may also have been distributed through other mechanisms. The distribution of these materials through markets by the producers indicates close connections between producers and consumers (Yaeger 2010).

In addition to biface production specialization, we see some instances of specialized production of generalized tools, or the preparation of cores, such as at Callar Creek Quarry (Horowitz 2017, 2018, 2019). The quarry is an area for the extraction and production of generalized cores and blanks which were transported away from the quarry (Horowitz 2017; Figure 3). The adjacent households were involved in production activities, and were probably part-time lithic specialists, who were also involved in farming and other activities (Horowitz 2017, 2018, 2019). The density of materials suggests production beyond that which would be necessary for the households (Figure 4). The fact that this non-formal tool production area also has specialized production is interesting, as it indicates more variety in the types of activities that people were performing as lithic producers. The evidence from Callar Creek Quarry points to a diversity of production activities performed by knowledgeable lithic producers.

Non-specialized Production Activities

In contrast to the specialized production activities, the materials found in non-lithic producing

Figure 3. Quarrying activities at Callar Creek Quarry (photo by author)

Figure 4. Density of lithic production at Callar Creek Quarry (photo by author)

households are indicative of non-specialized production. Extensive excavations of households in the region (e.g. Connell 2000; Robin 1999; VandenBosch 1999; Yaeger 2000), illustrate that lithic debitage was present in most households. However, the production of materials within these households was generalized. Specifically, people engaged in the production and use of informal tools within households (Horowitz 2019). These informal tools include unmodified flakes, minimally retouched flakes, and other minimally altered flake tools. The presence of retouch on the edges of the flakes indicates their use as informal tools – the retouch was all macroscopically visible and distinguishable from post-depositional ware. The presence of lithic debitage in household contexts illustrates that non-specialists had the skills to make and use some tools, particularly flake tools including retouched flakes, drills, and scrapers. However, there is little evidence of biface production activity outside of the specialized biface areas. The lack of biface material, combined with the presence of biface finishing and retouching at the Buenavista and Xunantunich markets (Cap 2011, 2015, 2019), indicates that non-specialists did not make bifaces and other formal tools. Furthermore, Cap's (2011, 2015, 2019) research in marketplaces highlighted that specialists were also repairing bifaces, as evidence by biface retouching flakes with polish on them. These data indicate that biface producers were also retouching bifaces to order, and suggest that householders were not repairing their bifaces. Thus, we have a similar dichotomy in western Belize to that seen in other sedentary societies, where specialists made specific types of tools and non-specialists made

more generalized tools used for a variety of functions.

Discussion

From this overview of lithic production in western Belize, we can draw the conclusion that in the lowland Maya region, specialists made mostly formal tools and non-specialist householders produced informal tools. This pattern indicates the presence of multiple production and exchange networks operating within the lithic economy.

From this dichotomy, we can draw comparisons with other regions to address the relative skill of the producers. While studies of the skill of specialist and non-specialist producers in the Maya area have not been performed, in studies of other sedentary societies Manclossi and Rosen (2019) propose that with increased specialization of tool producers, the skill level of non-specialized producers decreases. This pattern makes sense as non-specialists would no longer be performing the complex activities necessary to make more complicated tools, and thus would not possess those skills.

Another arena of interest to discussions of specialization, which is comparable across sedentary societies, is that given these specialized production systems for formal tools, there must be exchange systems in place; otherwise people would not be able to obtain the materials they require to perform daily tasks. In the upper Belize River valley, excavations at marketplaces (Cap 2015, 2019) indicate that at least some of this trade was conducted via market exchange, although other mechanisms of exchange could also have been utilized. In terms of the exchange of non-biface material, Cap's investigations illustrated only biface production in marketplaces. This does not indicate that other types of materials were not distributed through such means, only that they were not reduced in marketplaces. Other means of exchange could have also occurred, such as exchange with neighboring groups, gifting, and other activities. As such, multiple exchange mechanisms were probably operating for lithic raw materials.

For lithic producers, their engagement in lithic economies provides opportunities to accumulate wealth and to integrate within broader economic and political communities. Although craft producers are often associated with poor agricultural land and thus low economic status, this case study indicates that material wealth was gained through lithic production, or perhaps more likely, access to raw material sources. As craft specialists, lithic producers exchanged materials with other individuals which facilitated their integration in broader political communities. At Callar Creek Quarry, ceramics from the surrounding households point to connections with the neighboring political community of Buenavista (Horowitz 2017, 2019). These materials reflect the relationships between these communities and the economic wealth that was brought about through lithic production and exchanges.

Conclusions

In general, we can see several broad trends resulting from the impacts of sedentism on tool

technologies. One is that there are informal tools in sedentary societies, as proposed by Parry and Kelly (1987), but these informal tools are found in conjunction with formal tools produced by specialists. Alongside the increase in specialized production, non-specialists see a decrease in skill level, as they are not practicing the skills necessary to make these tool types (Manclossi and Rosen 2019). And, presumably, they spend less time working on lithic materials, which would also lead to a decrease in skill. Access to non-local formal tools, such as obsidian, may also impact these activities, due to variability in the reliance on different types of materials.

The presence of specialization implies that exchange networks were integral parts of daily life. The role of acquisition networks becomes vital to obtaining utilitarian tools, among other types of material. As such, these tools may have different constraints than tools that were made by non-specialists, as they must function when they were intended to function, as the non-specialists could not make their own. For example, colleagues and I (Horowitz et al. 2019) illustrated that some bifaces in the Maya area were purposefully thicker than we expect bifaces to be, which might result from functional requirements. These functional requirements probably resulted in part from the acquisition of the bifaces from specialists, as that would increase the requirement of the tools that they function when necessary, as users were not making their own tools. As most people were not producing or retouching bifaces (Cap 2015), they would have had limited options were a biface to break during use, particularly during important or time restricted activities. Thus, producers may have designed the tools with their reliability in mind, hence the tool thickness. This is just one example of the ways in which tool functionality can change due to sedentism and the reliance on specialized production, illustrating the connection between tool form and sedentism.

As discussed above, economic exchange has implications for our understandings of the wealth of producers. The use of various exchange mechanisms for the circulation of lithic materials indicates that materials are used as methods of economic integration (Horowitz 2019). Thus, we see that the role of specialists has important implications for our understanding of the ways that economies functioned and of the constraints on stone tool form.

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References

Anderson, Patricia C., Jacques Chabot, and Annelou van Gijn

2004 The Functional Riddle of 'Glossy' Canaanean Blades and the Near Eastern Threshing Sledge. *Journal of Mediterranean Archaeology* 17(1): 87-130.

Andrefsky, William Jr.

1994a Raw-Material Availability and the Organization of Technology. A*merican Antiquity* 59: 21-34.

1994b The Geological Occurrence of Lithic Material and Stone Tool Production Strategies. *Geoarchaeology* 9(5): 375-391.

2005 *Lithics: Macroscopic Approaches to Analysis*. 2nd edition. Cambridge University Press, Cambridge.

Aoyama, Kazuo

2009 *Elite Craft Producers, Artists, and Warriors at Aguateca: Lithic Analysis*. University of Utah Press, Salt Lake City.

2011 Socioeconomic and Political Implications of Regional Studies of Maya Lithic Artifacts: Two Case Studies of the Copan Region, Honduras and the Aguateca Region Guatemala. In *The Technology of Maya Civilization: Political Economy and Beyond in Lithic Studies*, edited by Zachary X. Hruby, Geoffrey E. Braswell, and Oswaldo Chinchilla Mazariegos, pp 37-54. Equinox, Sheffield.

Beck, Charlotte, Amanda K. Taylor, George T. Jones, Cynthia M. Fadem, Caitlyn R. Cook and Sara A. Millard.

2002 Rocks are Heavy: Transport Costs and Paleoarchaic Quarry Behavior in the Great Basin. *Journal of Anthropological Archaeology* 21: 481-507.

Binford, Lewis R.

1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1): 4-20.

Braswell, Geoffrey E.

2002 Praise the Gods and Pass the Obsidian? The Organization of Ancient Economy in San Martin Jilotepeque, Guatemala. In *Ancient Maya Political Economies*, edited by Marilyn A. Masson and David A. Freidel, pp 285-306. AltaMira Press, Walnut Creek.

Cap, Bernadette

2011 Investigating an Ancient Maya Marketplace at Buenavista del Cayo, Belize. *Research Reports in Belizean Archaeology* 8: 241-254.

2015 *Classic Maya Economies: Identification of a Marketplace at Buenavista del Cayo, Belize*. Ph.D. Dissertation, Department of Anthropology, University of Wisconsin, Madison.

2019 A Classic Maya Marketplace at Xunantunich, Belize. *Research Reports in Belizean Archaeology* 16: 111-122.

Carballo, David M.
2014 Obsidian Symbolism in a Temple Offering from La Laguna, Tlaxcala. In, *Obsidian Reflections: Symbolic Dimensions of Obsidian in Mesoamerica*, edited by Marc N. Levine and David M. Carballo, pp 195-221. University Press of Colorado, Boulder.

Carr, Philip J., Andrew P. Bradbury, and Sarah E. Price
2012 Lithic Studies in the Southeast: Retrospective and Future Potential. In *Contemporary Lithic Analysis in the Southeast: Problems, Solutions, and Interpretations*, edited by Philip J. Carr, Andrew P. Bradbury, and Sarah E. Price, pp 1-12. University of Alabama Press, Tuscaloosa.

Chase, Arlene F. and James F. Garber
2004 The Archaeology of the Belize Valley in Historical Perspectives. In *Ancient Maya of the Belize Valley: Half a Century of Archaeological Research*, edited by James F. Garber, pp 1-14. University Press of Florida, Gainesville.

Clark, Geoffrey A. and Michael Barton
2017 Lithics, Landscape, and the Longue-duree: Curation and Expediency as Expressions of Forager Mobility. *Quaternary International*, 450, 137-149.

Clark, John E. and James C. Woods
2014 Squeezing Life from Stones: The Human Side of Replication Experiments. In *Works in Stone: Contemporary Perspectives on Lithic Analysis*, edited by Michael J. Shott, pp 197-212. University of Utah Press, Salt Lake City.

Cobb, Charles C.
2000 *From Quarry to Cornfield: The Political Economy of Mississippian Hoe Production*. University of Alabama Press, Tuscaloosa.

Connell, Samuel V.
2000 *Were they Well Connected? An Exploration of Ancient Maya Regional Integration from the Middle Level Perspective of Chaa Creek, Belize*. PhD dissertation, Department of Anthropology, University of California Los Angeles.

Costin, Cathy L.
1991 Craft Specialization: Issues in Defining, Documenting, and Explaining the Organization of Production. *Archaeological Method and Theory* 3: 1-56.
2004 Craft economies of Ancient Andean States. In *Archaeological Perspectives on Political Economy*, edited by Gary M. Feinman and Linda M. Nichols, pp 189-221. University of Utah Press, Salt Lake City.

Gaxiola, Margarita and John E. Clark, eds.
1989 *La obsidiana en Mexoamerica*. Instituto nacional de arqueología e historia, Mexico.

Goodale, Nathan, Ian Kuijt, and Bill Finlayson
2002 Results from the 2001 Excavations at Dhra', Jordan: Chipped Stone Technology, Typology, and Intraassemblage Variability. *Paleorient* 28(1): 125-140.

Hearth, Nicholas F.
2012 Organization of Chert Tool Economy during Late and Terminal Classic Periods at Chan: Preliminary thoughts Based upon Debitage Analyses. In *Chan: An Ancient Maya Farming Community*, edited by Cynthia Robin, pp 192-206. University of Florida Press, Gainesville.

Hirth, Kenneth G., ed.
2003 *Mesoamerican Lithic Technology: Experimentation and Interpretation*. University of Utah Press, Salt Lake City.
2006 *Obsidian Craft Production in Ancient Central Mexico*. University of Utah Press, Salt Lake City.

Hirth, Kenneth G. and Bradford Andrews, eds.
2002 *Pathways to Prismatic Blades: A Study in Mesoamerican Obsidian Core Blade Technology*. Cotsen Institute of Archaeology, UCLA, Los Angeles.

Horowitz, Rachel A.
2017 *Understanding Ancient Maya Economic Variability: Lithic Technological Organization in the Mopan Valley, Belize*. PhD Dissertation, Department of Anthropology, Tulane University, New Orleans, LA.
2018 Uneven Lithic Landscapes: Raw Material Procurement and Economic Organization among the Late/Terminal Classic Maya in western Belize. *Journal of Archaeological Sciences: Reports* 19: 949-947.
2019 The Organization and Economic Activity Related to the Extraction and Production of Utilitarian Tools in the Mopan Valley, Belize. In *Global Perspectives on Lithic Technologies in Complex Societies,* Rachel A. Horowitz and Grant S. McCall, eds., pp 139-163. University of Colorado Press, Louisville.

Horowitz, Rachel A., Bernadette Cap, Jason Yaeger, Meaghan Peuramaki-Brown, and Mark C. Eli
2019 Material Preferences for Stone Tools: The Use of Limestone Bifaces in the Mopan Valley, Belize. *Latin American Antiquity* 30(1): 198-204.

Horowitz, Rachel A. and Grant S. McCall
2019 Lithics in Complex Societies: Themes, Methods, and Directions. In *Global Perspectives on Lithics in Complex Societies,* Rachel A. Horowitz and Grant S. McCall eds., pp 3-35. University of Colorado Press, Louisville.

Houk, Brett A.
2015 *Ancient Maya Cities of the Eastern Lowlands*. University Press of Florida, Gainesville.

Kardulias, P. Nick
2008 Interpreting the Past through the Present: The Ethnographic, Ethnoarchaeological, and Experimental Study of Agriculture. In *Archaeology and History in Roman, Medieval, and Post-Medieval Greece: Studies on Method and Meaning in Honor of Timothy E. Gregory*, edited by William R. Caraher and R. Scott Moore, pp. 90-126. Ashgate, London.

Kelly, Robert L.
1988 The Three Sides of a Biface. *American Antiquity* 53: 717-734.

King, Eleanor M.
2012 The Social Dimensions of Production and Consumption within Late Classic Colha, Belize. *Lithic Technology* 37(2): 77-94

Kwoka, Joshua J., H. Colleen Hanratty, and Thomas H. Guderjan
2019 From Crafting to Caching: Technological and Iconographic Analysis of Blue Creek Cache 37. *Journal of Field Archaeology* 44:352–366.

LeCount, Lisa J., Jason Yaeger, Richard M. Leventhal, and Wendy Ashmore
2002 Dating the Rise and Fall of Xunantunich: Belize: A Late and Terminal Classic Lowland Maya Regional Center. *Ancient Mesoamerica* 13: 41-63.

Levine, Marc N. and David M. Carballo (eds.)
2014 *Obsidian Reflections: Symbolic Dimensions of Obsidian in Mesoamerica*. University Press of Colorado, Boulder.

Lewenstein, Suzanne M.
1987 *Stone Tool Use at Cerros: The Ethnoarchaeological and Use-Wear Evidence*. University of Texas Press, Austin.

Manclossi, Francesca and Steven A. Rosen
2019 The Importance of Being *Ad Hoc*: Patterns and Implications of Expedient Lithic Production in the Bronze Age in Israel. In *Global Perspectives on Lithics in Complex Societies*, edited by Rachel A. Horowitz and Grant S. McCall, pp 69-88. University of Colorado Press, Louisville.

McAnany, Patricia A.
1989 Stone-Tool Production and Exchange in the Eastern Maya Lowlands: The Consumer Perspective from Pulltrouser Swamp, Belize. *American Antiquity* 54(2): 332-346.

McCall, Grant
2019 "The place is full of cabbages": An analysis of the Irish Late Mesolithic stone tool technology from Kenure, Co. Dublin. *Journal of Archaeological Science: Reports* 23: 203-215.

McCall, Grant S. and Rachel A. Horowitz
2014 Comparing Forager and Pastoralist Technological Organization in the Central Namib Desert, Western Namibia. In *Works in Stone: Contemporary Perspectives on Lithic Analysis*, edited by

Michael J. Shott, pp 63-77. University of Utah Press, Salt Lake City.

McCall, Grant S., Rachel A. Horowitz, and Dan M. Healan
2019 Chert at Chalcatzingo: Implications of Knapping Strategies and Technological Organization for Formative Economics. In *Global Perspectives on Lithics in Complex Societies*, edited by Rachel A. Horowitz and Grant S. McCall, pp 164-183. University of Colorado Press, Louisville.

McDonald, Mary M. A.
1991 Technological Organization and Sedentism in the Epipaleolithic of Dakhleh Oasis, Egypt. *The African Archaeological Review* 9: 81- 109.

Meissner, Nathan J.
2017 A Social Network Analysis of the Postclassic Lowland Maya Obsidian Projectile Industry. *Ancient Mesoamerica* 28:137–156.

Nelson, Margaret C.
1991 The Study of Technological Organization. In *Archaeological Method and Theory Volume 3*, edited by Michael B. Schiffer, pp 57-100. The University of Arizona Press, Tucson.

Parry, William J.
2001 Production and Exchange of Obsidian tools in Late Aztec City States. *Ancient Mesoamerica* 12: 101-111.

Parry, William J. and Robert L. Kelly
1987 Expedient Core Technology and Sedentism. In *The Organization of Core Technology*, edited by Jay K. Johnson and Carol A. Morrow, pp 285-304. Westview Press, Boulder.

Quintero, Leslie A. and Phil J. Wilke
1995 Evolution and Economic Significance of Naviform Core Blade Technology in the Southern Levant. *Paleoriente* 21(1): 17-33.

Rice, Prudence M.
1987 Economic Change in the Lowland Maya Late Classic Period. In *Specialization, Exchange, and Complex Societies*, edited by Elizabeth M. Brumfiel and Timothy K. Earle, pp 76-85. Cambridge University Press, Cambridge.

Robin, Cynthia
1999 *Towards an Archaeology of Everyday Life: Maya Farmers of Chan Noohol and Dos Chambitos Cik'in, Belize*. PhD Dissertation, Department of Anthropology, University of Pennsylvania, Philadelphia, PA.

Shafer, Harry J. and Thomas R. Hester
1983 Ancient Maya Chert Workshops in Northern Belize, Central America. *American Antiquity* 48(3): 519-543.

1991 Lithic Craft Specialization and Product Distribution at the Maya Site of Colha, Belize. *World Archaeology* 23(1): 79-97.

Stemp, W. James
2001 *Chipped Stone Tool Use in the Coastal Economies of Marco Gonzalez and San Pedro, Ambergis Caye, Belize*. BAR, Archaeopress, Oxford.

Stemp, W. James., and Elizabeth Graham.
2006 Ancient Maya Procurement and Use of Chipped Chert and Chalcedony Tools at Marco Gonzalez, Ambergris Caye, Belize. *Lithic Technology* 31: 27–55

Sullivan, Kelsey J., Jaime J. Awe, and Shane Montgomery
2016 Welcome to Bedrock: Archaeological Investigations at the Lithic Tool Production Area, the Etz'nab Tunich Group, Cayo, Belize. In *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2015 Field Season*, edited by Julie A. Hoggarth and Jaime J. Awe, pp. 182-212. Report submitted to the Institute of Archaeology, Belmopan, Belize.

Teltser, Patrice A.
1991 Generalized Core Technology and Tool Use: A Mississippian Example. *Journal of Field Archaeology* 18(3): 363-375.

Titmus, Gene L. and James C. Woods
2003 The Maya Eccentric: Evidence for the Use of the Indirect Percussion Technique in Mesoamerica from Preliminary Experiments Concerning their Manufacture. In *Mesoamerican Lithic Technology: Experimentation and Interpretation*, edited by Kenneth G. Hirth, pp 132-246. University of Utah Press, Salt Lake City.

VandenBosch, Jon C.
1999 *Lithic Economy and Household Interdependence among the Late Classic Maya of Belize*. PhD Dissertation, Department of Anthropology, University of Pittsburgh, Pittsburgh, PA.

VandenBosch, Jon C., Lisa J. LeCount, and Jason Yaeger
2010 Integration and Interdependence: The Domestic Chipped Stone Economy of the Xunantunich Polity. In *Classic Maya Provincial Polities: Xunantunich and its Hinterlands*, edited by Lisa J. LeCount and Jason Yaeger, pp 272-294. University of Arizona Press, Tucson.

Vaquero, Manuel and Francesca Romagnoli
2018 Searching for Lazy People: The Significance of Expedient Behavior in the Interpretation of Paleolithic Assemblages. *Journal of Archaeological Method Theory* 25: 334-367.

Whittaker, John
2019 Stone Age Economics: Efficiency, Blades, Specialization, and Obsolescence. In *Global Perspectives on Lithics in Complex Societies,* Rachel A. Horowitz and Grant S. McCall eds., pp 229-244. University of Colorado Press, Boulder.

Whittaker, John, Kathryn Kamp, and Emek Yilmaz
2009 Cakmak Revisited: Turkish Flintknappers Today. *Lithic Technology* 34(2): 93-110.

Whittaker, John C. Kathryn A. Kamp, Anabel Ford. Rafael Guerra, Peter Brands, Jose Guerra, Kim McLean, Alex Woods, Melissa Badillo, Jennifer Thornton, and Zerifeh Eiley
2009 Lithic Industry in a Maya Center: An Axe Workshop at El Pilar, Belize. *Latin American Antiquity* 20(1): 134-156.

Woods, James C. and Gene L. Titmus
1996 Stone on Stone: Perspectives on Maya Civilization from Lithic Studies. In *Eighth Palenque Round Table, 1993. The Palenque Round Table Series*, Vol 10, edited by Merle Green Robertson, Martha J. Marci, and Jan McHargue, pp 479-489. Pre-Columbian Art Research Institute, San Francisco.

Yaeger, Jason
2000 *Changing Patterns of Social Organization: The Late and Terminal Classic Communities at San Lorenzo, Cayo District, Belize*. PhD Dissertation, Department of Anthropology, University of Pennsylvania, Philadelphia, PA.
2010 Commodities, Brands, and Village Economies in the Classic Maya Lowlands. In *Cultures of Commodity Branding*, edited by Andrew Bevan and David Wengrow, pp 167-195. Left Coast Press, Walnut Creek.

Yerkes, Richard W.
2000 Ethnoarchaeology in Central Cyprus: Interdisciplinary Studies of Ancient Population and Agriculture by the Athienou Archaeological Project. *Near Eastern Archaeology* 63(1): 20-34.