

# Social Complexity and the Bow in the Eastern Woodlands

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Bingham and Souza<sup>1</sup> have presented an evolutionary theory that specifies a causal relationship between the advent of powerful projectile weapons such as the bow and radical rearrangements in social relations and histories. They propose that the acquisition of weapons that permitted humans to kill at ever-increasing distances provided the coercive means to suppress conflicts of interest among nonkin, self-interested individuals in social groups, thus paving the way for greater social complexity. An unprecedented reduction in projectile point size identifies the arrival of the bow *ca.* A.D. 300 in the Eastern Woodlands of North America, which initiated a causal chain of cultural changes. In the Midwest, the bow, combined with food production, precipitated the decline of Hopewell by conferring household autonomy and dispersal, which at first suppressed social complexity, but later created conditions favorable to maize intensification. In the lower Southeast, where food production was unimportant, populations aggregated at concentrated wild-food sources, and the bow did not confer household autonomy. The relationship between the bow and social complexity varied under different environmental, social, and historical conditions.

## IDENTIFICATION AND CHRONOLOGY OF THE BOW

Motivated by Bingham and Souza's provocative theory, we revisited the relationship between social

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complexity and the bow in the Eastern Woodlands. The first step was to reexamine bow identification and chronology. In the absence of bow or arrow remains, adoption of the bow can be detected in the archeological record by a reduction in the size of projectile points, since arrow points are smaller and lighter than atlatl dart points. The point size-reduction claim is not controversial, supported as it is by ethnographic data.<sup>2</sup> It is widely accepted that small triangular and triangular-notched projectile points identify the bow in the Eastern Woodlands at *ca.* A.D. 600.<sup>3</sup> Surprisingly, there are few systematic studies of the bow identification problem in the Eastern Woodlands, and none that we could find for the central Southeast.<sup>4–6</sup> In measurements of ethnographically known arrow points and dart points, thickness, weight, and especially shoulder width have proven to be the measurements that best separate atlatl dart points from arrow points.<sup>2,6</sup> A shoulder width of >2 cm is

recognized as an important threshold for the metric discrimination of dart and arrow points.<sup>6</sup>

We examined the point-size reduction claim by measuring the shoulder (maximum) width, weight, and thickness of 922 hafted bifaces (a functionally neutral term for flaked-stone artifacts that are projectile points/knives) from 33 locations in northern Alabama and Mississippi. Twenty morphological types with established age ranges were used to place the sample in a relative chronological order spanning ten millennia. Our regional sample shows a significant decrease in biface width, weight, and thickness late in the sequence. Also, these biface attributes become significantly less variable than they are earlier in the sequence. For biface shoulder width, the significant size-reduction threshold occurred with the Copena type to Baker's Creek type transition, when mean shoulder width dropped below 2 cm for the first time in the ten-thousand-year sequence (Fig. 1). The significant weight reduction threshold also occurred at this transition, but the significant thickness threshold occurred a few centuries later, with the appearance of the last two types in the sequence, Jack's Reef and Hamilton/Madison, which are narrow, lightweight, and very thin.

Based on these results, we identify the shoulder width and weight reduction threshold between Copena and Baker's Creek types as marking the initial adoption of the bow. The radical reduction of thickness in the last two types indicates a refinement of bow technology. We consider all 15 of the hafted biface types on the

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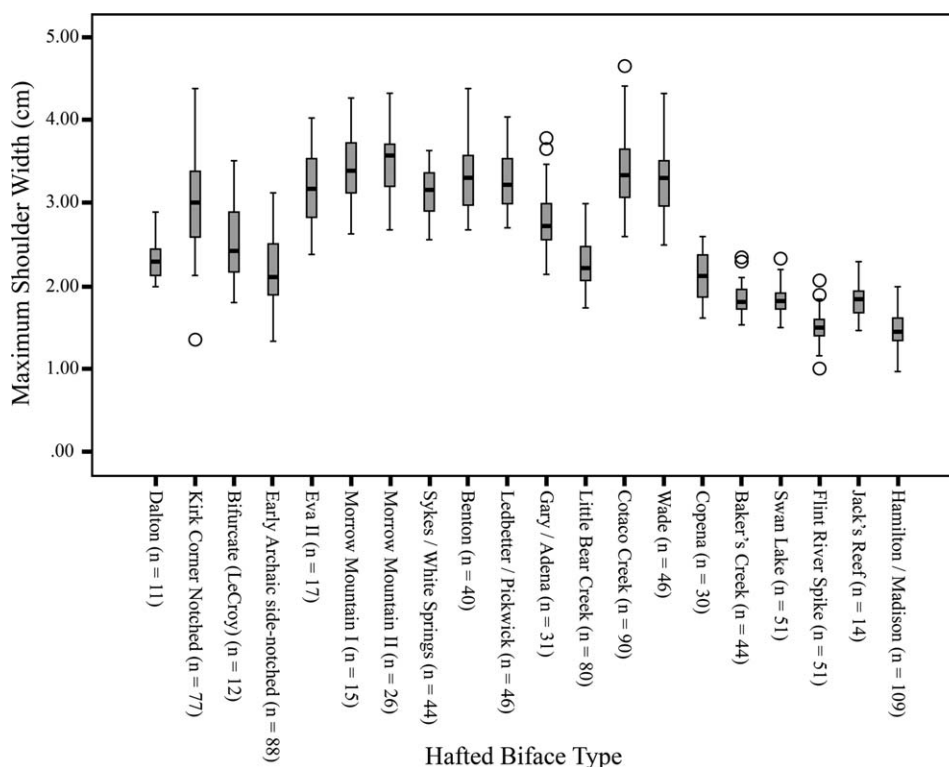


Figure 1. Box-and-whisker plots of shoulder width for 20 hafted biface types ( $n = 922$ ) arranged from oldest (Dalton) to most recent (Hamilton/Madison). Circles are outliers.

older side of the size-reduction threshold to be dart points and/or multi-use implements such as knives or spear points, and the five types on the late side of the threshold to be arrow points. We identify Baker's Creek, Swan Lake, and Flint River Spike types as early arrow points (A.D. 300–600) and the Jack's Reef and Hamilton/Madison types as late arrow points (A.D. 600 to the 1700s). Unlike the 15 multi-purpose projectile points or knives, which often show extensive reworking, the arrow points are far less variable in width, weight, and thickness because they are special-purpose tools; they were made narrow, light, and thin-to-tip arrows and they stayed that way throughout their use life (Fig. 2).

Our reevaluation of bow identification and chronology places the initial appearance of early arrow points at A.D. 300–400, three centuries prior to the conventionally accepted dating for the adoption of the bow. The significance of this size-reduction threshold has been overlooked by placing too much emphasis on

variation within types and not enough on the powerful and pervasive patterns evident when the entire chronological continuum of hafted biface morphology in a regional sample is compared. However, we are not alone in detecting the beginning of the hafted biface down-sizing trend at the end of the Middle Woodland period.<sup>6</sup> While the purpose of our regional sample study was to identify when the bow appeared, the results support certain predictions about how variation in projectile point morphology should change in response to the transition from atlatl to bow. In particular, the results support the predictions that the magnitude of variation in attributes of early arrow points will initially be great at the time of bow adoption as users experiment and modify dart points to accommodate the new technology, but that, through time, the magnitude of variation will decrease as selection eliminates attributes that are less effective, resulting in the size-reduction trend of the late arrow points.<sup>7,8</sup>

Hafted bifaces identical or similar to our regional sample types appear in the same relative order throughout the Eastern Woodlands. For this reason, the bow identification and chronology pattern we see in our sample is comparable to adjacent regions of the Midwest and Southeast, although the timing of the appearance of specific types varies north to south, as we will discuss. What is important here is the irreversible size-reduction trend that establishes the presence of the bow and the causal relationships between bow technology and social complexity. Beginning A.D. 300–400, the bow replaced the atlatl in most regions, the extensive exchange of nonlocal materials known as the Hopewell Interaction Sphere was discontinued, and the associated burial-mound ceremonialism declined. Subsequently, at variable rates in different locales, but nevertheless as a persistent trend, there was intensification and broadening of the use of wild-food resources, increased cultivation of crops, radical changes in settlement patterns, larger sedentary communities, growth in

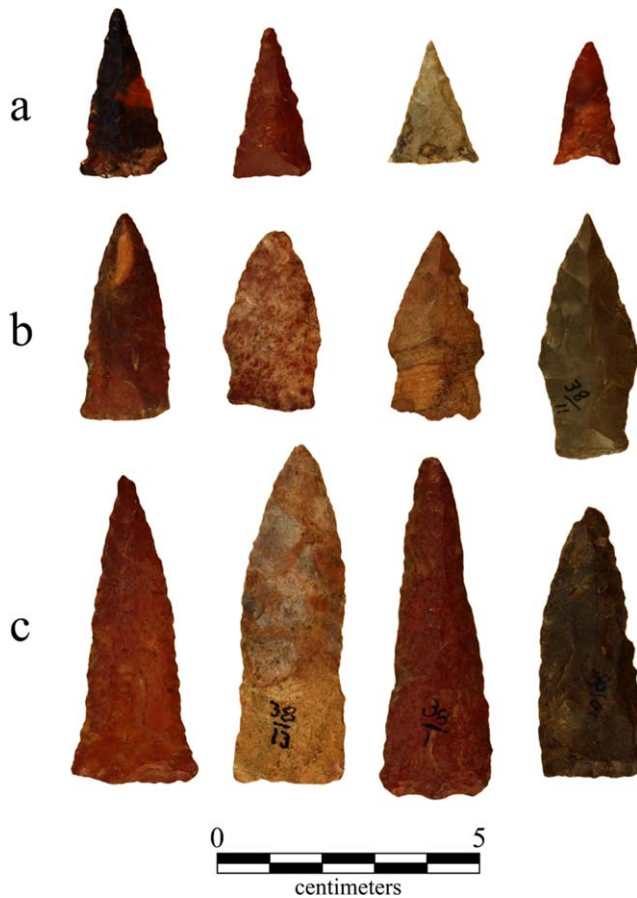


Figure 2. Projectile points: a, late arrow points (Hamilton/Madison type); b, early arrow points (Baker's Creek type); c, dart points (Copena type). (Color figure can be viewed in the online issue, which is available at [wileyonlinelibrary.com](http://wileyonlinelibrary.com).)

regional populations, and more visibility in the archeological record of intergroup violence. The bow was central to these changes, but the causes and consequences are complex, variable across time and space, and best understood if we compare and contrast the Midwest and interior Upland South with the Lower Mississippi Valley and Gulf Coastal Plain during three sequential time spans of the Late Woodland period.

### THE BOW AND DECLINE OF HOPEWELL (A.D. 300–600)

#### Midwest and Upland South

Early arrow points coincide with the transition from the Middle Woodland to Late Woodland period, the decline of the Hopewell Interaction Sphere, and the widespread abandonment of ceremonial mound centers. Middle Woodland dart

points (Copena, Snyders types) served as the preforms or prototypes for early arrow points, accomplished by a reduction in width (Spike Cluster types) and alteration of the hafting element into an expanded stem (Lowes Cluster types) to create smaller points.<sup>9</sup> This adaptation of a traditional stone tool to fit a new weapon implies an indigenous response to contact with initial bow technology rather than a complete borrowing of an alien lithic technology. Some investigators view the projectile point size-reduction trend as the result of a gradual transition from atlatl to bow in this region,<sup>6</sup> and the Copena dart-point prototype has been found to co-occur with the Baker's Creek early arrow-point type.<sup>9</sup> Nevertheless, adoption of the bow must have been relatively rapid because dart points disappear from the archeological record in the Midwest and Upland South with the

appearance of the early arrow types. We interpret the projectile point size-reduction trend during this interval as the result of alterations to dart-point prototypes to accommodate use with bows rather than a long interval when both bow and atlatl were in use. While alteration of dart points could be viewed as evidence of independent invention of the bow, this is unlikely for the Eastern Woodlands because Middle Woodland peoples had access to resources in the Mountain West (obsidian, grizzly bear teeth) where the bow was in prior use.<sup>3</sup>

Theories of the Hopewell decline are based on the premise that periodic rituals at ceremonial centers episodically occupied by dispersed groups insured access to needed resources through maintenance of alliance-exchange relationships.<sup>10</sup> An early explanation for the Hopewell decline identified adoption of the bow as the facilitator of warfare, which severed the alliance-exchange networks and led to collapse of the associated ceremonialism.<sup>10</sup> This theory fell into disfavor due to the lack of evidence of warfare and the prevailing view that the bow, identified by the small triangular points which we now designate as late arrow points, appeared too late in time for this scenario.<sup>3</sup> A current theory for the decline proposes that increased production of native seed crops led to greater household subsistence autonomy, freeing families of the need for periodic aggregation at mound centers to maintain the food-sharing alliances that buffered risk of shortages.<sup>10</sup> If we factor in the adoption of the bow, then household subsistence autonomy was increased still more because the bow is twice as accurate as the atlatl (Bettinger, this issue) and reduced the need for large-group game drives. That the bow increased hunting efficiency is supported by faunal remains, at least from some sites, suggesting greater emphasis on smaller, fast-moving prey.<sup>10</sup> The new subsistence autonomy stimulated a settlement shift away from major river floodplains to interfluvial uplands and prairie areas.<sup>10</sup> No longer tethered to floodplains with the

greatest abundance of wild foods, the bow and a commitment to horticulture allowed groups to settle in marginal ecosystems that had been used for temporary purposes.

### Lower Mississippi Valley and Gulf Coastal Plain

During this interval, populations in the Lower Mississippi Valley and portions of the Gulf Coastal Plain took a different historical path. Population aggregation at ceremonial mound centers and group mortuary facilities continued, but instead of nonlocal exchange networks, intensification of local wild food resources and feasting was emphasized.<sup>11</sup> Most mound centers are quite small and there is little evidence of any significant social ranking or hierarchy.<sup>11</sup> Unlike the Midwest and Upland South, cultivation of native seed crops was unimportant.<sup>11,12</sup> Early arrow points are present (Baker's Creek type, plus regional variants that are morphological equivalents to our sample types). As in the north, an indigenous dart-point prototype (Gary type) was reduced in size for use with the bow without radical change to the lithic tradition. However, in contrast to the Midwest and Upland South, the continued presence of larger hafted bifaces in some locales suggests that the atlatl was still in use.<sup>4</sup>

In sum, we have two different regional responses to the Hopewell decline: in the north, replacement of the atlatl with the bow, abandonment of ceremonial centers, resettlement in new locales, and dependence on native seed crops and, in the southernmost regions, use of both bow and atlatl, continuity of ceremonial centers and settlement, and rejection of food production. These divergent cultural practices may be explained, in part, by the relative importance of the bow under different conditions of climate and wild food availability, specifically, the "Caldwell effect."<sup>12</sup>

### THE BOW, THE "CALDWELL EFFECT," AND MAIZE INTENSIFICATION (A.D. 600–800)

If we are correct that the bow was available and in use throughout the

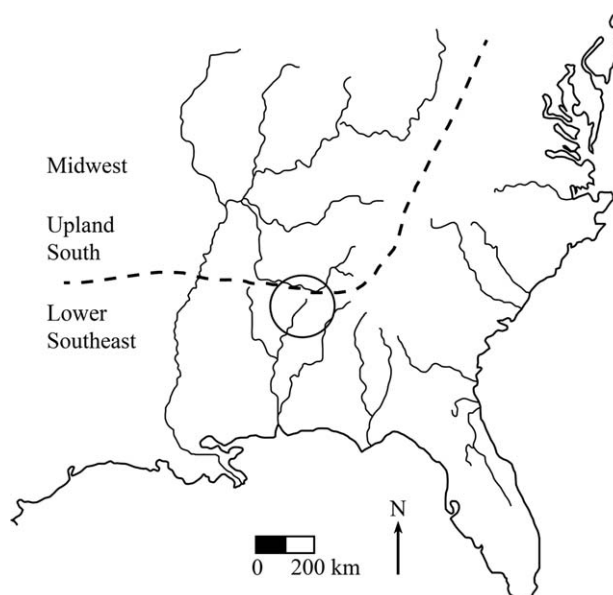


Figure 3. Map of Eastern Woodlands. Regions north of the dash line have >60 days of below-freezing temperatures. The circle marks the location of the hafted biface sample.

Eastern Woodlands by A.D. 300–400, and that it was a factor in the Hopewell decline, why were mound centers abandoned in the Midwest and Upland South when they continued to be used in the Lower Mississippi Valley and Gulf Coastal Plain? Part of the answer is found in the costs and benefits of food production in different environments (Fig. 3). Gremillion<sup>12</sup> found that Woodland period sites in northern areas with >60 days of below-freezing temperatures produced evidence of dependency on native seed crops, while sites in southern areas with <50 days of below-freezing temperatures lacked evidence of premaize farming.<sup>12</sup> Colder areas have pronounced annual fluctuations in natural plant foods, making investment in seed crops as a storable surplus to prevent winter food shortages a cost-effective subsistence strategy.<sup>12</sup> This finding supports Caldwell's "primary forest efficiency" proposal that the greater economic benefits of concentrated wild foods such as nuts, fish, and shellfish precluded the labor-intensive development of premaize farming in the warmer areas of the lower Southeast,<sup>13</sup> or the "Caldwell effect."<sup>12</sup> The absence of food production in the lower Southeast promoted the continuity of large-group

efforts at mass-collecting aquatic resources and nut foods, and not the small-group subsistence autonomy of bow hunters and seed-crop producers of the Midwest and Upland South. Consequently, the highest population densities and the largest sites in the lower Southeast were in the areas of greatest natural food concentration, especially the Lower Mississippi Valley and adjacent coastal zones.<sup>11</sup> What was the effect of bow technology in these different social and natural environments?

### Midwest and Upland South

Late arrow points appeared *ca.* A.D. 600 and a rapid replacement of early arrow points occurred.<sup>3,10</sup> This transition to small, thin, triangular or triangular corner-notched points has long been accepted as evidence of the bow, but variation in the morphology of late arrow point types suggest that this transition was governed by social and historical factors that varied across these regions. For example, Jack's Reef Corner-Notched, a late arrow-point type, represents a further indigenous refinement of the expanded-stem early arrow prototypes (Baker's Creek and other Lowes Cluster types), which in turn were derived from the Middle Woodland



Snyders dart-point type.<sup>9</sup> This lineage of morphological types supports the gradualist interpretation of an *in-situ* selection process that reduced variation in arrow point attributes.<sup>7,8</sup> However, another late arrow point form, the triangular Hamilton/Madison type, has no obvious indigenous prototypes or transitional forms in the Midwest and Upland South. Instead, the Hamilton/Madison type is the Eastern Woodlands variant of morphologically similar arrow points (that is, Fresno type) in use farther west at an earlier date and probably derived from that source.<sup>9</sup> In this case, selection was for rapid technological replacement rather than incremental refinement of regional prototypes.<sup>3</sup>

It is possible that late arrow points accompanied a more advanced bow technology, but there is no necessary relationship between the form of the arrow point and the type of bow.<sup>6</sup> However, the innovation of fletching may explain the changes. Experimental studies show that the addition of fletching increases accuracy by flattening the trajectory of the arrow, but it also decreases velocity.<sup>14</sup> This problem is avoided by a corresponding decrease in arrow-point weight or thickness, which is the significant metric distinction between early and late arrow points. The desire for lighter, thinner arrow points may also explain a radical change in lithic technology, present in the north, but particularly prevalent in the south, from flake-tool production to expedient core-tool production.<sup>4</sup> The shift to expedient core-tool production, common in late prehistory throughout North America, made use of poor-grade stone and small gravels, and has been interpreted as a cost-benefit response to sedentism.<sup>15</sup> Recently, the sedentism explanation for the shift to core-tool production has been challenged in a detailed case study that attributes the change specifically to production of arrow points.<sup>16</sup>

No satisfactory explanation has been provided for a major puzzle of Eastern Woodlands social evolution: Why is there a time lag between the first appearances of maize at *ca.* A.D. 100 and the beginning of maize intensification *ca.* A.D. 800?<sup>10,11</sup> We

propose that the household autonomy and territory expansion made possible by the bow and native seed crops not only contributed to the Hopewell decline, but established the conditions favorable to maize intensification. Continued population growth, sustained by the increased yields of bow hunting and native seed crops, packed the landscape with settlements.<sup>10</sup> Resource areas previously used as temporary foraging sites were now occupied by groups armed with the bow. For the first time, there is evidence, in the form of group and individual burials with embedded arrow points,<sup>10</sup> of the bow as the primary weapon of intergroup violence. Population growth, reduced access to resources, sedentism, and the desire to avoid

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conflict made the high costs of intensified food production more attractive. Maize had higher yields than native crops, rewarding efforts to get more food from smaller territories.<sup>12</sup> Floodplains again became a focus of settlement.<sup>11</sup> Larger sedentary communities were established, providing an opportunity for a resurgence of corporate groups. Nevertheless, significant social ranking or hierarchy is not evident.<sup>10</sup>

#### **Lower Mississippi Valley and Gulf Coastal Plain**

Late arrow points were slow to disseminate into the southernmost areas, appearing about 100–150 years

later than in the north.<sup>3,4</sup> In contrast to the indigenous artifact lineage of the Jack's Reef Corner-Notched arrow point in the north, when late arrow points appear in the lower Southeast, they are not derived from the early arrow-point types. The Hamilton/Madison late arrow point is present, as it is in the north, as well as several diminutive stemmed types (not represented in the regional study sample). Because none of the late arrow points in the lower Southeast have regional prototypes, it is likely they were introduced from the west via the Great Plains, where similar forms have greater antiquity.<sup>3,4</sup>

The arrival of late arrow points at *ca.* A.D. 700 is coincident with the appearance and proliferation of civic-ceremonial centers with massive earthen mounds and associated sedentary populations.<sup>11</sup> What causal relationship there might be between the bow and the establishment of civic-ceremonial centers in the lower Southeast, if any, has not been established. Populations may have aggregated into larger communities for defense, but mortuary evidence of intergroup violence is absent or minimal. Some civic-ceremonial centers are encircled by earthworks, but it is unclear whether or not these are fortifications, since earthworks may be built to demarcate sacred space. Despite the obvious increase in social complexity indicated by formal arrangements of plazas and mounds, the social order had a corporate cast, with emphasis on feasts and group burials.<sup>11</sup> The clear difference, then, between these southern populations and their northern contemporaries was the presence of large civic-ceremonial centers and a lack of substantial food production. Therefore, the "Caldwell effect" favored continuity of traditional subsistence practices and, consequently, the bow did not confer the degree of household autonomy that it initially did farther north.

#### **THE BOW AND THE RISE OF THE MISSISSIPPIANS (A.D. 800–1000) Midwest and Upland South**

During this interval, native seed crops declined in importance as the

production of maize intensified, making it the staple food crop (except in the northernmost Midwest) that fueled population growth.<sup>10,11</sup> Aggregation into large communities continued and the scale of social integration and differentiation increased. Site plans gained greater internal complexity as houses clustered into courtyard groups and, toward the end of this era, the southern pattern of civic-ceremonial centers with large earthen mounds was established in many places.<sup>10,11</sup> Nucleated settlements may have been a defensive response to bow warfare. Burials with embedded arrow points and sites fortified with palisades and ditches are widespread, although not present everywhere (Milner, this issue). New social roles linked to community defense, organization of labor, and communal storage of maize in secure central places laid the foundation for the increased group differentiation, competition, and hierarchy of the Mississippian period beginning A.D. 1000.

Toward the end of this interval, there is a new diversity of arrow-point forms (not examined in the regional sample study), as several types of small stemmed, notched, and barbed arrow points appear without obvious regional prototypes. These new arrow points have western spatial distributions that overlap with the Great Plains, the probable route of introduction.<sup>3,4,9</sup> Barbed points, which are difficult to extract, may have been intended for humans.

### Lower Mississippi Valley and Gulf Coastal Plain

Unlike in the north, maize and food production remained unimportant or absent, even as population growth and use of the bow characterized both regions.<sup>12</sup> Evidence of warfare is variable and difficult to measure, however, and sites with palisades and ditches mostly date after A.D. 1000. Occupation of civic-ceremonial centers, some quite large, continued unabated, especially in the Lower Mississippi Valley. Although late arrow points are ubiquitous after A.D. 800, the atlatl continued to be used in Gulf coastal regions for the specialized practice of hunting

on open water until historic contact.<sup>3,4</sup>

There was a resurgence of exchange networks for nonlocal resources, notably marine shell, which linked populations north and south.<sup>10,11</sup> Production of marine shell beads was greatly intensified in various locales toward the end of this era, further expanding the spatial networks of social integration while providing a valuable that could be manipulated to increase wealth, economic competition, and social differentiation. The scale of shell-bead production far exceeds that in previous eras, which leads us to propose that bow technology generated another innovation, the bow drill, which provided a more rapid and efficient means of converting hard shell into beads.

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### CONCLUSIONS

The archeological evidence reviewed here provides a means to evaluate the proposition that adoption of the bow was the primary causal factor for increased social complexity in the Eastern Woodlands. As proposed in the introduction to this issue, there are two competing theories about the relationship between the bow and social complexity, each with predictable effects that can be detected in the archeological record. Bingham and Souza's social coercion theory proposes that improved weaponry such as the bow provided a cost-effective

means of suppressing conflicts of interest among nonkin within social groups and caused a rapid increase in social complexity and economic intensification within communities. Archeological evaluation of the social coercion theory requires that initial evidence of the bow correlate with evidence of social complexity and intensification, such as increased sedentism, larger sites, or civic-ceremonial centers. Alternatively, warfare theory could also explain a relationship between the bow and social complexity, predicting that a local introduction of the bow conferred a military advantage to those groups who adopted it, with a corresponding escalation in intercommunity warfare that caused increases in social complexity and economic intensification. Archeological evaluation of the warfare theory requires that initial evidence of the bow correlate with evidence of increased warfare such as fortified sites or significant increases in osteological indicators of violent death from arrows.

Evaluation of the two competing theories is difficult because of the requirement that we place evidence of the bow, social complexity, economic intensification, and warfare in temporal sequence over a large geographical area. Furthermore, the relationship between the bow and social complexity was amplified or diffused by a complex interaction of environmental, social, and historical factors, as can be seen in the different ways social groups responded to the arrival of the bow in the northern and southern regions. We suggest that in the Midwest and Upland South, the bow, paired with native seed crops, hastened the Hopewell decline by providing families with subsistence autonomy and the means to resist the demands of increased complexity. Initially, the immediate social consequence of the bow in the Midwest and Upland South was an increase in economic intensification and a decrease in social complexity as subsistence autonomy permitted families to settle in formerly marginal, low-resource areas. This result, not predicted by either of the two

competing theories, appears to be the consequence of an environment having low resources and low population density. Paradoxically, the expansion of settlement permitted by the bow and native seed crops filled the landscape and reduced the size of resource territories that could be accessed by groups without potential bow warfare with others. This situation created a motivation to further intensify food production by investment in the superior yields of maize, a labor-intensive strategy for getting more food from less territory that made population growth and aggregation into larger settlements both feasible and desirable. It is only in this later interval, following evidence of increased social complexity and economic intensification, that we see any substantial evidence for warfare. Thus, the case can be made that adoption of the bow, paired with native seed crops, created the social conditions that initiated maize intensification, which reversed the earlier trend toward household autonomy and, instead, underwrote the zenith of complexity in the subsequent Mississippian era.

In the lower Southeast, the "Caldwell effect" discouraged food production. Population and aggregation was highest in environments with concentrated wild foods, such as floodplains and estuaries, resources that were easiest to exploit with large-group hunting and collecting techniques. Under these circumstances, increased social integration, intensification of wild-food resources, and ritualized feasting at civic-ceremonial centers delivered greater advantages to families than did independence, even after adoption of the bow. Unlike the Midwest and Upland South, ceremonial centers in the lower Southeast continued into the Late Woodland period. Later, large

civic-ceremonial towns rapidly replaced nonresidential ceremonial centers with the arrival of late arrow points *ca.* A.D. 700. Although its effects are difficult to evaluate directly, the bow may have furthered social complexity at civic-ceremonial towns in the manner suggested by Bingham and Souza,<sup>1</sup> as a communal means to enforce cooperation, a potential solution to the social problem presented by the need to integrate nonkin in sedentary communities of unprecedented scale. As is the case with regions farther north, substantial evidence of warfare in the lower Southeast appears after the evidence of increased social complexity.

We conclude that the evidence of a relationship between the bow and social complexity is a better fit with the predictions of social coercion theory than with the predictions of warfare theory. In the Eastern Woodlands, the bow was a catalyst for the important social transformations of the Late Woodland period and a prerequisite for accelerating social complexity. The contrasting social impact of the bow in northern and southern regions supports Bettinger's observation (this issue) that acquisition of the bow could, under different circumstances, propel societies toward either integration and hierarchy or dispersal and anarchy. Circumstances change, however, and dispersal and anarchy as means to resist hierarchy were not sustained in most of the Eastern Woodlands, where the long-term trend was increased population aggregation and greater social complexity.

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